Appendix E

ADDENDUM ENGINEERING DESIGN & IMPACT STATEMENT FOR

BASEMENT DEVELOPMENT

at

59 Goldhurst Terrace

London

NW6 3HB

02nd November 2018

By

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6447-DS01		DRAFT – For planning ONLY	18/12/2018
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1.0 Executive Summary

1.1 The proposed development will be formed underneath the footprint of the existing house using a traditional 'hit-and-miss' underpinning sequence. Once complete, these underpin will form a reinforced 'concrete box' basement. Where the basement extends outside the footprint of the existing house, the small light-wells will be formed using a reinforced concrete 'ring beam' at the top of the light-well. This will then be underpinned, as for the main house.

1.2 Heave protection will be required to the basement slab to mitigate uplift pressure. Void formers will be used under the basement slab to mitigate the effects of heave. In line with common practice, preliminary heave force will be taken as 70% of the overburden pressure.

1.3 With good workmanship and adherence to the prescribed methodology, we believe the risk of structural damage to No. 59 Goldhurst Terrace (BO) from the basement construction should not exceed 'slight' (*Category 2, Table 6.4 of CIRIA C760*).

1.4 With good workmanship and adherence to the prescribed methodology, we believe the risk of structural damage to No. 57 Goldhurst Terrace (AO1) from the basement construction should not exceed 'slight' (*Category 2, Table 6.4 of CIRIA C760*).

1.5 With good workmanship and adherence to the prescribed methodology, we believe the risk of structural damage to No. 61 Goldhurst Terrace (AO 2) should not exceed 'very slight' (*Category 1, Table 6.4 of CIRIA C760*).

1.6 With good workmanship and adherence to the prescribed methodology, we believe the risk of structural damage to No. 8 Marston Close (AO 3) from the basement construction should not exceed 'negligible' (Category 0, Table 6.4 of CIRIA C760)

1.7 The structural aspects of the proposal are consistent with industry best practice and in keeping with the broad principles of *London Borough of Camden's Guidance for Subterranean Development Issue 01 18th November 2010* .

1.8 This report is an addendum to Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352 and cannot be considered in isolation.

2.0 Brief

2.1 Pole Structural Engineers were appointed by Ashton Bennett Engineering Geologists and Environmental Specialists to provide advice on the structural aspects of the proposed basement development at No. 59 Goldhurst Terrace (BO) London, NW6 3HB.

2.2 Based on the proposed Architectural scheme by Etch Design Ltd., Pole Structural Engineers have produced a structural scheme and outline construction methodology.

2.3 This report describes the general proposal, the structural feasibility, temporary and permanent works, the assumed sequence of construction and the expected impact on existing structures ONLY.

2.4 This is an addendum report and not a stand-alone document. It can only be considered when reading in conjunction with the overarching Basement Impact Assessment document; Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352.

2.5 This report is based on the broad principles outlined in the *London Borough of Camden's Guidance for Subterranean Development Issue 01 18th November 2010* ..

2.6 Alan Baxter's *Residential Basement Study Report (December 2012)* states that 'A Chartered Structural or Civil Engineer must be retained to detail the structural works, review the contractor's proposal, method statements and temporary works proposals and monitor the construction.' Pole Structural Engineers would, of course, be happy to provide this service following the planning stage, by separate agreement.

3.0 Site Description

Figure 1 - Approximate position of the proposed basement in relation to neighbouring structures

3.1 From British Geological Society drift maps, the general ground conditions are expected to be London Clay weathering to silty clay.

3.2 The site at No. 59 Goldhurst Terrace (BO) is occupied by a three storey mid-terrace house constructed in the Victorian period, circa 1894.

3.3 No. 59 Goldhurst Terrace (BO) is part of the row of terrace with roughly ten number of Victorian houses, front facing onto Goldhurst Terrace.

3.4 The site is gently sloping, falling from North to South (i.e. left to right when viewing from the front on Goldhurst Terrace).

3.5 We understand that these properties are generally built using the traditional construction of solid brick external walls with suspended timber floors at upper floors and in all probability a concrete ground floor. The existing roof profile is a pitch roof timber roof structure.

3.6 We understand that the existing house at No. 59 Goldhurst Terrace (BO) does not have a basement. However, from our site visit observation, we noted there is a small underground passage linking from front to rear, which would have provided an external access in the past. We have no access to this private passage as it was blocked during our site inspection.

3.7 Apart from this underground passage, we have not been made aware of any specific buried obstructions / hazards such as historic river courses and underground infrastructure, including utilities services, drains, tunnels, etc.

3.8 During our site visit, we have only access to the ground floor rear garden flat. We understand that there are eight numbers of other flats in the same property which we have no access to.

3.9 We have not been provided with any record drawings or information on the existing structure or past alterations.

3.10 We have not been made aware of any conservation requirements pertaining to the development or adjacent properties.

3.11 When viewed from the road, No. 59 Goldhurst Terrace (BO) is flanked by No. 57 Goldhurst Terrace (AO1) on the left-hand side and No. 61 Goldhurst Terrace (AO 2) to the right.

3.12 To the rear of No. 59 Goldhurst Terrace (BO), there are no significant structures for a considerable distance on No. 8 Marston Close (AO 3).

3.13 Both properties at No. 57 Goldhurst Terrace (AO1) and No. 61 Goldhurst Terrace (AO 2) were constructed as part of the row of terrace in the same period of construction. Similar to No. 59 Goldhurst Terrace (BO), these properties are also three storeys mid-terrace with masonry wall construction.

3.14 We are not aware of any existing basement to No. 57 Goldhurst Terrace (AO1), or any current planning applications that may be impacted by the proposed basement development.

3.15 From the Planning records, we understand that No. 61 Goldhurst Terrace (AO 2) already constructed a basement along almost the full length of the Party Wall. (Based on Planning Application ref. no. 2014/2046/P). We are not aware of any current planning applications that may be impacted by the proposed basement development.

3.16 We are not aware of any existing basement to No. 8 Marston Close (AO 3), or any current planning applications that may be impacted by the proposed basement development.

4.0 Summary of Geological, Hydrological, Hydrogeological and Arboricultural Conditions

4.1 The following is a brief summation of the relevant findings in reports by others only. It is included here for background only and the referenced reports must be considered in their entirety. Refer to Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352.

4.2 The ground conditions are generally made ground overlying London Clay.

4.3 The allowable bearing pressure at low (basement) level will be less than 120kPa as per Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352.

4.4 Heave protection will be required to the basement slab to mitigate uplift pressure. Void formers will be used under the basement slab to mitigate the effects of heave.

4.5 Groundwater was not encountered drilling, and was encountered between 2.46m and 2.79m below ground level during monitoring as per Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352. The basement should be designed for a maximum hydrostatic head of 1.0m BGL as per BS8102:2009.

4.6 The ground conditions have been identified as Design Sulphate Class 2 (DS-2), corresponding to an Aggressive Chemical Environment for Concrete of 2 (ACEC-2). This requirement is explained in more detail in the later technical section.

4.7 No arboricultural report was provided to Pole Structural Engineers.

5.0 Functional requirements of the proposed development (Architectural)

5.1 The proposed development is outlined in Etch Design Ltd. planning drawings;

- ✓ ED/59GT/302 - Proposed First, Second & Third floor Plans;
- ✓ ED/59GT/303 - Proposed Ground & Basement floor Plans;
- ✓ ED/59GT/305 - Proposed Roof Plan;
- ✓ ED/59GT/402 - Proposed Elevation & Section 1-1
- ✓ ED/59GT/4002 - Proposed Elevation & Section 2-2
- ✓ ED/59GT/4004 - Proposed Section 1-1

5.2 The proposal is to construct a single storey basement extension directly under the existing footprint of the house. The basement will be overlain by a part terrace and additional ground floor living space.

5.3 The basement will be generally rectangular in shape with stepped access to the garden directly from the basement. The basement extends under the existing house to the rear extension.

5.4 The new basement will be founded at approximately 3.5 meters below the existing ground level which will achieve an internal floor-to-ceiling height of approximately 2.5 meters.

5.5 The retaining structures are to be constructed solely within the site boundaries.

6.0 Grade of water tightness:

6.1 The Architect has advised that the basement is to be a habitable space and so should perform as a ‘Dry environment’ (i.e. Grade 3 level of water tightness in accordance with BS 8102:2009 Code of practice for protection of below-ground structures against water from the ground.)

6.2 The waterproofing system (Type A, Type C or Type A+C) will be specified by the Architect to comply with the requirements of BS 8102:2009.

6.3 Structurally integral protection (Type B) has not been allowed for.

7.0 Functional requirements of proposed the development (Structural)

7.1 This section must be read with reference to the Pole Structural Engineers drawings appended to this report.

7.2 The final basement construction will form a ‘concrete box’, consisting of the reinforced concrete basement floor slab, walls and flooring above. This is a common and robust method of constructing underground structures.

7.3 Lateral earth pressures, including surcharge and hydrostatic loadings; will be resisted by the reinforced concrete retaining walls acting as ‘unpropped cantilevers’.

7.4 Residual heave forces and hydrostatic uplift will be resisted by a reinforced concrete basement slab and beam arrangement. Heave forces will be mitigated by placing void former below the basement slab.

7.5 More detailed information on the design is included in the later section *Basement Design (Technical)*

8.0 Effects on Adjacent Buildings (Structural Only)

8.1 Deflection of the wall - Temporary propping will be used to reduce the expected deflection at the tip of the wall. Deflection of the wall will be controlled by complying with l/d (slenderness) ratios.

8.2 Expected ground settlement - As stated in Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352, "ground movements are in Appendix D of the BIA report".

8.3 Some of the proposed works may require notification under the Party Wall etc. Act 1996. The Client has been notified that is their responsibility to fulfil their obligations of the Act. If at all unsure of what these requirements are, they should contact a Party Wall Surveyor for advice.

8.4 Effect on No. 57 Goldhurst Terrace (AO1):

8.4.1 The Adjoining property along the main house at No. 57 Goldhurst Terrace (AO1) and the proposed development at No. 59 Goldhurst Terrace (BO) shared the Party Wall. The Party Wall will be underpinned using reinforced concrete retaining structure. The lateral soil pressure will be resisted by the new RC retaining walls. Hence, this is within the theoretical zone which some ground movement is expected.

8.4.2 The existing three storey rear addition at No. 57 Goldhurst Terrace (AO1) is approximately 2m away from the boundary and excavation. It is within the theoretical zone in which some ground movement is expected.

8.4.3 Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352 provided ground movement analysis. Refer to Appendix D of their BIA report.

8.4.4 To minimise the potential ground movement, temporary propping is required together with using traditional 'hit-and-miss' underpinning sequences.

8.4.5 With good workmanship, this ground movement is expected to equate any damage to No. 57 Goldhurst Terrace (AO1) should not exceed *'slight' (Category 2, Table 6.4 of CIRIA C760).*

8.5 Effect on No. 61 Goldhurst Terrace (AO 2):

8.5.1 The existing main house and rear extension at No. 61 Goldhurst Terrace (AO 2) already contained a single storey basement. This is along the full length of the proposed development at No. 59 Goldhurst Terrace (BO).

8.5.2 No. 61 Goldhurst Terrace (AO 2) shared the Party Walls with No. 59 Goldhurst Terrace (BO). The proposed basement will extend slightly further (i.e. less than 2.0m in length).

8.5.3 Since No. 61 Goldhurst Terrace (AO 2) already have a full height basement, the proposed excavation will not undermine the existing basement foundation. Hence, this is outside the theoretical ground movement zone.

8.5.4 Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352 provided ground movement analysis. Refer to Appendix D of their BIA report.

8.5.5 The expected level of damage to No. 61 Goldhurst Terrace (AO 2) should not exceed 'very slight' *(Category 1, Table 6.4 of CIRIA C760*).

8.6 Effect on No. 8 Marston Close (AO 3):

8.6.1 The distance in plan between No. 8 Marston Close (AO 3) and the proposed basement development is over 5 times the basement excavation depth. This is outside the theoretical ground movement zone.

8.6.2 The expected level of damage to No. 8 Marston Close (AO 3) should not exceed 'negligible' (Category 0, Table 6.4 of CIRIA C760).

8.6.3 For Ground movement analysis results, refer to Appendix D of Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352.

8.7 The level of expected damage to neighbouring buildings is classified in accordance with CIRCA C760 Guidance on embedded retaining wall design. Table 6.4 form this document is included below for information;

Table 6.4 Classification of visible damage to walls (after Burland et al, 1977, Boscardin and Cording, 1989, and Burland, 2001)

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain, ε_{lim} (%)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0 to 0.05
1 Very slight	**Fine cracks that can easily be treated during normal decoration.** Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05 to 0.075
2 Slight	**Cracks easily filled. Redecoration probably required.** Several slight fractures showing inside of building. Cracks are visible externally and **some repointing may be required externally** to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075 to 0.15
3 Moderate	**The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.** Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5 to 15 or a number of cracks >3	0.15 to 0.3
4 Severe	**Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.** Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted.	15 to 25, but also depends on number of cracks	>0.3
5 Very severe	**This requires a major repair, involving partial or complete rebuilding.** Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	Usually >25, but depends on numbers of cracks	

Notes

1 In assessing the degree of damage, account must be taken of its location in the building or structure.

2 Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

Figure 2 - Table 6.4 from CIRIA C760 Guidance on embedded retaining wall design

9.0 Design of retaining wall and assumptions (Techincal)

9.1 The retaining walls will be designed as ‘un-propped cantilever’, meaning the head deflection is not restrained at the ground floor level at the permanent stage.

9.2 To reduce the potential ground movement and defects to the neighbouring properties, it is suggested that the retaining walls be ‘propped’ at the temporary stage during excavation until the basement slab is cast and cured.

9.3 As the system is propped at the temporary stage, it will be designed to resist at-rest earth pressures (Ko).

9.4 The walls will be designed with the soil parameters described in Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352.

9.5 Void formers will be used under the basement slab to mitigate the effects of heave. In line with common practice, preliminary heave force will be taken as 70% of the overburden pressure.

9.6 The basement slab and walls will be designed to resist a maximum hydrostatic head of 1,0m BGL.

9.7 The retaining walls will be designed for the following surcharges;

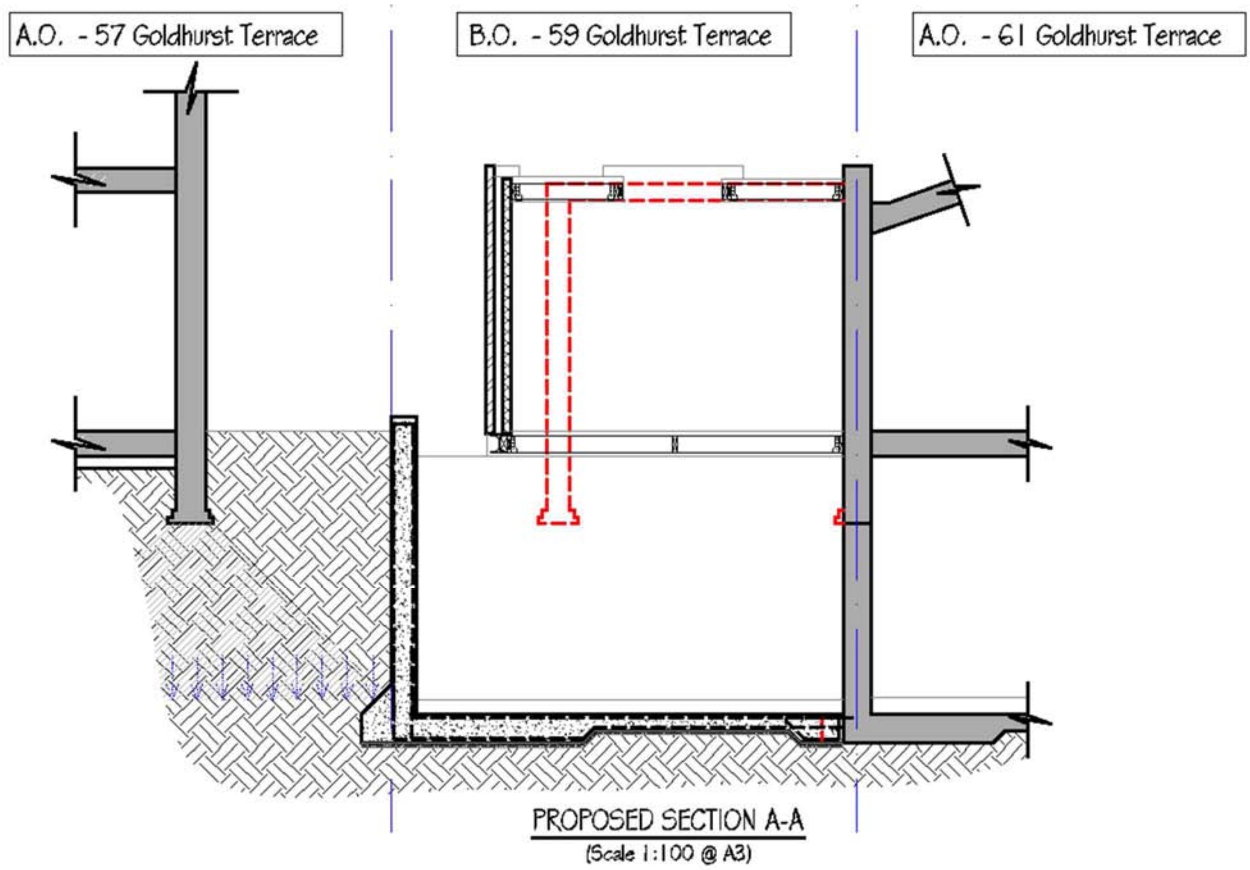
- ✓ Internal live load (e.g. floors) 2.5 kPa
- ✓ External: e.g. gardens, paving 5.0 kPa
- ✓ External: e.g. roadways 10 kPa

9.8 The Party Walls between No. 61 Goldhurst Terrace (AO 2) and the proposed development has been previously underpinned along the full length using reinforced concrete underpinning according to the Planning record drawings. Therefore, the neighbouring buildings’ foundations are not expected to exert any surcharge on the proposed basement.

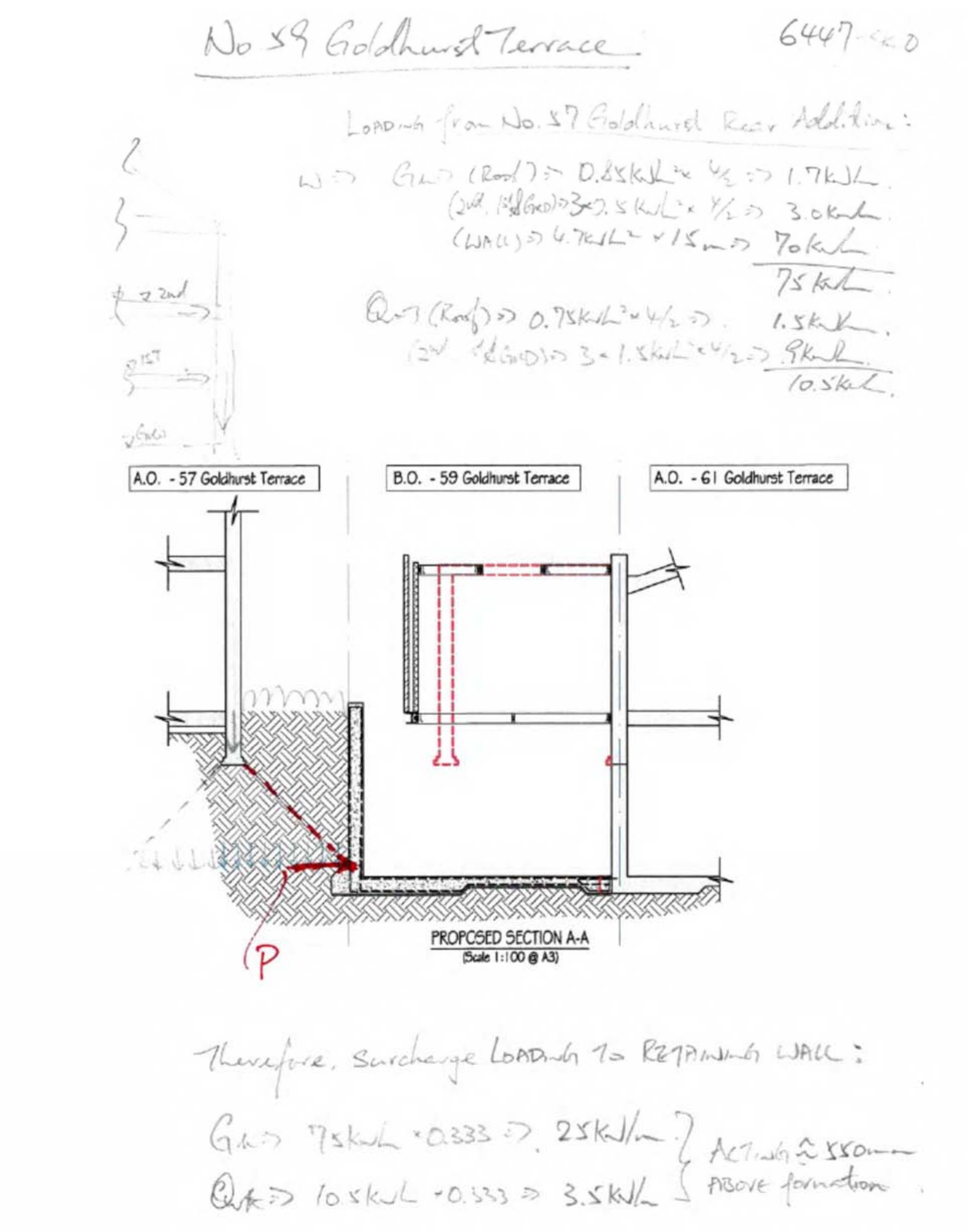
9.9 Since the Party Walls at the main house between No. 57 Goldhurst Terrace (AO1) and the proposed development will be underpinned using reinforced concrete underpinning, the neighbouring buildings' foundations are not expected to exert any surcharge on the proposed basement.

9.10 There is a three storeys rear additions located at No. 57 Goldhurst Terrace (AO1), which is is approximately two meters away from the boundary and the proposed development. Hence, the loading from this neighbouring building foundations will be surcharge onto the new retaining structure.

9.11 This surcharge loadings will only be applied to the lower part of the retaining wall closed to the base level due to the 45 degrees load spreads. See below diagram.



9.12 Below is the preliminary calculations for this surcharge loading:

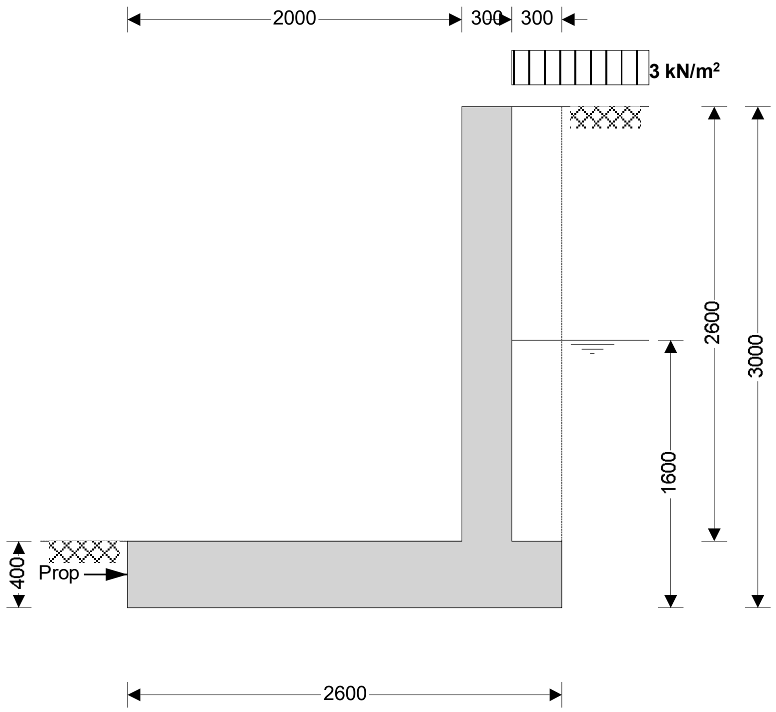


10.0 Calculations for a typical section of retaining wall in temporary and permanent case

Case 1) Permanent Case unpropped cantilever with no vertical loads:

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type;	**Cantilever propped at base**
Height of retaining wall stem;	h_{stem} = **2600** mm
Thickness of wall stem;	t_{wall} = **300** mm
Length of toe;	l_{toe} = **2000** mm
Length of heel;	l_{heel} = **300** mm
Overall length of base;	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **2600** mm
Thickness of base;	t_{base} = **400** mm
Depth of downstand;	d_{ds} = **0** mm
Position of downstand;	l_{ds} = **1100** mm
Thickness of downstand;	t_{ds} = **400** mm
Height of retaining wall;	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **3000** mm
Depth of cover in front of wall;	d_{cover} = **0** mm
Depth of unplanned excavation;	d_{exc} = **0** mm
Height of ground water behind wall;	h_{water} = **1600** mm
Height of saturated fill above base;	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\text{ mm})$ = **1200** mm
Density of wall construction;	γ_{wall} = **23.6** kN/m^3
Density of base construction;	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall;	α = **90.0** deg

Angle of soil surface behind wall; β = **0.0** deg

Effective height at virtual back of wall; $h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **3000** mm

Retained material details

Mobilisation factor; M = **1.5**

Moist density of retained material; γ_m = **19.0** kN/m^3

Saturated density of retained material; γ_s = **21.5** kN/m^3

Design shear strength; ϕ' = **24.2** deg

Angle of wall friction; δ = **18.6** deg

Base material details

Soft clay

Moist density; γ_{mb} = **18.0** kN/m^3

Design shear strength; ϕ'_b = **24.2** deg

Design base friction; δ_b = **18.6** deg

Allowable bearing pressure; $P_{bearing}$ = **100** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.369}$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material; $K_0 = 1 - \sin(\phi')$ = **0.590**

Loading details

Surcharge load on plan; Surcharge = **2.5** kN/m^2

Applied vertical dead load on wall; W_{dead} = **0.0** kN/m

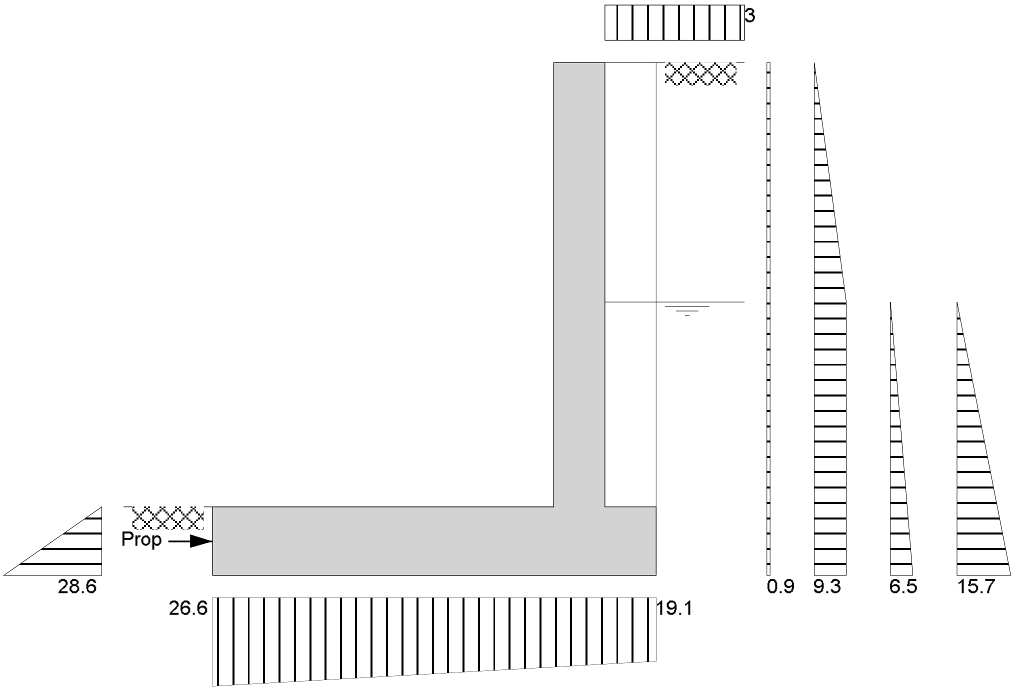
Applied vertical live load on wall; W_{live} = **0.0** kN/m

Position of applied vertical load on wall; l_{load} = **0** mm

Applied horizontal dead load on wall; F_{dead} = **0.0** kN/m

Applied horizontal live load on wall; F_{live} = **0.0** kN/m

Height of applied horizontal load on wall; h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m²

Vertical forces on wall

Wall stem; $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **18.4** kN/m

Wall base; $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **24.5** kN/m

Surcharge; w_{sur} = Surcharge $\times l_{heel}$ = **0.8** kN/m

Moist backfill to top of wall; $w_{m\_w} = l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **8** kN/m

Saturated backfill; $w_s = l_{heel} \times h_{sat} \times \gamma_s$ = **7.7** kN/m

Total vertical load; $W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m\_w} + w_s$ = **59.4** kN/m

Horizontal forces on wall

Surcharge; $F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times$ Surcharge $\times h_{eff}$ = **2.6** kN/m

Moist backfill above water table; $F_{m\_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **6.5** kN/m

Moist backfill below water table; $F_{m\_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **14.9** kN/m

Saturated backfill; $F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **5.2** kN/m

Water; $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **12.6** kN/m

Total horizontal load; $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water}$ = **41.8** kN/m

Calculate propping force

Passive resistance of soil in front of wall; $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **5.7** kN/m

Propping force; $F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur}) \times \tan(\delta_b), 0 \text{ kN/m})$

F_{prop} = **16.4** kN/m

Overturning moments

Surcharge; $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **3.9** kNm/m

Moist backfill above water table; $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 =$ **13.5** kNm/m

Moist backfill below water table; $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2 =$ **11.9** kNm/m

Saturated backfill; $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3 =$ **2.8** kNm/m

Water; $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 =$ **6.7** kNm/m

Total overturning moment; $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water} =$ **38.8** kNm/m

Restoring moments

Wall stem; $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2) =$ **39.6** kNm/m

Wall base; $M_{base} = w_{base} \times l_{base} / 2 =$ **31.9** kNm/m

Moist backfill; $M_{m\_r} = (w_{m\_w} \times (l_{base} - l_{heel} / 2) + w_{m\_s} \times (l_{base} - l_{heel} / 3)) =$ **19.6** kNm/m

Saturated backfill; $M_{s\_r} = w_s \times (l_{base} - l_{heel} / 2) =$ **19** kNm/m

Total restoring moment; $M_{rest} = M_{wall} + M_{base} + M_{m\_r} + M_{s\_r} =$ **110** kNm/m

Check bearing pressure

Surcharge; $M_{sur\_r} = w_{sur} \times (l_{base} - l_{heel} / 2) =$ **1.8** kNm/m

Total moment for bearing; $M_{total} = M_{rest} - M_{ot} + M_{sur\_r} =$ **73** kNm/m

Total vertical reaction; $R = W_{total} =$ **59.4** kN/m

Distance to reaction; $x_{bar} = M_{total} / R =$ **1229** mm

Eccentricity of reaction; $e = abs((l_{base} / 2) - x_{bar}) =$ **71** mm

Reaction acts within middle third of base

Bearing pressure at toe; $p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) =$ **26.6** kN/m^2

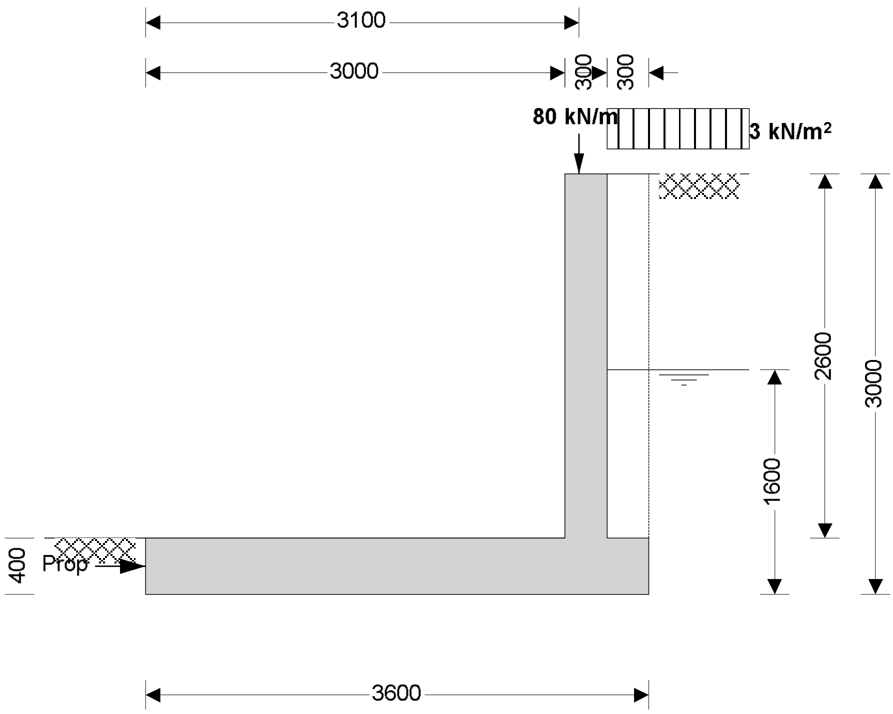
Bearing pressure at heel; $p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) =$ **19.1** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Case 2) Permanent Case unpropped cantilever with vertical loads (MAIN HOUSE):

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type;	**Cantilever propped at base**
Height of retaining wall stem;	h_{stem} = **2600** mm
Thickness of wall stem;	t_{wall} = **300** mm
Length of toe;	l_{toe} = **3000** mm
Length of heel;	l_{heel} = **300** mm
Overall length of base;	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **3600** mm
Thickness of base;	t_{base} = **400** mm
Depth of downstand;	d_{ds} = **0** mm
Position of downstand;	l_{ds} = **1100** mm
Thickness of downstand;	t_{ds} = **400** mm
Height of retaining wall;	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **3000** mm
Depth of cover in front of wall;	d_{cover} = **0** mm
Depth of unplanned excavation;	d_{exc} = **0** mm
Height of ground water behind wall;	h_{water} = **1600** mm
Height of saturated fill above base;	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\text{ mm})$ = **1200** mm
Density of wall construction;	γ_{wall} = **23.6** kN/m^3
Density of base construction;	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall;	α = **90.0** deg
Angle of soil surface behind wall;	β = **0.0** deg
Effective height at virtual back of wall;	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **3000** mm

Retained material details

Mobilisation factor;	M = **1.5**

Moist density of retained material; γ_m = **19.0** kN/m^3

Saturated density of retained material; γ_s = **21.5** kN/m^3

Design shear strength; ϕ' = **24.2** deg

Angle of wall friction; δ = **18.6** deg

Base material details

Soft clay

Moist density; γ_{mb} = **18.0** kN/m^3

Design shear strength; ϕ'_b = **24.2** deg

Design base friction; δ_b = **18.6** deg

Allowable bearing pressure; $P_{bearing}$ = **100** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.369}$

Passive pressure coefficient for base material

$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.187}$

At-rest pressure

At-rest pressure for retained material; $K_0 = 1 – \sin(\phi') = \mathbf{0.590}$

Loading details

Surcharge load on plan; Surcharge = **2.5** kN/m^2

Applied vertical dead load on wall; W_{dead} = **62.0** kN/m

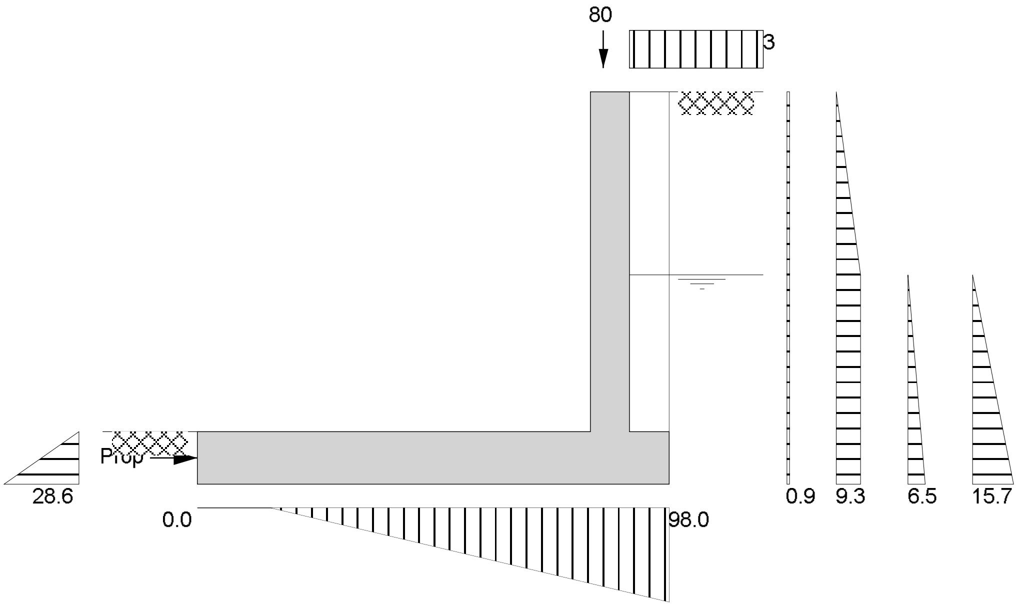
Applied vertical live load on wall; W_{live} = **18.0** kN/m

Position of applied vertical load on wall; l_{load} = **3100** mm

Applied horizontal dead load on wall; F_{dead} = **0.0** kN/m

Applied horizontal live load on wall; F_{live} = **0.0** kN/m

Height of applied horizontal load on wall; h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Vertical forces on wall

Wall stem; $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **18.4** kN/m

Wall base; $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **34** kN/m

Surcharge; w_{sur} = Surcharge × l_{heel} = **0.8** kN/m

Moist backfill to top of wall; $w_{m\_w} = l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **8** kN/m

Saturated backfill; $w_s = l_{heel} \times h_{sat} \times \gamma_s$ = **7.7** kN/m

Applied vertical load; $W_v = W_{dead} + W_{live}$ = **80** kN/m

Total vertical load; $W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m\_w} + w_s + W_v$ = **148.9** kN/m

Horizontal forces on wall

Surcharge; $F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times$ Surcharge $\times h_{eff}$ = **2.6** kN/m

Moist backfill above water table; $F_{m\_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **6.5** kN/m

Moist backfill below water table; $F_{m\_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **14.9** kN/m

Saturated backfill; $F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **5.2** kN/m

Water; $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **12.6** kN/m

Total horizontal load; $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water}$ = **41.8** kN/m

Calculate propping force

Passive resistance of soil in front of wall; $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **5.7** kN/m

Propping force; $F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur} - W_{live}) \times \tan(\delta_b), 0$ kN/m)

F_{prop} = **0.0** kN/m

Overturning moments

Surcharge; $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **3.9** kNm/m

Moist backfill above water table; $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **13.5** kNm/m

Moist backfill below water table; $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2$ = **11.9** kNm/m

Saturated backfill; $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3$ = **2.8** kNm/m

Water; $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3$ = **6.7** kNm/m

Total overturning moment; $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water}$ = **38.8** kNm/m

Restoring moments

Wall stem; $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **58** kNm/m

Wall base; $M_{base} = w_{base} \times l_{base} / 2$ = **61.2** kNm/m

Moist backfill; $M_{m\_r} = (w_{m\_w} \times (l_{base} - l_{heel} / 2) + w_{m\_s} \times (l_{base} - l_{heel} / 3))$ = **27.5** kNm/m

Saturated backfill; $M_{s\_r} = w_s \times (l_{base} - l_{heel} / 2)$ = **26.7** kNm/m

Design vertical dead load; $M_{dead} = W_{dead} \times l_{load}$ = **192.2** kNm/m

Total restoring moment; $M_{rest} = M_{wall} + M_{base} + M_{m\_r} + M_{s\_r} + M_{dead}$ = **365.6** kNm/m

Check bearing pressure

Surcharge; $M_{sur\_r} = w_{sur} \times (l_{base} - l_{heel} / 2)$ = **2.6** kNm/m

Design vertical live load; $M_{live} = W_{live} \times l_{load}$ = **55.8** kNm/m

Total moment for bearing; $M_{total} = M_{rest} - M_{ot} + M_{sur\_r} + M_{live}$ = **385.2** kNm/m

Total vertical reaction; $R = W_{total}$ = **148.9** kN/m

Distance to reaction; $x_{bar} = M_{total} / R$ = **2587** mm

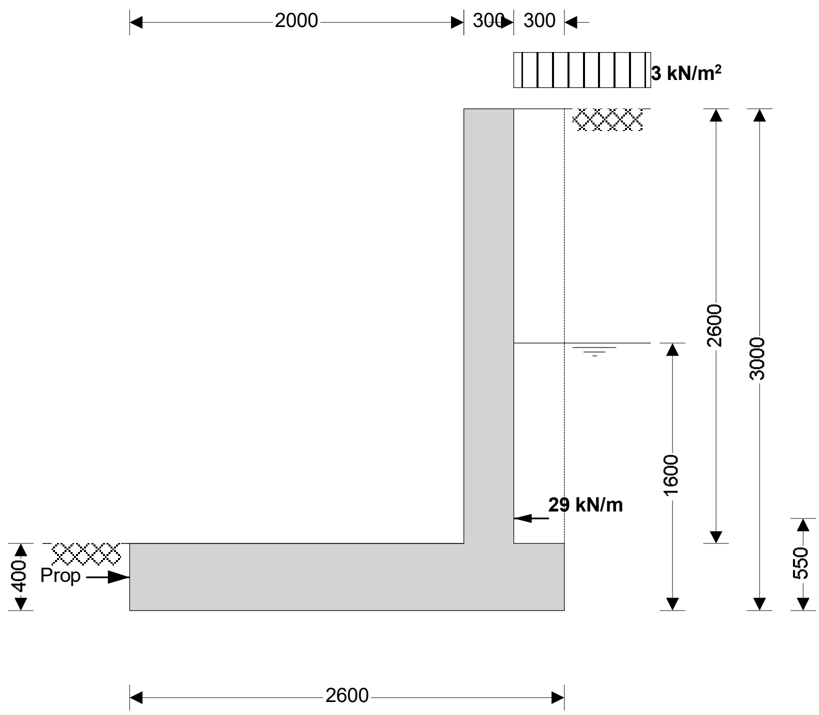
Eccentricity of reaction;	$e = abs((l_{base} / 2) - x_{bar})$ = **787** mm
	Reaction acts outside middle third of base
Bearing pressure at toe;	p_{toe} = 0 kN/m^2 = **0** kN/m^2
Bearing pressure at heel;	$p_{heel} = R / (1.5 \times (l_{base} - x_{bar}))$ = **98** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Case 3) Permanent Case unpropped cantilever with surcharge loadings (ADJACENT TO NEIGHBOUR'S REAR ADDITION):

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type;	**Cantilever propped at base**
Height of retaining wall stem;	h_{stem} = **2600** mm
Thickness of wall stem;	t_{wall} = **300** mm
Length of toe;	l_{toe} = **2000** mm
Length of heel;	l_{heel} = **300** mm
Overall length of base;	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **2600** mm
Thickness of base;	t_{base} = **400** mm
Depth of downstand;	d_{ds} = **0** mm
Position of downstand;	l_{ds} = **1100** mm
Thickness of downstand;	t_{ds} = **400** mm
Height of retaining wall;	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **3000** mm
Depth of cover in front of wall;	d_{cover} = **0** mm

Depth of unplanned excavation;	d_{exc} = **0** mm
Height of ground water behind wall;	h_{water} = **1600** mm
Height of saturated fill above base;	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0 \text{ mm})$ = **1200** mm
Density of wall construction;	γ_{wall} = **23.6** kN/m^3
Density of base construction;	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall;	α = **90.0** deg
Angle of soil surface behind wall;	β = **0.0** deg
Effective height at virtual back of wall;	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **3000** mm

Retained material details

Mobilisation factor;	M = **1.5**
Moist density of retained material;	γ_m = **19.0** kN/m^3
Saturated density of retained material;	γ_s = **21.5** kN/m^3
Design shear strength;	ϕ' = **24.2** deg
Angle of wall friction;	δ = **18.6** deg

Base material details

Soft clay

Moist density;	γ_{mb} = **18.0** kN/m^3
Design shear strength;	ϕ'_b = **24.2** deg
Design base friction;	δ_b = **18.6** deg
Allowable bearing pressure;	$P_{bearing}$ = **100** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.369}$$

Passive pressure coefficient for base material

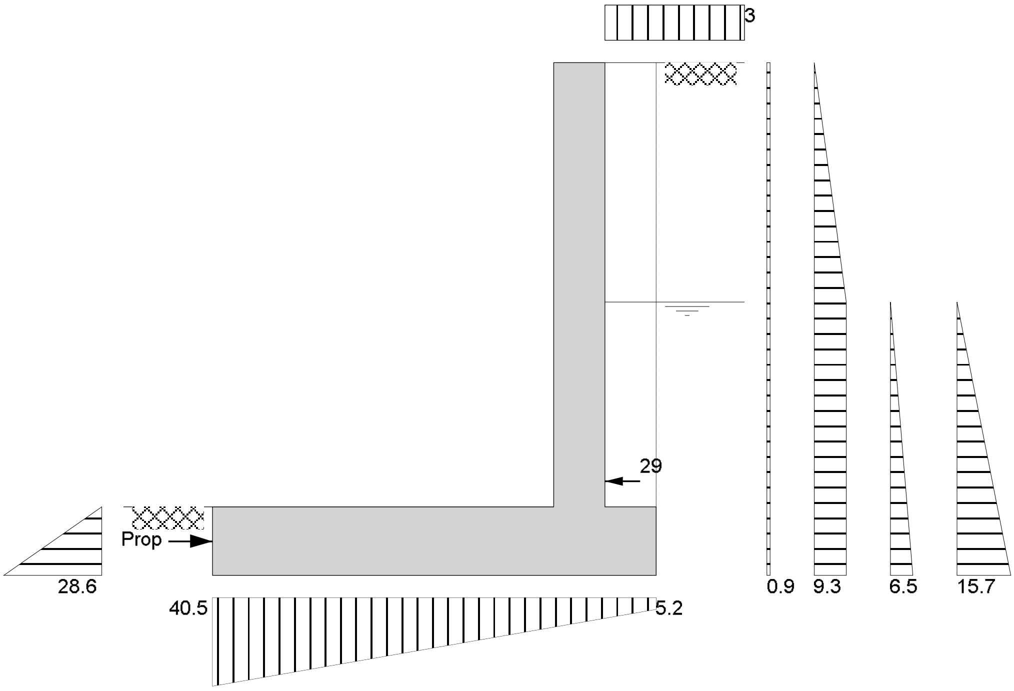
$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material;	$K_0 = 1 - \sin(\phi')$ = **0.590**

Loading details

Surcharge load on plan;	Surcharge = **2.5** kN/m^2
Applied vertical dead load on wall;	W_{dead} = **0.0** kN/m
Applied vertical live load on wall;	W_{live} = **0.0** kN/m
Position of applied vertical load on wall;	l_{load} = **0** mm
Applied horizontal dead load on wall;	F_{dead} = **25.0** kN/m
Applied horizontal live load on wall;	F_{live} = **3.5** kN/m
Height of applied horizontal load on wall;	h_{load} = **550** mm



Loads shown in kN/m, pressures shown in kN/m²

Vertical forces on wall

Wall stem;	$w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **18.4** kN/m
Wall base;	$w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **24.5** kN/m
Surcharge;	w_{sur} = Surcharge $\times\ l_{heel}$ = **0.8** kN/m
Moist backfill to top of wall;	$w_{m\_w} = l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **8** kN/m
Saturated backfill;	$w_s = l_{heel} \times h_{sat} \times \gamma_s$ = **7.7** kN/m
Total vertical load;	$W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m\_w} + w_s$ = **59.4** kN/m

Horizontal forces on wall

Surcharge;	$F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times$ Surcharge $\times\ h_{eff}$ = **2.6** kN/m
Moist backfill above water table;	$F_{m\_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **6.5** kN/m
Moist backfill below water table;	$F_{m\_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **14.9** kN/m
Saturated backfill;	$F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **5.2** kN/m
Water;	$F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **12.6** kN/m
Applied horizontal load;	$F_h = F_{dead} + F_{live}$ = **28.5** kN/m
Total horizontal load;	$F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water} + F_h$ = **70.3** kN/m

Calculate propping force

Passive resistance of soil in front of wall;	$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **5.7** kN/m
Propping force;	$F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur}) \times \tan(\delta_b), 0\ kN/m)$ F_{prop} = **44.9** kN/m

Overturning moments

Surcharge;	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **3.9** kNm/m

Moist backfill above water table; $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 =$ **13.5** kNm/m

Moist backfill below water table; $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2 =$ **11.9** kNm/m

Saturated backfill; $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3 =$ **2.8** kNm/m

Water; $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 =$ **6.7** kNm/m

Applied horizontal load; $M_{hor} = F_h \times h_{load} =$ **15.7** kNm/m

Total overturning moment; $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water} + M_{hor} =$ **54.5** kNm/m

Restoring moments

Wall stem; $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2) =$ **39.6** kNm/m

Wall base; $M_{base} = w_{base} \times l_{base} / 2 =$ **31.9** kNm/m

Moist backfill; $M_{m\_r} = (w_{m\_w} \times (l_{base} - l_{heel} / 2) + w_{m\_s} \times (l_{base} - l_{heel} / 3)) =$ **19.6** kNm/m

Saturated backfill; $M_{s\_r} = w_s \times (l_{base} - l_{heel} / 2) =$ **19** kNm/m

Total restoring moment; $M_{rest} = M_{wall} + M_{base} + M_{m\_r} + M_{s\_r} =$ **110** kNm/m

Check bearing pressure

Surcharge; $M_{sur\_r} = w_{sur} \times (l_{base} - l_{heel} / 2) =$ **1.8** kNm/m

Total moment for bearing; $M_{total} = M_{rest} - M_{ot} + M_{sur\_r} =$ **57.4** kNm/m

Total vertical reaction; $R = W_{total} =$ **59.4** kN/m

Distance to reaction; $x_{bar} = M_{total} / R =$ **965** mm

Eccentricity of reaction; $e = abs((l_{base} / 2) - x_{bar}) =$ **335** mm

Reaction acts within middle third of base

Bearing pressure at toe; $p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) =$ **40.5** kN/m^2

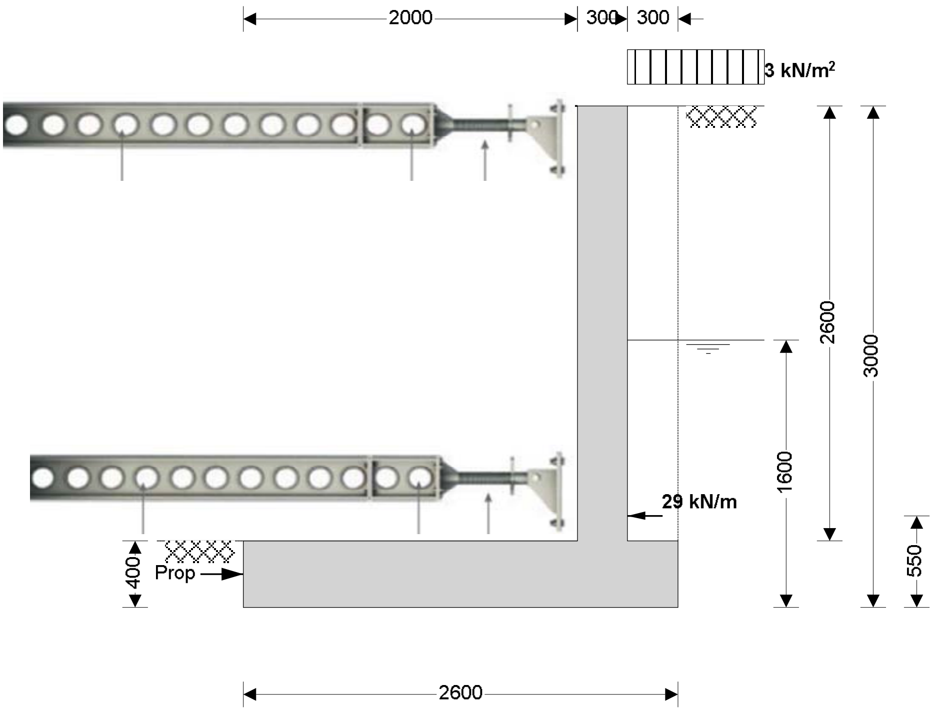
Bearing pressure at heel; $p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) =$ **5.2** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Case 4) Temporary case propped at top and bottom with no vertical load:

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type;	**Cantilever propped at both**
Height of retaining wall stem;	h_{stem} = **2600** mm
Thickness of wall stem;	t_{wall} = **300** mm
Length of toe;	l_{toe} = **2000** mm
Length of heel;	l_{heel} = **300** mm
Overall length of base;	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **2600** mm
Thickness of base;	t_{base} = **400** mm
Depth of downstand;	d_{ds} = **0** mm
Position of downstand;	l_{ds} = **1100** mm
Thickness of downstand;	t_{ds} = **400** mm
Height of retaining wall;	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **3000** mm
Depth of cover in front of wall;	d_{cover} = **0** mm
Depth of unplanned excavation;	d_{exc} = **0** mm
Height of ground water behind wall;	h_{water} = **1600** mm
Height of saturated fill above base;	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\text{ mm})$ = **1200** mm
Density of wall construction;	γ_{wall} = **23.6** kN/m^3
Density of base construction;	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall;	α = **90.0** deg
Angle of soil surface behind wall;	β = **0.0** deg
Effective height at virtual back of wall;	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **3000** mm

Retained material details

Mobilisation factor;	M = **1.5**
Moist density of retained material;	γ_m = **19.0** kN/m^3
Saturated density of retained material;	γ_s = **21.5** kN/m^3
Design shear strength;	ϕ' = **24.2** deg
Angle of wall friction;	δ = **18.6** deg

Base material details

Soft clay

Moist density;	γ_{mb} = **18.0** kN/m^3
Design shear strength;	ϕ'_b = **24.2** deg
Design base friction;	δ_b = **18.6** deg
Allowable bearing pressure;	$P_{bearing}$ = **100** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \surd(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))]^2) = \mathbf{0.369}$$

Passive pressure coefficient for base material

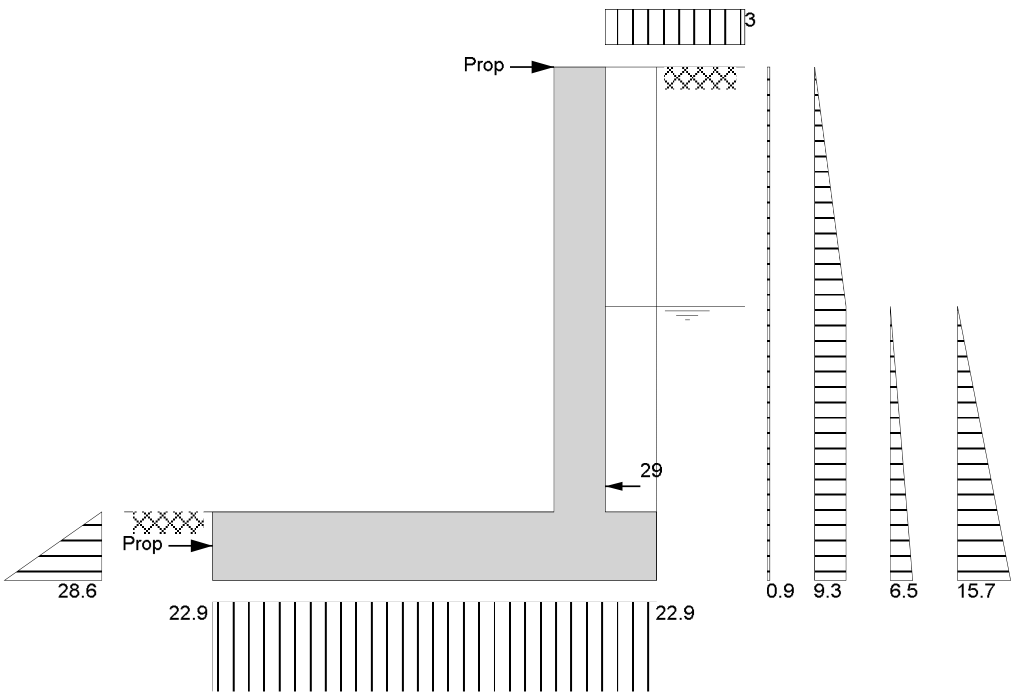
$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \surd(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))]^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material;	$K_0 = 1 - \sin(\phi')$ = **0.590**

Loading details

Surcharge load on plan;	Surcharge = **2.5** kN/m^2
Applied vertical dead load on wall;	W_{dead} = **0.0** kN/m
Applied vertical live load on wall;	W_{live} = **0.0** kN/m
Position of applied vertical load on wall;	l_{load} = **0** mm
Applied horizontal dead load on wall;	F_{dead} = **25.0** kN/m
Applied horizontal live load on wall;	F_{live} = **3.5** kN/m
Height of applied horizontal load on wall;	h_{load} = **550** mm



Loads shown in kN/m, pressures shown in kN/m^2

Vertical forces on wall

Wall stem; $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **18.4** kN/m

Wall base; $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **24.5** kN/m

Surcharge; w_{sur} = Surcharge $\times l_{heel}$ = **0.8** kN/m

Moist backfill to top of wall; $w_{m\_w} = l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **8** kN/m

Saturated backfill; $w_s = l_{heel} \times h_{sat} \times \gamma_s$ = **7.7** kN/m

Total vertical load; $W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m\_w} + w_s$ = **59.4** kN/m

Horizontal forces on wall

Surcharge; $F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times$ Surcharge $\times h_{eff}$ = **2.6** kN/m

Moist backfill above water table; $F_{m\_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **6.5** kN/m

Moist backfill below water table; $F_{m\_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **14.9** kN/m

Saturated backfill; $F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **5.2** kN/m

Water; $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **12.6** kN/m

Applied horizontal load; $F_h = F_{dead} + F_{live}$ = **28.5** kN/m

Total horizontal load; $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water} + F_h$ = **70.3** kN/m

Calculate total propping force

Passive resistance of soil in front of wall; $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **5.7** kN/m

Propping force; $F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur}) \times \tan(\delta_b), 0 \text{ kN/m})$

F_{prop} = **44.9** kN/m

Overturning moments

Surcharge; $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **3.9** kNm/m

Moist backfill above water table; $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **13.5** kNm/m

Moist backfill below water table; $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2$ = **11.9** kNm/m

Saturated backfill; $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3$ = **2.8** kNm/m

Water; $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3$ = **6.7** kNm/m

Applied horizontal load; $M_{hor} = F_h \times h_{load}$ = **15.7** kNm/m

Total overturning moment; $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water} + M_{hor}$ = **54.5** kNm/m

Restoring moments

Wall stem; $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **39.6** kNm/m

Wall base; $M_{base} = w_{base} \times l_{base} / 2$ = **31.9** kNm/m

Moist backfill; $M_{m\_r} = (w_{m\_w} \times (l_{base} - l_{heel} / 2) + w_{m\_s} \times (l_{base} - l_{heel} / 3))$ = **19.6** kNm/m

Saturated backfill; $M_{s\_r} = w_s \times (l_{base} - l_{heel} / 2)$ = **19** kNm/m

Total restoring moment; $M_{rest} = M_{wall} + M_{base} + M_{m\_r} + M_{s\_r}$ = **110** kNm/m

Check bearing pressure

Total vertical reaction; $R = W_{total}$ = **59.4** kN/m

Distance to reaction; $x_{bar} = l_{base} / 2$ = **1300** mm

Eccentricity of reaction; $e = abs((l_{base} / 2) - x_{bar}) = \mathbf{0}$ mm

Reaction acts within middle third of base

Bearing pressure at toe; $p_{toe} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) = \mathbf{22.9}$ kN/m^2

Bearing pressure at heel; $p_{heel} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) = \mathbf{22.9}$ kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Calculate propping forces to top and base of wall

Propping force to top of wall

$$F_{prop\_top} = (M_{ot} - M_{rest} + R \times l_{base} / 2 - F_{prop} \times t_{base} / 2) / (h_{stem} + t_{base} / 2) = \mathbf{4.554} \text{ kN/m}$$

Propping force to base of wall; $F_{prop\_base} = F_{prop} - F_{prop\_top} = \mathbf{40.306}$ kN/m

11.0 Calculation of heave / buoyancy and global stability

11.1 Residual heave forces and hydrostatic uplift will be resisted by a reinforced concrete basement slab.

11.2 We have carried a preliminary calculation check and confirm that the dead weight of the structures will be greater than the potential heave force. Therefore, no tension piles are required to resist the uplift.

11.3 Heave protection will be required to the basement slab to mitigate uplift pressure.

11.4 Void formers will be used under the basement slab to mitigate the effects of heave.

11.5 In line with common practice, preliminary heave force will be taken as 70% of the overburden pressure. Refer to below calculations:

Pole
Structural Engineers
www.pole.co.uk

Project: 59 Goldhurst Terrace.
Sheet:
Date:
Element: Heave / Buoyancy check
Engineer:
Job No: 6447

Preliminary check for Heave / Buoyancy check

Total soil loading:

Area ⇒ 5.6m × 24m ⇒ 135m²

Soil Load ⇒ 18kN/m³ × 135m² × 3m ⇒ 7290kN

⇒ 70% Heave ⇒ 5103kN

Loading from above (DL only)

P ⇒ (Roof) ⇒ 1.0kN/m² × (52+20) ⇒ 72kN
(2nd & 1st fl.) ⇒ 2 × 1.0kN/m² × 72m² ⇒ 144kN
(1st Roof) ⇒ 1.0kN/m² × 26m² ⇒ 26kN
(1st to 2nd walls) ⇒ 4.7kN/m² × 42m × 6m ⇒ 1185kN
(INT walls 1st to 2nd) ⇒ 2.3kN/m² × 20 × 6m ⇒ 276kN
(GND Floor) ⇒ 1.0kN/m² × 98m² ⇒ 98kN
(Ext wall GND + 1st) ⇒ 4.7kN/m² × 60m × 3m ⇒ 846kN
(INT wall GND) ⇒ 2.3kN/m² × 33m × 3m ⇒ 228kN
(BASE walls) ⇒ 8.5kN/m² × 56m × 3m ⇒ 1428kN
(400mm BASE) ⇒ 24kN/m³ × 0.4 × 57m² ⇒ 547kN
(Slab) ⇒ 24kN/m³ × 0.25m × (13·32) ⇒ 250kN
(INT wall) ⇒ 24kN/m³ × 0.3m × 7.3m × 3m ⇒ 158kN
5258kN

⇒ Dead Load ⇒ 5258kN > 5103kN

∴ Heave uplift is not an issue.
⇒ SITE IS ON A SLOPE AND ALSO
No groundwater encounter during excavation
However, buoyancy will be less than heave uplift force therefore, okay by inspection

12.0 Concrete:

12.1 Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352 has classed the site conditions as DS-2 and ACEC-2 as per *BRE Special Digest 1:2005 - Concrete in aggressive ground*.

12.2 The Groundwater data during the soil investigation is described in Ashton Bennett Engineering Geologists and Environmental Specialists Report RA 3352. The basement should be designed for a maximum hydrostatic head of 1.0m BGL as per BS8102:2009.

12.3 No concrete section will be less than 200mm thick.

12.4 The intended working life of the basement is at least 50 years.

12.5 Based on the above information, we recommend that any concrete in contact with the ground is specified in accordance with the requirements of DC-2 as per table D2 of *BRE Special Digest 1:2005 Concrete in aggressive ground.* This is to protect the concrete from accelerated degradation due to the chemical composition of the ground.

12.6 Note that the concrete mix will be specified by the concrete supplier (not Pole Structural Engineers) and the requirements listed above must be repeated in the contract documentation.

12.7 Extracts from *BRE Special Digest 1:2005 Concrete in aggressive ground* are included below.

Table D1 Selection of the DC Class and the number of APMs for concrete elements where the hydraulic gradient due to groundwater is 5 or less: for general in-situ use of concrete [a,b,c]

ACEC Class (from Tables C1 and C2)	Intended working life: At least 50 years[d,e]	At least 100 years
AC-1s, AC-1	DC-1	DC-1
AC-2s, AC-2	DC-2	DC-2
AC-2z	DC-2z	DC-2z
AC-3s	DC-3	DC-3
AC-3z	DC-3z	DC-3z
AC-3	DC-3	DC-3 + one APM of choice
AC-4s	DC-4	DC-4
AC-4z	DC-4z	DC-4z
AC-4	DC-4	DC-4 + one APM of choice
AC-4ms	DC-4m	DC-4m
AC-4m	DC-4m	DC-4m + one APM of choice
AC-5z	DC-4z + APM3[f]	DC-4z + APM3[f]
AC-5	DC-4 + APM3[f]	DC-4 + APM3[f]
AC-5m	DC-4m + APM3[f]	DC-4m + APM3[f]

For specification of DC Class, see Table D2. For choice of additional protective measures, see Table D4.

Notes

a Where the hydraulic gradient across a concrete element is greater than 5, one step in DC Class or one APM over and above the number indicated in this table should be applied except where the original provisions included APM3. Where APM3 is already required, or has been selected, an extra APM is not needed.

b A section thickness of 140 mm or less should be avoided in in-situ construction but, where this is not practical, apply one step higher DC Class or an extra APM except where the original provisions included APM3. Where APM3 is already required, or has been selected, an extra APM is not necessary.

c Where a section thickness greater than 450 mm is used and some surface chemical attack is acceptable, a relaxation of one step in DC Class may be applied. For reinforced concrete, the cover should be sufficiently thick to allow for estimated surface degradation during the intended working life (Section D6.5).

d Foundations of low-rise housing that have an intended working life of at least 100 years may be constructed with concrete selected from the column headed 'At least 50 years' (Section D7).

e Structures with an intended working life of at least 50 years but for which the consequences of failure would be relatively serious, should be classed as having an intended working life of at least 100 years for the selection of the DC Class and APM (Section D7).

f Where APM3 is not practical, see Section D6.1 for guidance.

Figure 3 - Table D1, reproduced from Part D of BRE Special Digest 1:2005 - Concrete in aggressive ground

Table D2 Concrete qualities to resist chemical attack for the general use of in-situ concrete: limiting values for composition

DC Class	Maximum free-water/cement or combination ratio	Minimum cement or combination content (kg/m³) for maximum aggregate size of: ≥ 40 mm	20 mm	14 mm	10 mm	Recommended cement and combination group
DC-1	–	–	–	–	–	A to G inclusive
DC-2	0.55	300	320	340	360	D, E, F
	0.50	320	340	360	380	A, G
	0.45	340	360	380	380	B
	0.40	360	380	380	380	C
DC-2z	0.55	300	320	340	360	A to G inclusive
DC-3	0.50	320	340	360	380	F
	0.45	340	360	380	380	E
	0.40	360	380	380	380	D, G
DC-3z	0.50	320	340	360	380	A to G inclusive
DC-4	0.45	340	360	380	380	F
	0.40	360	380	380	380	E
	0.35	380	380	380	380	D, G
DC-4z	0.45	340	360	380	380	A to G inclusive
DC-4m	0.45	340	360	380	380	F

Grouped cements and combinations

	Cements	Combinations
A	CEM I, CEM II/A-D, CEM II/A-Q, CEM II/A-S, CEM II/B-S, CEM II/A-V, CEM II/B-V, CEM III/A, CEM III/B	CIIA-V, CIIB-V, CII-S, CIIIA, CIIIB, CIIA-D, CIIA-Q
B	CEM II/A-L[a], CEM II/A-LL[a]	CIIA-L[a], CIIA-LL[a]
C	CEM II/A-L[a], CEM II/A-LL[a]	CIIA-L[a], CIIA-LL[a]
D	CEM II/B-V+SR, CEM III/A+SR	CIIB-V+SR, CIIIA+SR
E	CEM IV/B (V), VLH IV/B (V)	CIVB-V
F	CEM III/B+SR	CIIIB+SR
G	SRPC	–

For cement and combination types, compositional restrictions and relevant Standards, see Table D3.

Figure 4 - Table D2, reproduced from Part D of BRE Special Digest 1:2005 - Concrete in aggressive ground

13.0 Propping system (temporary)

13.1 This section must be read with reference to the Pole Structural Engineers drawings appended to this report.

13.2 The proposed propping systems and construction sequence are explained in more detailed in the following Outline Construction Method Statement.

13.3 Temporary propping will be required to the top and bottom of the perimeter RC retaining wall. These props will span the width of the basement excavation and prevent the top of the RC retaining wall bending inwards as the excavations are undertaken. This is known as a 'stiff' method and reduced the ground movements and risks of damage behind the wall. This propping is to stay in place until the basement slab has been cast and cured.

13.4 Permanent propping will be provided to the bottom of the retaining wall by the reinforced concrete basement slabs.

13.5 The Client must engage a Temporary Works Design Engineer with adequate experience and a watching brief to design and oversee the temporary works and propping.

14.0 Propping system (Permanent)

14.1 This section must be read with reference to the Pole Structural Engineers drawings appended to this report.

14.2 At the permanent stage, the RC retaining walls are designed as 'Unpropped Cantilever', propping only at the base. The deflection of the tip of the wall will be designed to be within the limit and controlled by complying with l/d (slenderness) ratios.

15.0 Movement monitoring specification

15.1 To safeguard the existing and neighbouring structures during underpinning and new basement construction, movement monitoring is to be undertaken to both Building Owner's and Adjoining Owner's properties.

15.2 The primary purpose of the monitoring is to observe movement to ensure that it is within the expected ranges and to enable the early detection of any unexpected behaviour. It will also enable the rapid implementation of any remedial actions if required.

15.3 Movement monitoring is to take the form of an external survey using Electric Distance Measurement (EDM). It should utilise appropriate control stations as to avoid disruption by construction activities.

15.4 The readings should ideally be taken at the same time of day on each occasion to minimise the effect of temperature fluctuations. Ideally, they should be taken by the same individual using the same instrument. The task may be subcontracted entirely to an outside organisation. In either case, this must be recognised as a precision activity: appropriately trained staff should be employed and equipment must be calibrated regularly, preferably to nationally accepted standards.

15.5 Survey target studs will be fixed to the existing masonry walls. These studs should be located on the front and rear elevation walls, as well as the rear extension flank walls at the project address and the immediately adjacent buildings.

15.6 Final target locations and numbers of points to be confirmed with properties owners and Party Wall Surveyors, prior to installation.

15.7 The positions of the monitoring targets are to be measured in three directions and their coordinates in easting, northing and vertical elevation (E, N, Z) established.

15.8 For the convenience of access, it is suggested that the monitoring points to be installed close to window openings. The type of stud / reflector should be selected by the Surveyor in accordance with best practice.

15.9 Ideally, the monitoring studs should be fixed in between mortar joint rather than brickwork for easier repair.

15.10 The allowance is to be made for removal of survey studs and the Contractor to reinstate and 'make good' to match existing structures. (i.e. colour to match existing)

15.11 Throughout ground works and basement excavation, visual checks of the superstructures should be carried out at the start and end of each day by the Site Manager or dedicated competent individual. If any cracks appear, they should be immediately noted and gauged for further monitoring in accordance with the EDM survey report.

15.12 Additional crack monitoring may be required subjects to site conditions.

15.13 The reporting format will be in the form of a table listing out the survey points, dates of readings along with accumulative movements as per Appendix 4 of CIRIA Guide C579. Include a reference drawing showing the position of survey points. Provided the 'Green' level is not exceeded, the reports should be issued monthly to the following parties.

15.14 Should the measured deflections exceed the 'Green' level, the reports are to be issued within 24 hours of each reading being taken.

15.15 Monitoring Frequency and trigger values:

15.15.1 Readings are to be taken weekly for the duration of the basement construction.

15.15.2 The basement construction will be considered to start when the first excavation extends below existing foundation level.

15.15.3 The end of basement construction will be the completion of all the concrete underpins, slabs and removal of temporary props.

15.15.4 The start of basement construction is to be preceded by at least three number readings to establish a baseline.

15.15.5 Once basement works completed, reduce monitoring to monthly readings for minimum 3 months when the structural works are fully completed.

15.15.6 If any of the trigger levels are reached during the works, all parties will need to be notified immediately and the monitoring frequency will be increased.

15.15.7 Movement of survey points (both vertical, horizontal and resultant / ultimate) must not exceed the following values:

Trigger Levels	**WARNING – AMBER**	**ACTION - RED**
< 5mm	**5mm – 8mm**	**>8mm**
Acceptable level of movement, no specific action required	Notify all parties. Assess cause and check temporary propping installation prepare contingency measures. Monitoring to be increased to daily measurements until structure stabilised.	Stop works and notify all parties. Stop any activities associated with party wall and implement contingency measures to arrest movement and safeguard structure. Monitoring to be increased to daily measurements until structure stabilised.

16.0 Conclusions

16.1 The structural aspects of the proposal are consistent with industry best practice and in keeping with the broad principles of the London Borough of Camden's Guidance for Subterranean Development Issue 01 18th November 2010 .

16.2 Temporary propping will be required to the top and bottom of the perimeter RC retaining wall. These props will span the width of the basement excavation and prevent the top of the RC retaining wall bending inwards as the excavations are undertaken. This is known as a 'stiff' method and reduced the ground movements and risks of damage behind the wall. This propping is to stay in place until the basement slab has been cast and cured.

16.3 With good workmanship, we believe the risk of structural damage to No. 57 Goldhurst Terrace (AO1) from ground movement during basement construction to be low.

16.4 With good workmanship, we believe the risk of structural damage to No. 61 Goldhurst Terrace (AO 2) from ground movement during basement construction to be very low or negligible.

16.5 With good workmanship, we believe the risk of structural damage to No. 8 Marston Close (AO 3) to be very low or negligible.

APPENDICES

17.0 APPENDIX A – Pole Structural Engineers Drawings for BIA

POLE Structural Engineers Drawing Register list with revision reference:

DRAWING REGISTER

Pole Structural Engineers
24 High Street Wimbledon Village
London SW19 5DX
mail@pole.co.uk www.pole.co.uk
Fax: 020 8944 9326 Tel: 020 8944 9955

Project: 59 Goldhurst Terrace, Camden, London MW6 3HB **Project No:** 6447 **Sheet No:** 1/1

Purpose of Issue	
Preliminary (P)	
Information	X
Building Regs / Approvals (B)	
Tender (T)	
Construction (C)	
As Instructed	

Dwg No.		Drawing Title:	Scale:	Size:	
6447	/GA/01	PROPOSED BASEMENT PLAN - SHOWING STRUCTURES UNDER	1:50	A3	0
6447	/GA/02	PROPOSED BASEMENT PLAN - SHOWING STRUCTURES OVER	1:50	A3	0
6447	/GA/05	PROPOSED SECTION A-A & SECTION B-B	1:50	A3	0
6447	/GA/06	PROPOSED SECTION C-C	1:50	A3	0
6447	/SK11	SUGGESTED UNDERPINNING SEQUENCES OF WORK - SHEET 1 OF 3	N.T.S.	A3	0
6447	/SK12	SUGGESTED UNDERPINNING SEQUENCES OF WORK - SHEET 2 OF 3	N.T.S.	A3	0
6447	/SK13	SUGGESTED UNDERPINNING SEQUENCES OF WORK - SHEET 3 OF 3	N.T.S.	A3	0

Day	02
Month	11
Year	18

Distribution:		Sent:
CLIENT	Client	e
ARCHITECT		
ARCHITECT		
PARTY WALL SURVEYOR		
QS		
CONTRACTOR		
M&E		
File Copy		

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18.0 APPENDIX B – Extract from CIRIA C760 Guidance on embedded retaining wall design

Stiff clays

Figure 6.15 shows horizontal and vertical ground surface movements behind walls embedded in competent ground (stiff clay).

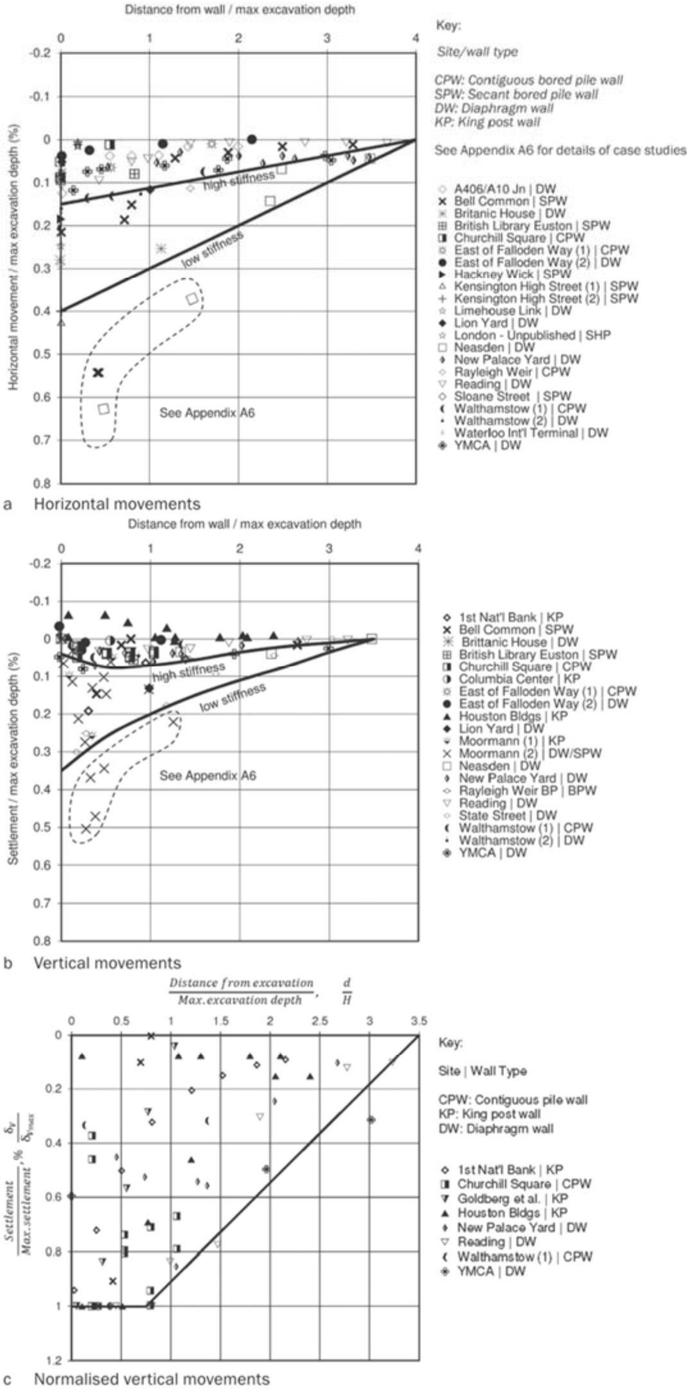


Figure 6.15 ***Ground surface movements due to excavation in front of wall embedded in stiff clay***

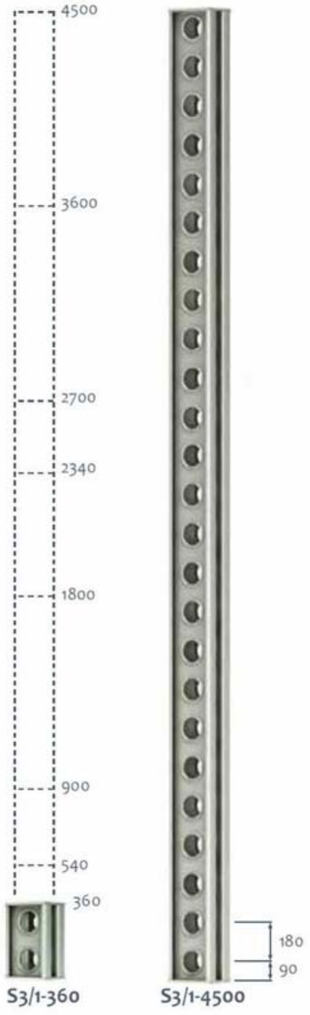
19.0 APPENDIX C – Temporary Propping System (example)

Mabey System Temporary Propping Data – Prop Units

System 160 - prop units

System 160 prop units form the basis of this system.

The unique design provides high load capacity in a compact 230mm x 180mm prop unit. Components are sized to allow the system to be built by hand within existing structures where required.



System Benefits

Versatile high load system	✓
Compact 230mm x 180mm prop can be manhandled if necessary	✓
Comprehensive range of fittings	✓
Choice of needle beam sizes and lengths available	✓
Available from depot locations throughout the country	✓

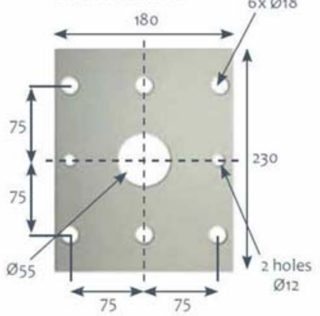
Eight standard lengths up to 4500mm

Code No.	Description	Length (mm)	Weight (kg)
S3/1-4500	Prop Unit	4500	101.0
S3/1-3600	Prop Unit	3600	82.0
S3/1-2700	Prop Unit	2700	62.5
S3/1-2340	Prop Unit	2340	52.0
S3/1-1800	Prop Unit	1800	40.0
S3/1-900	Prop Unit	900	25.0
S3/1-540	Prop Unit	540	15.7
S3/1-360	Prop Unit	360	11.8

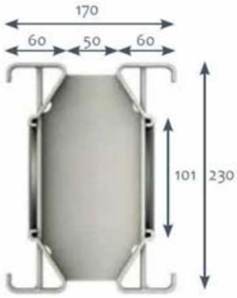
Note:

Prop end connections are made by using 6 No. S3/22 M16GR8.8 bolts 45mm in length.

End Elevation



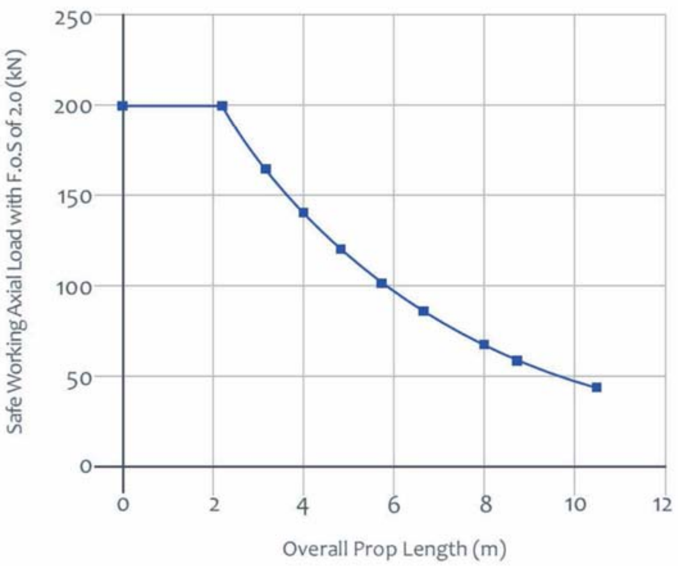
Typical Cross Section



Mabey System Temporary Propping Data – Properties

System 160 - properties

Prop Loading Chart



Section Modulus (Nett)	168cm³
Minimum cross sectional area through lightening holes	21cm²
Maximum cross sectional area	25cm²
Second moment of area	1940cm⁴
Maximum bending moment suitably restrained assuming no local point load	60kNm
Maximum moment of resistance at joint (6no M16 bolts)	25kNm
Maximum shear capacity	120kN

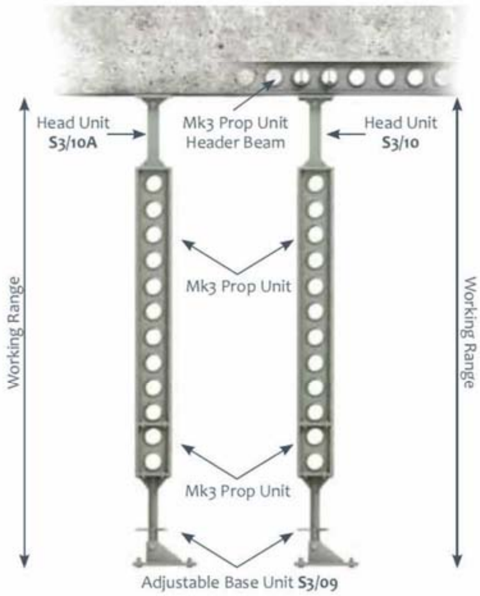
Note:

1. When used in tension the Safe Working Load is 120kN.
2. Values assume that the load is applied concentrically along the centre of the prop ie no eccentricity.
3. For controlled situations where the loading is predictable a factor of safety of 1.7 may be used.
4. In horizontal applications, the capacity above may be used providing that the props are used with the soldier webs/ lightening holes in the vertical plane.
5. Longer props can be braced to reduce the effective length and improve the capacity. Please refer to the System 160 Data Sheet.
6. All bolt joints require 6 no. S3/22 bolts.
7. Straightness requirement: When the prop is assembled, the maximum deviation from straight should be 2mm per metre length eg 10mm for a 5m prop. Should a prop fall outside this requirement, components should be checked for damage.
8. Limitations of End Fittings: Values may be limited by the type of end fittings used. In the absence of a standard end fitting, the load must be applied through a stiff surface such as a steel plate or uniform concrete surface.
9. Further information should be obtained from the product technical data sheets or Mabey Hire Services engineers.

Mabey System Temporary Propping Data – Capacities

System 160 - prop lengths & capacities

Prop Components and Height Range with Fixed Length Head Unit and Adjustable Base Unit



Working Range	Adj. Base S3/09 (318mm - 767mm)	Fixed Head Unit S3/10A 512mm	S3/1-360	S3/1-900	S3/1-1800	S31-2700	S3/1-3600	S3/1-4500	S3/22 Bolts	Kit Assembly Ref.	Weight (kg)
859 - 1279	1	1	-	-	-	-	-	-	4	S3/KP/1	50
1190 - 1639	1	1	1	-	-	-	-	-	8	S3/KP/2	62
1550 - 1999	1	1	2	-	-	-	-	-	12	S3/KP/3	76
1730 - 2179	1	1	-	1	-	-	-	-	8	S3/KP/4	76
2090 - 2539	1	1	1	1	-	-	-	-	12	-	88
2450 - 2899	1	1	2	1	-	-	-	-	16	-	101
2630 - 3079	1	1	-	-	1	-	-	-	8	S3/KP/5	91
2990 - 3439	1	1	1	-	1	-	-	-	12	-	103
3350 - 3799	1	1	2	-	1	-	-	-	16	-	116
3530 - 3979	1	1	-	-	-	1	-	-	8	S3/KP/6	113
3890 - 4339	1	1	1	-	-	1	-	-	12	-	126
4250 - 4699	1	1	2	-	-	1	-	-	16	-	138
4430 - 4879	1	1	-	-	-	-	1	-	8	S3/KP/7	133
4790 - 5239	1	1	1	-	-	-	1	-	12	-	145
5150 - 5599	1	1	2	-	-	-	1	-	16	-	158
5330 - 5779	1	1	-	-	-	-	-	1	8	S3/KP/8	152
5690 - 6139	1	1	1	-	-	-	-	1	12	-	162
6050 - 6499	1	1	2	-	-	-	-	1	16	-	177
6230 - 6679	1	1	-	1	-	-	-	1	12	S3/KP/9	177
6590 - 7039	1	1	1	1	-	-	-	1	16	-	190
6950 - 7399	1	1	2	1	-	-	-	1	20	-	203
7130 - 7579	1	1	-	-	1	-	-	1	12	S3/KP/10	193
7490 - 7939	1	1	1	-	1	-	-	1	16	-	206
7850 - 8299	1	1	2	-	1	-	-	1	20	-	234
8030 - 8479	1	1	-	-	2	-	1	-	16	S3/KP/11	214
8390 - 8839	1	1	1	-	2	-	1	-	20	-	227
8750 - 9199	1	1	2	-	2	-	1	-	24	-	239
8930 - 9379	1	1	-	-	2	-	-	1	24	S3/KP/12	231
9830 - 10279	1	1	-	-	2	1	-	-	24	S3/KP/13	257

*A kit assembly reference is given to assist in ordering the props. The kit includes all parts and bolts necessary depending upon the manner in which the prop is used.
The kit assembly reference number must be followed by the A, B or C suffix i.e. a Type 9 Prop to support Mk2 Prop Units would be called off as **S3/KP/9C**.

Head of prop will comprise **S3/10** or **S310A** used viz:

S3/10 Use A - To prop Mk3 props
S3/10A Use B - To prop vertical members other than props
S3/10A Use C - To prop Mk2 props

Notes

1. The **S3/10** is required in the vertical prop to make a connection with another prop unit (as shown in the sketch above) add 2 x **S3/05** Web Connectors and 2 x **S3/21** bolts.
2. Alternative prop unit combinations may be used for the same height ranges if the longer prop units are undesirable due to handling considerations.
3. Depending on the working range required, the use of **S3/1-540** prop units may be preferable.
4. It is important to avoid eccentric loading in the props. The **S3/09** Base Units and the **S3/10** and **S3/10A** Head Units are pinned about one axis only, so only crossfalls perpendicular to the longitudinal axis of the pin are acceptable.
5. A kit assembly reference is given to assist in ordering the props. The kit includes all parts and bolts necessary depending upon the manner in which the prop is used.

Construction Management Plan (CMP)

for the

Re-development of 59 Goldhurst Terrace, London NW6 3HB

prepared by

Haig CM Limited

Issue No.	Revision Description	Produced by	Date
1	Draft for Project Team	TM	2018
2	Final	TM	2018

Contents

Section 1 Introduction - Description of the Site and Development

The following Construction Management Plan (CMP) has been produced for Ashton Bennett to explain the proposed programming and construction logistics, methodology and traffic management for the redevelopment of 59 Goldhurst Terrace NW6 3HB.

Site Address 59 Goldhurst Terrace
Camden
London
NW6 3HB

Planning Ref: 2018/0462/P

Main Contractor and Site Contact Details

Full contacts details of the site project manager responsible for the day-to-day management of the works and dealing with any complaints from local residents and businesses will be confirmed by Ashton Bennett post.

Outline Scope

The scope includes the re-arrangement of an existing HMO to provide a 7-bed HMO including loft conversion & new rear dormer window; extension at ground floor level to provide additional floorspace for existing self-contained flat; excavation of basement level with front and rear lightwells to provide new self-contained unit at basement level

The CMP provides an overview for both the excavation and construction works, its phasing, logistics and traffic management proposals and the management of health, safety, and environmental issues on and around the development. The intention is that the site operations will commence with demolition/strip out, underpinning, excavation works, new basement & waterproofing and fit out works.

Site Location

The site lies just off the A41, Finchley Rd a short distance north of Swiss Cottage Underground Station. The A41 is a busy road with lots of through traffic. The area is Predominately residential with commercial units along the Finchley Road.

Location Plan

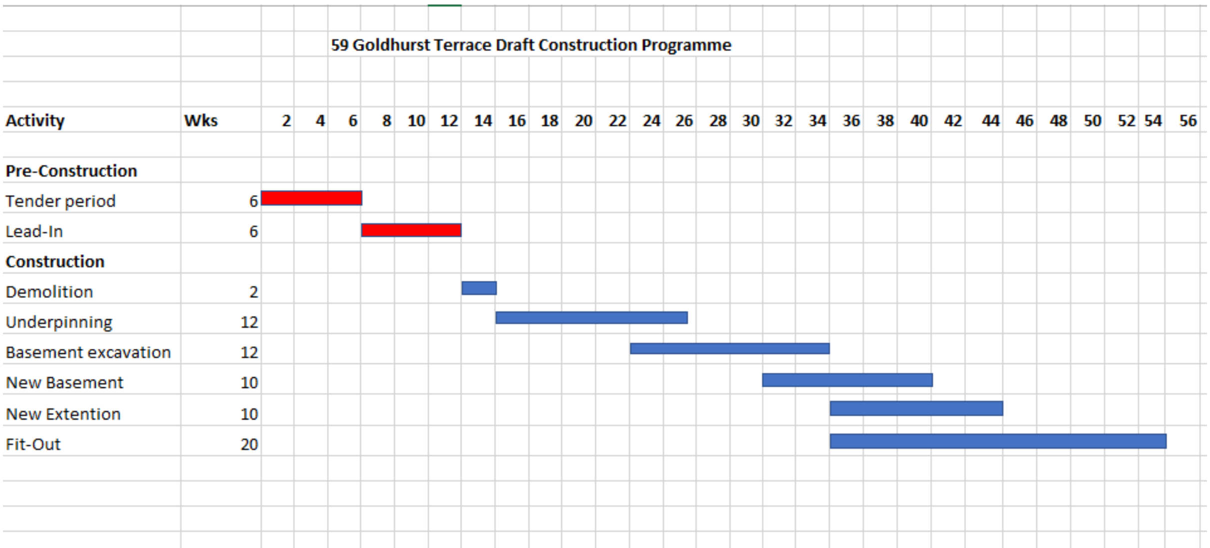
Key Issues and Challenges

- The limited site space as the entire footprint is part of the development.
- The site is within close proximity to neighbouring residential properties.
- The one-way streets leading to and from site.
- Ensuring the basement works follow a strict methodology with constant monitoring of adjacent properties

Site Entrance

Section 2 Programming and Phasing

The programme outlined below, assumes that all planning issues have been resolved, and that all party wall awards with the adjacent owners are in place, if these are not it is likely that there will be a substantial extension to the pre-construction period whilst these are resolved.



- Preconstruction – finalisation of tender documentation (2 weeks), Tender (4 weeks), Review and Award contract (2 weeks).

- Lead Time – 4-6 weeks we would consider as normal for a specialist basement contractor.

- On site – we would anticipate the overall construction period to complete the works to be in the order of 42 weeks. The works will follow a strict method statement for the underpinning and basement formation with input from both the structural and temporary works engineers. The new extension and fitout works will be phased in with the basement works as the project progresses

The principle strategy in programming the works is to minimise the disruption to the residents surrounding 59 Goldhurst Terrace. We would propose to achieve this both by timing the works to minimise disruption to adjacent properties during the working day, but to also avoid traffic movements to and from the site during peak periods.

On commencement of the works it is envisaged that the excavation and underpinning would be carried out in a three to four-month period with the construction of the new basement completed in the following two to three months, with the overall construction and fit out works being completed over a total five to six-month period.

The phasing will be as follows:

Phase 1. Demolition & strip out	2 weeks
Phase 2. Underpinning	10-12 weeks
Phase 3. Basement excavation	10-12 weeks
Phase 4. Forming basement box and waterproofing	10 weeks
Phase 5. Construction and Fit out	20 weeks
Overall construction period (phases overlapped)	**42 weeks**

The phasing outlined above is indicative and there will be some overlapping between the phases to suit site conditions and sequencing.

It is envisaged that during the Phase 1 Excavation and underpinning works all with excavated material will be loaded onto skips from basement to ground floor level via a conveyor and then manual handled to a skip in the suspended bay.

The programme is based on the working hours for the site being:

08:00 and 18:00 Monday to Friday
08:00 and 13:00 on Saturday; and
No work on Sunday, Bank and Public Holidays.

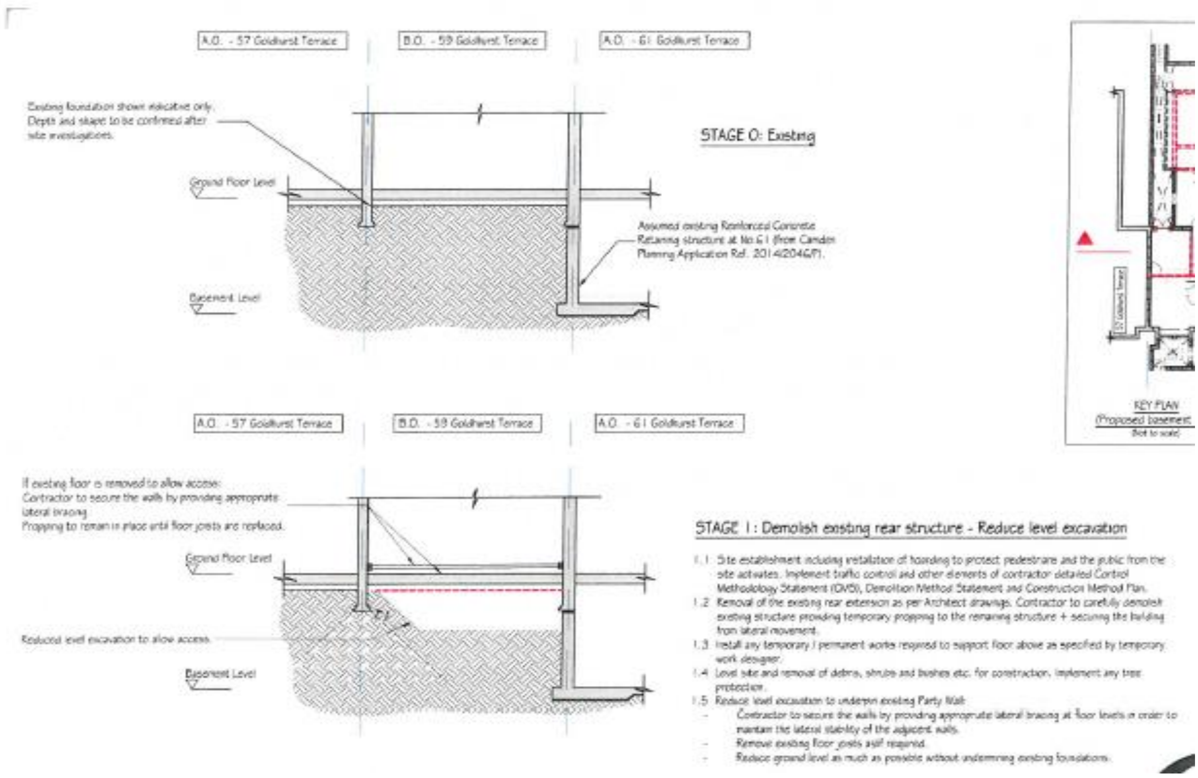
All site deliveries and rubbish removal will be arranged between these hours and will be co-ordinated and managed on a 'just-in-time' delivery basis. Deliveries will be programmed to avoid the peak travel periods. All subcontractors and suppliers will be required to agree dates and times prior to delivery in addition confirmation of size of vehicle and unloading point.

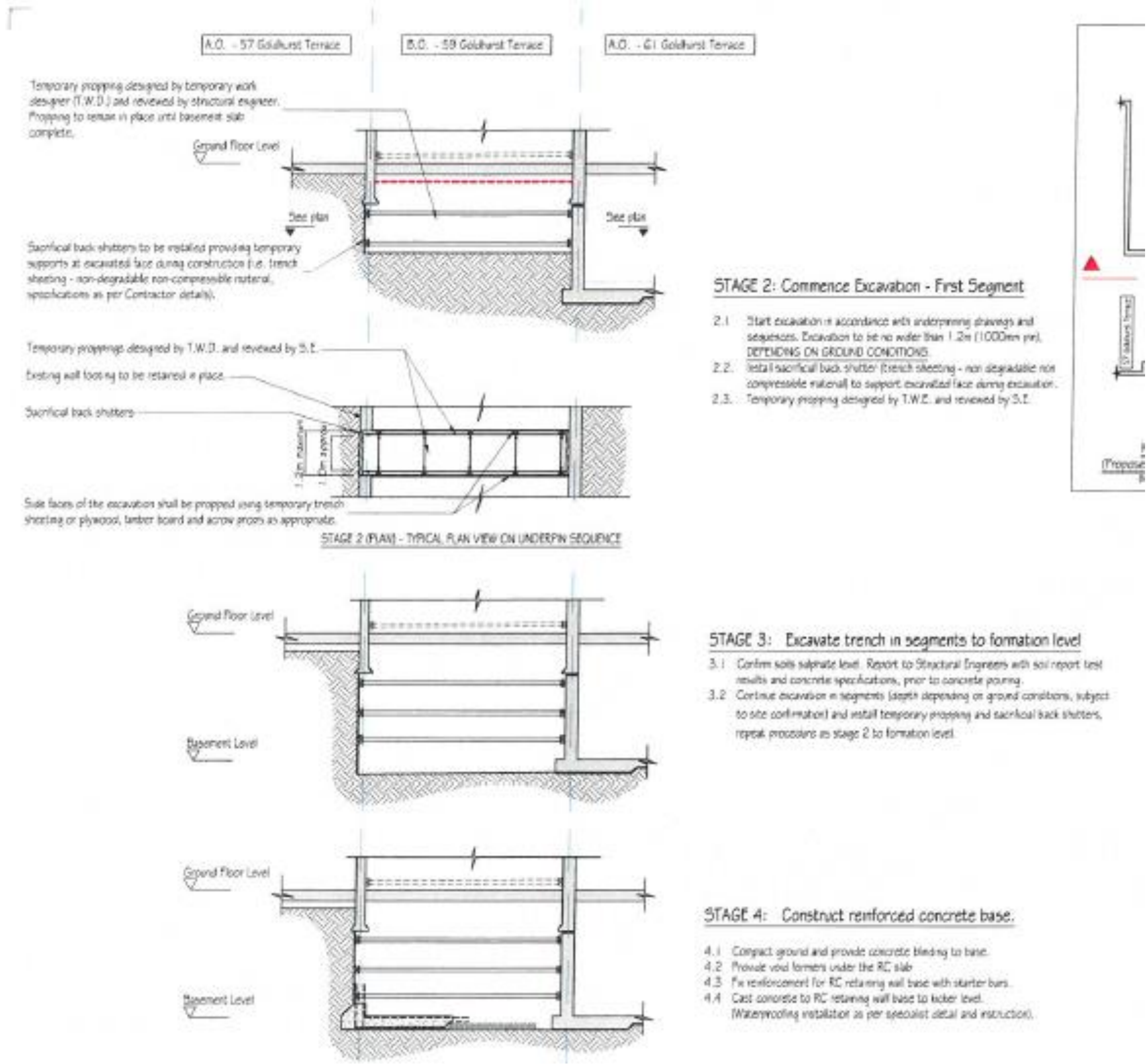
Any noisy work outside these hours will only be undertaken by prior agreement, and/or reasonable notice to Camden Council Highways and Environmental Health Teams.

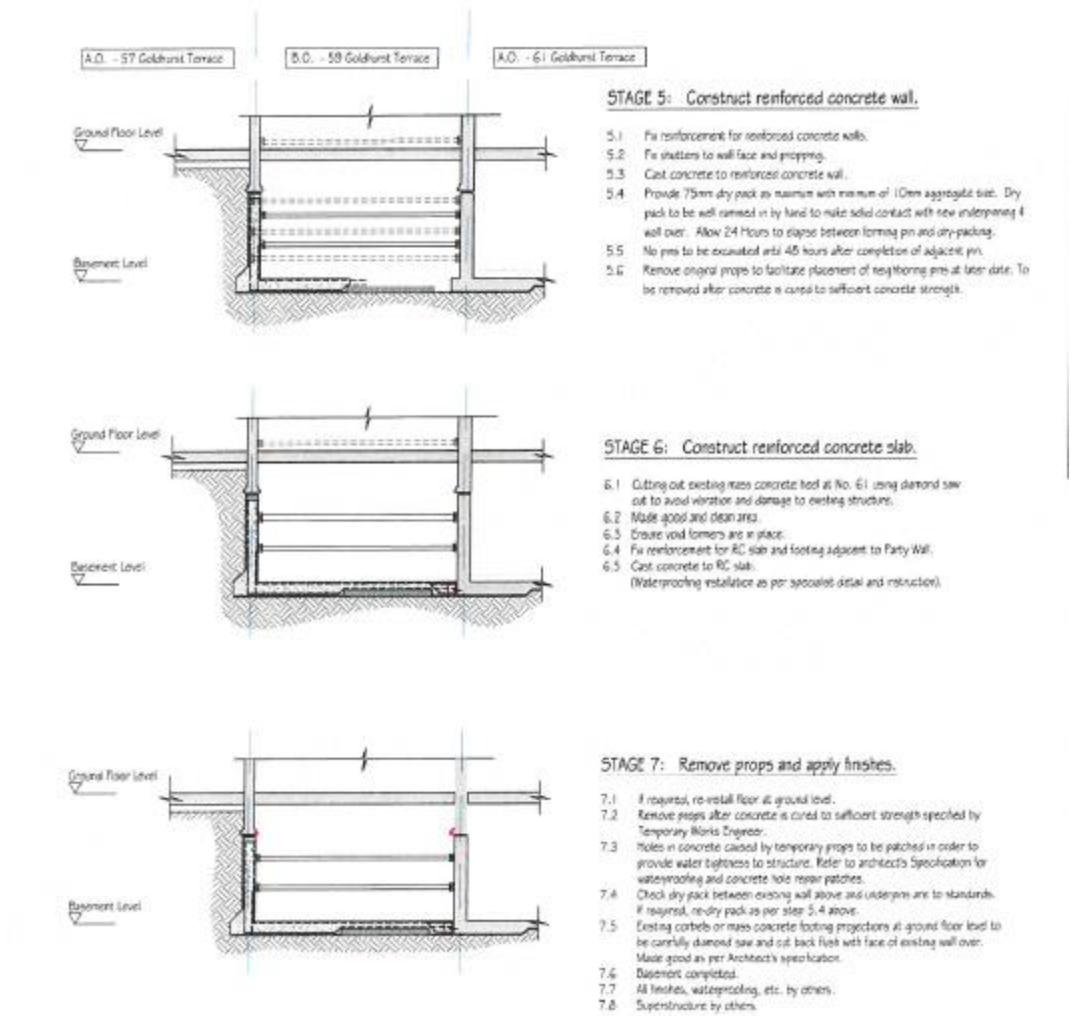
It is not envisaged that works will require a road closure. If works required a road closure this would be discussed with Camden Council Highways Team before applying for the necessary permissions and orders.

Section 2 Construction/underpinning methodology

The following sketches show the outline method statement for carrying out the underpinning works. Details will be further developed with the temporary works engineer before commencement




A.O. - 57 Goldhurst Terrace
B.O. - 59 Goldhurst Terrace
A.O. - 61 Goldhurst Terrace
Temporary propping designed by temporary work designer (T.W.D.) and reviewed by structural engineer. Propping to remain in place until basement slab complete.
Ground Floor Level
See plan
See plan
Sacrificial back shutters to be installed providing temporary supports at excavated face during construction (i.e. trench sheeting - non-degradable non-compressible material, specifications as per Contractor details).
Temporary proppings designed by T.W.D. and reviewed by S.E.
Existing wall footing to be retained in place
Sacrificial back shutters
Side faces of the excavation shall be propped using temporary trench sheeting or plywood, timber board and acrow props as appropriate.
STAGE 2 (PLAN) - TYPICAL PLAN VIEW ON UNDERPIN SEQUENCE
STAGE 2: Commence Excavation - First Segment
2.1 Start excavation in accordance with underpinning drawings and sequences. Excavation to be no wider than 1.2m (1000mm pin), DEPENDING ON GROUND CONDITIONS.
2.2. Install sacrificial back shutter (trench sheeting - non degradable non compressible material) to support excavated face during excavation.
2.3. Temporary propping designed by T.W.E. and reviewed by S.E.
Ground Floor Level
Basement Level
STAGE 3: Excavate trench in segments to formation level
3.1 Confirm soils sulphate level. Report to Structural Engineers with soil report test results and concrete specifications, prior to concrete pouring.
3.2 Continue excavation in segments (depth depending on ground conditions, subject to site confirmation) and install temporary propping and sacrificial back shutters, repeat procedures as stage 2 to formation level.
Ground Floor Level
Basement Level
STAGE 4: Construct reinforced concrete base.
4.1 Compact ground and provide concrete blinding to base.
4.2 Provide void formers under the RC slab
4.3 Fix reinforcement for RC retaining wall base with starter bars.
4.4 Cast concrete to RC retaining wall base to kicker level. (Waterproofing installation as per specialist detail and instruction).



Section 3 Construction Logistics

Site Offices and Welfare Facilities

It is proposed that the site offices and welfare facilities are located within the building. During the course of the works this may not be possible so will be temporarily located within the confines of the site. Access to site will be via the gate/hoarding.

Typical site set up during initial stages of the project. This will move into the building following completion of the demolition and excavation phases

Hoardings and Gates

The site entrance at the front of the property will be fully hoarded with a single point of entry and exit. These will have clear signage to direct public away from site and secured to prevent unauthorised site access. The hoarding provided will be 2.4m high plywood faced and painted hoarding. The hoarding will be extended from the front door of No 59 to the boundary wall at the back of the pavement

Scaffolding and Gantries

During the basement works scaffold access into the basement area will be provided as work progresses within the hoarding line.

Cranes and Plant

It is proposed to utilise pallet trucks, dollies and sack trucks for moving the majority of materials on to site from the unloading area. A conveyor will be located on site to take material from basement to ground where it will be manual handled to the skip located in the suspended bay. To lower steel and heavy materials into the basement a temporary winch/hoist will be required.

Vehicle Offloading points

To ensure the minimum disruption to traffic a loading/unloading area will be established by suspending a couple of bays on Goldhurst Terrace. All deliveries will be distributed into site immediately on arrival. Unloading of lorries will be marshalled by a Traffic Marshal and chapter 8 barrier to prevent cars parking where vehicles will be unloading thus preventing hold ups and frustration for residents.

An application to Camden Council will be made to suspend the two residents parking bays immediately outside of 59 Goldhurst Terrace for the duration of the project. This is to ensure that there is always an area available for unloading/loading out of the traffic flow to avoid traffic hold ups or congestion

As Goldhurst Terrace is a one-way road, all vehicles delivering to site will enter and leave via the Finchley Road end of Goldhurst Terrace. Upon leaving site they will continue to the end of Goldhurst Terrace and turn left and make their way back onto the Finchley Road (A41). Traffic Marshalls will be available to assist vehicles in leaving via this route on request.

Entrance to Goldhurst Terrace from Finchley Rd

Vehicle loading/unloading area

Licenses

Should the installation of a gantry, erection of any hoardings, placing of the static pump or any skips outside the site boundary on the footpath or highway, the appropriate licensees will be obtained from Camden Council to agree the use of Goldhurst Terrace for vehicle unloading to the site.

Also, prior to the erection of any hoardings or commencement of any demolition works a full photographic record survey will be taken of the surrounding roads, pavements, road signage, to record the condition of these items prior to works commencing, a copy of this survey will be issued to Camden Council Highways Team.

Section 4 Vehicle / Plant Schedule

The following details and schedules provide an overview of all plant and vehicles that will be involved in the delivery of materials and construction activities on site. The frequency of deliveries will be ascertained during the detailed logistics and traffic management statement produced during the pre-construction period, and as the vehicle movement statistics are generated to reflect the works programme and design components.

Plant and Usage	**Phase 1**	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**	**Vehicle Movements**	**Total Duration On Site**
Ready mix Concrete Lorries required for new build construction		✓		✓		2 per week	5 months Total
Steelwork/Rebar Delivery Lorries required for new build construction		✓		✓		1 week	5 months
Concrete Pump Static required for new build construction		✓		✓		2 delivery & 2 collections	5 months
Mobile Cranes Not Anticipated							
Hand / Power Tools required for all works during period of construction	✓	✓	✓	✓	✓	1 week	11 months
Scaffolding and Hoardings required to protect public, safe methods of working to external envelope for movement of materials	✓	✓	✓	✓	✓	3-5 deliveries for erection (1-2 weeks) and dismantling	10 months
Material Delivery Vehicles required for all works during period of construction	✓	✓	✓	✓	✓	1 day	11 months
Skip and Compactor Vehicles required for all works during period of construction	✓	✓	✓	✓	✓	1-2 per day (1st 6 months) 3 per week (final 5 months)	1 months

All vehicles delivering to the site will be issued with the site rules in relation to delivery hours and will be allocated to a specific loading or unloading time. All delivery vehicles will be banked to minimise the risk to road users and pedestrians.

Section 5 Transportation

Photographic Condition Survey

The adjacent highways and footpaths and street signage in the vicinity of the site, will be subject to a photographic condition survey which will be completed prior to the commencement of any works on site. We will during the works, complete regular inspections to ensure any issues arising from the works traffic are notified and rectified promptly.

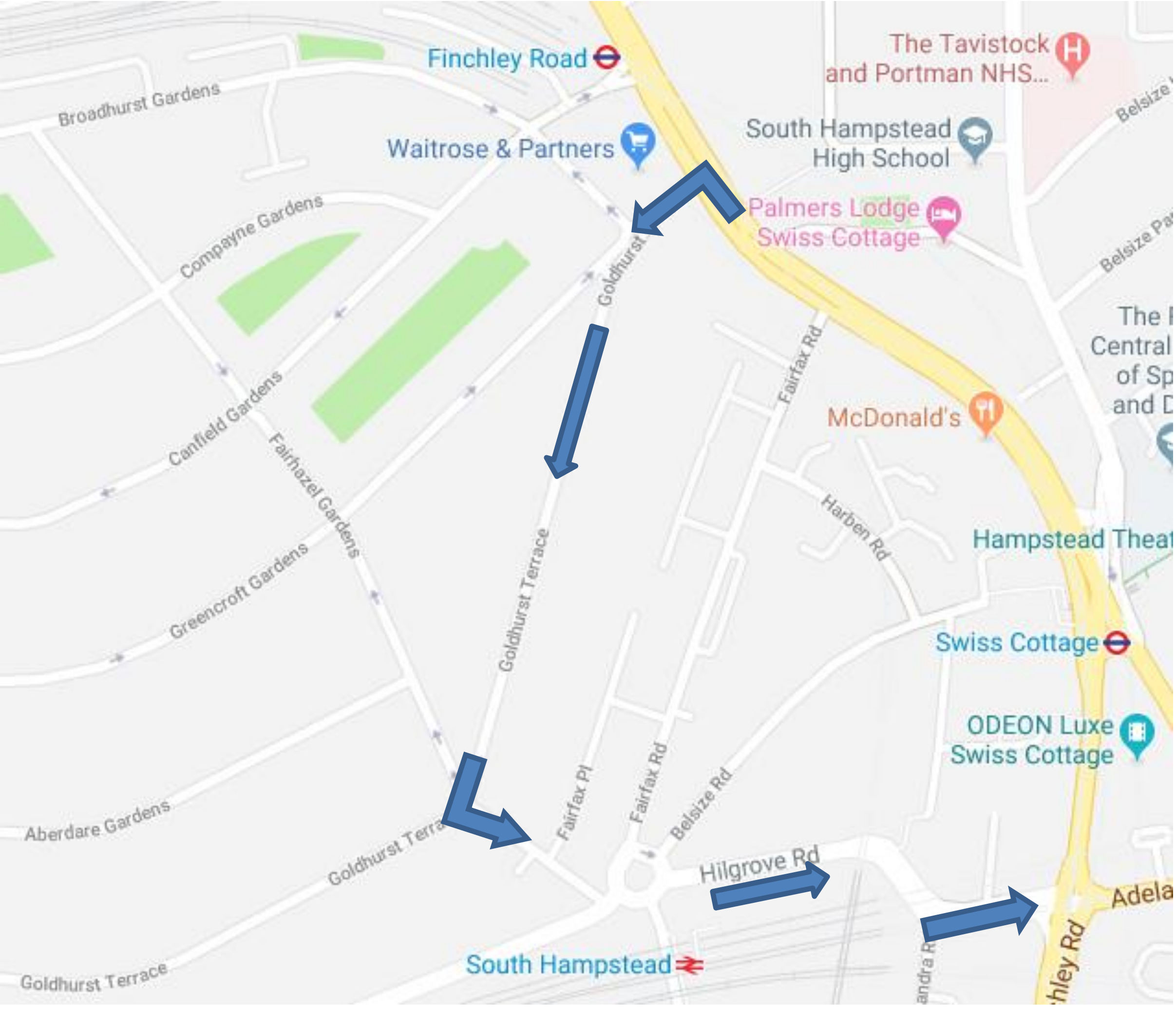
Construction Vehicles

Delivery vehicles will get as close to site as possible using the Transport for London Road Network (Red Routes) using either the A41. All vehicular access will be from Finchley Road, then on to Goldhurst Terrace.

59 Goldhurst Terrace located next to the A41, this links the A501 Westway and the A401 North Circular which, in turn, links to the M1 Motorway. This is one of the primary north/south routes from Central London out to the North Circular and the M1. The A41 will be the primary route used by all vehicles arriving and departing the site if arriving from the North and East of London via the North Circular. Vehicles arriving from the Central, West or South of London are likely to take the A501 and A41 to site.

All suppliers and subcontractors will be advised of the access routes to the site to ensure that vehicles follow the designated access route, signage will be provided adjacent to the loading point to advise no waiting is allowed, other than in the designated unloading bay.

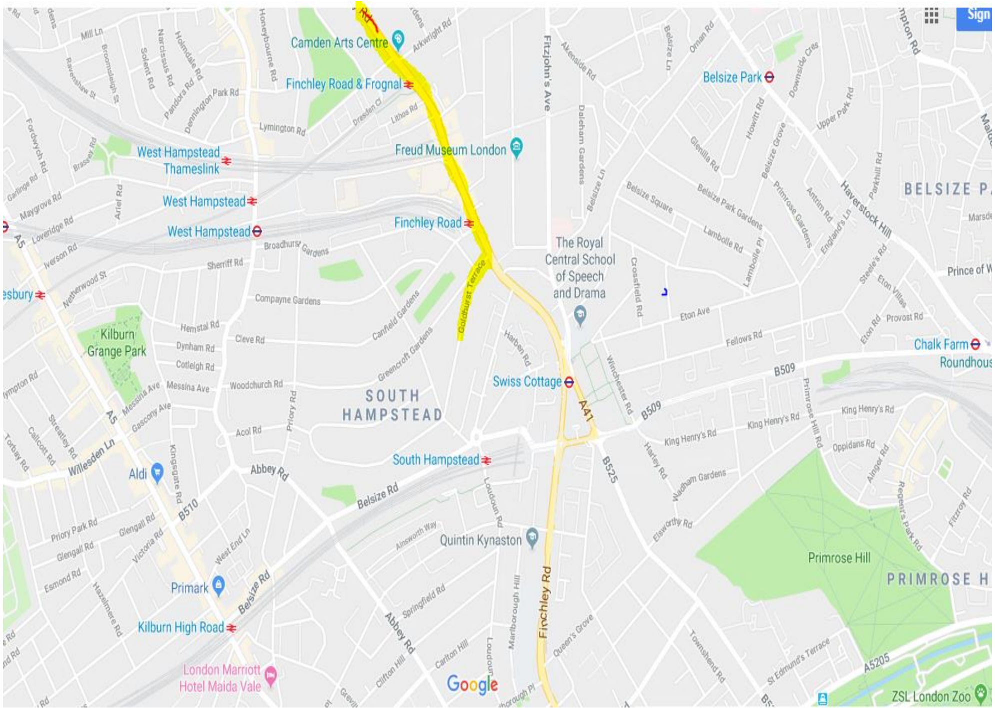
It is envisaged that there should be no implications to local bus routes from the proposed development.



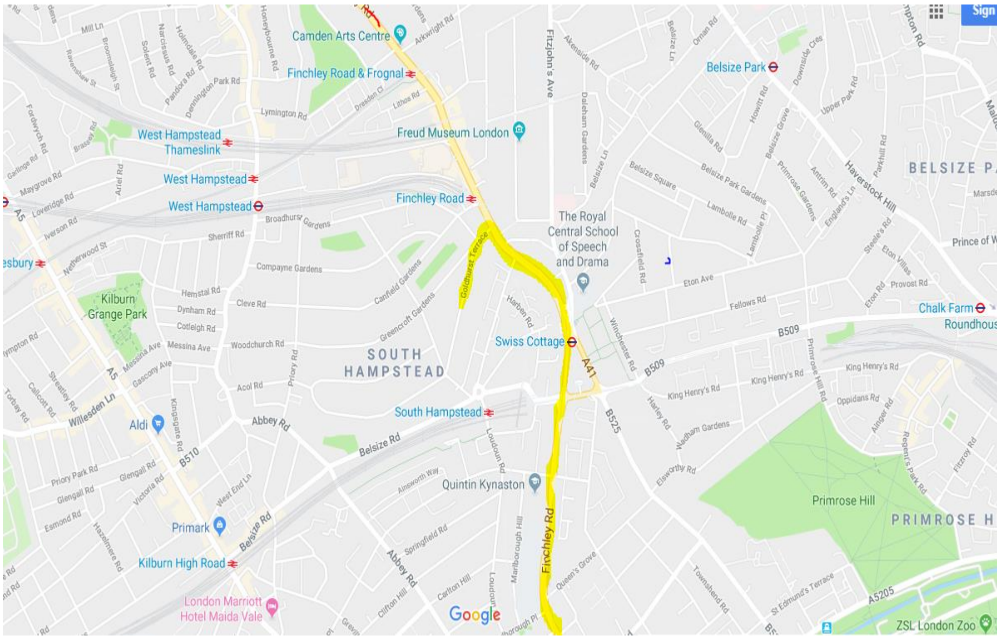
As Goldhurst Terrace is a one-way road, a one-way traffic system will be adopted

All deliveries will access Goldhurst terrace from the Finchley road (A41).

When leaving site, they will turn left from Goldhurst Terrace on to Fairhazel Gardens and back on to the Finchley Road via Hillgrove Road



Transport route from North



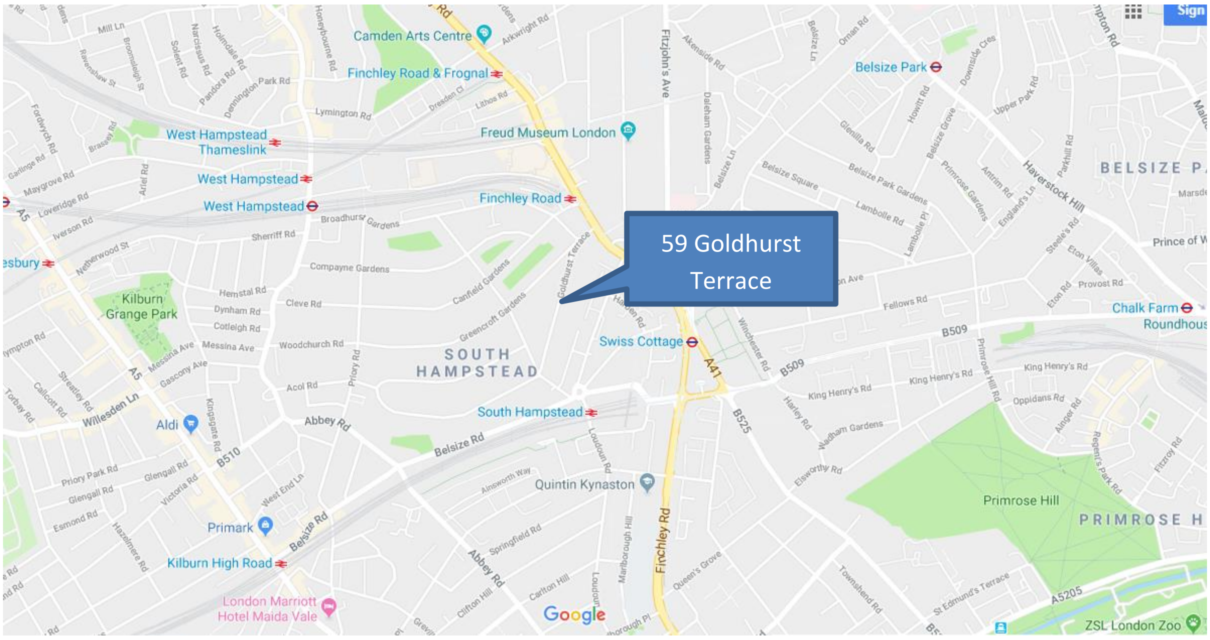
Transport route from South

Site Staff – Travel Plan

The location is well served with good transport links, so all site staff and operatives will be encouraged to use public transport to travel to and from the site, using the buses which operate on Finchley Road, or via the Jubilee Line at Swiss Cottage or Finchley Road.

There will be no onsite parking for site staff or operatives, and it will be made clear to all staff and operatives that the use of adjacent residential streets for parking will not be allowed. Any person found using adjacent streets for parking will be subject to a warning and any repeat offenders will be excluded from working on the site.

The premises are close to a busy high street. In developing the strategy for the CMP we have considered the peak hours for the nearby businesses and the residential nature of the adjacent properties.



Rail and underground links

Section 6 Environmental

Prior to commencement of any site works, we will produce a detailed Site Environmental Management Plan (SEMP). The SEMP will set out how we intend to operate the construction and work sites and will set out the specific control measures necessary to deliver the project, the SEMP will follow the parameters outlined below.

We will demonstrate, via the SEMP, the management, monitoring, auditing and training procedures that are in place to ensure compliance.

Due to the proximity of the residential properties to the Site particular focus will be given on managing noise, dust and air pollution. The following will be addressed when producing the final detailed risk assessments and method statements.

Area surrounding 69A Goldhurst Terrace. Predominately Residential properties

Noise

Where practicable noisy plant and equipment will be situated as far as possible from noise sensitive buildings and / or acoustic lined enclosures will be erected.

Where practicable, plant and equipment powered by mains electricity will be used in preference to equipment powered by petrol or diesel engine.

Where practicable, plant and equipment will be fitted with effective exhaust silencers; compressors will be fitted with properly lined and sealed acoustic covers which will be kept closed whenever in use; and pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers. All plant and equipment will be maintained in good and efficient working order and operated in such a manner as to minimise noise emissions. All plant will comply with the relevant statutory regulations.

Plant and equipment in intermittent use will be shut down or throttled down to a minimum when not in use.

Where practicable, percussive demolition equipment shall be avoided with preference given to bursting or nibbling equipment.

Vibration

Where practicable, plant, equipment and methods will be selected that will minimise vibration transferring to adjacent properties and the occupied retail units close by.

Dust and Air Pollution

The works will be carried out taking consideration of ‘The control of dust and emissions from construction and demolition’ best practice guide issued by the Mayor of London.

Methods of working will be selected for all activities that will aim to minimise dust and air pollution.

No burning of materials / refuse will be permitted on the site. No crushing of materials will be undertaken on site.

Excavation pollution will be minimised by a combination of screening and watering down.

All vehicles leaving the site, via Goldhurst Terrace, will be monitored to ensure that any dirt or dust dropped onto the highway is immediately cleaned up. Further to this, the area around the site, will be regularly and adequately swept on a regular basis to prevent any accumulation of dust and dirt, by the use of a visiting lorry mounted road sweeper during the demolition, excavation and piling phases.

All waste away vehicles shall be properly covered when leaving the site and disposed of at a licensed tip. In line with a project specific Site Waste Management Plan (SWMP).

Asbestos

A Type 3 Refurbishment & Demolition asbestos survey will be arranged when the site has been fully vacated. Any asbestos found will be removed by an approved removal company in accordance with all regulations and good practice.

Contaminated Land

Currently the project scope includes for a large amount of excavation which will produce spoil, therefore if contamination is discovered the Environmental Agency and Environmental Health Departments will be consulted; the contamination will be tested and the contaminated spoil, will be removed to a suitable licensed transfer station and/or landfill.

Drainage

Prior to demolition and excavation, any underground drainage runs connected to the public sewer, at risk of having construction waste entering into them, will be will be sealed off for the duration of these works.

Electrical, Data/Telecoms and Gas Services

All existing Gas Data/Telecoms and Electrical Services will be surveyed and terminated at the perimeter of the site, prior to commencement of main demolition works.

Section 7 Health & Safety

A site-specific health and safety plan, which will comply with the relevant Health and Safety Regulations for the works being undertaken including:

- Provision of first aid cover and equipment is present
- Responsible for ensuring that material movement to and from the workface does not cause damage to the works, the workforce or the public
- Complete safety inspections to company and client standards
- Ensure team has safety training to the company and client's standard programme
- Create appropriate logistics awareness training and deliver to site workforce
- Manage and maintain visitor PPE stocks
- Produce method statements, risk assessments ensure lifting plans are produced
- To protect road users and pedestrians from traffic created by the site works

Section 8 Liaising with the Authorities and the Public

Camden Council Liaison

We will liaise with the local Camden Council Environmental Inspectors both before the issuing of licenses and subsequently when the works commence.

In particular, a schedule of work will be issued to the Inspectors to enable the Council to assess the potential for nuisance including the location of plant with respect to sensitive areas and the locations of delivery, storage and handling areas.

In relation to the management of site traffic, we will work closely with the Camden Council – Highways Department to ensure that we minimise traffic disruption in the area surrounding the site.

As a member of the Considerate Constructor Scheme we will operate the site in line with their code.

Public

Prior to any works commencing, we will inform occupiers of adjoining properties which may be affected by construction works about the works to be undertaken. This will include details of the nature of the works, proposed hours of work and their expected duration. The information will be delivered as a letter to their premises and also erected in conspicuous positions around the site, with links to a website.

The letter will also include the name, mobile telephone number and e-mail address of a main contact within our organisation who is able to give further information and deal with any complaints or emergencies that may arise at any time. A log will be kept of contact with the public and the actions taken to resolve any issues arising.

The letter will be updated mid-way through the works informing the neighbours of site progress and projected activities that might cause loss of amenity in the next period, e.g. road closures etc.

Agreement

The agreed contents of this Construction Management Plan shall be complied with unless otherwise agreed in writing by the Council. This may require the CMP to be revised by the Developer/Main Contractor and reapproved by the Council. The Project Manager shall work with the Council to review this Construction Management Plan if problems arise in relation to the construction of the development. Any future revised plan must be approved by the Council in writing and complied with thereafter.

This CMP has been prepared by:

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