D. Structural Engineer’s Report

Report reference 5954, prepared by Julian Birch, CEng MIStructE, Owner / Principal at MBP and approved by Keith Jeremiah FICE FGS, Consultant and former Partner at MBP.

MBP

GROVE LODGE, LONDON NW3 6RS

Structural Engineer’s Report for Planning

Reference 5954

June 2015

Revision	Issue Date	Status	Approved
1	19 June 2015	Planning	JB

Executive Summary

Michael Barclay Partnership LLP (MBP) has been instructed by Mr C Berendsen to prepare the following Structural Engineer's Report in support of his planning application for a basement extension and alterations to Grove Lodge.

MBP have vast experience of designing basement structures and preparing reports to accompany planning applications. This report has been prepared by Julian Birch CEng MIStructE, a Chartered Structural Engineer with over 15 years of basement design experience, and reviewed by Keith Jeremiah FICE FGS, a Chartered Civil Engineer with over 30 years experience specialising in Ground Engineering. Geotechnical Assessments within this report have been made in conjunction with Steve Fleming CGeol of Ground Engineering Limited.

The purpose of this report is to demonstrate that the structural stability of the host building or its neighbouring buildings will not be put at risk by the proposed development.

This report forms an integral part of the Basement Impact Assessment prepared by HR Wallingford and has been prepared with reference to London Borough of Camden (LBC) Planning Guidance for Basements and Light-wells (CPG 4). This report provides support to the Land Stability element of the BIA by including and/or referring to the following supporting evidence:

- A desk study and detailed site investigation to confirm the ground and groundwater conditions around the property.
- A detailed investigation of the foundations of the host building and those of the adjacent buildings.
- A detailed assessment of ground movements and their impact on the host buildings and its neighbouring buildings
- A detailed construction sequence and methodology describing in detail how the host building and neighbouring buildings are to be protected in the temporary and permanent situations
- A detailed monitoring and contingency plan which is sufficiently robust to enable mitigation to be effectively implemented in the event of agreed trigger values for vertical and horizontal movements being exceeded at agreed monitoring positions.

This report concludes that the construction of the proposed basement will not have an adverse effect on the stability of the host building or its neighbouring properties.

Contents:

1.0 Introduction

1.1 Michael Barclay Partnership LLP (MBP) has been instructed by Mr C Berendsen to prepare the following Structural Engineer's Report to supplement a Basement Impact Assessment (BIA) prepared by HR Wallingford for a planning application for a basement extension and alterations to Grove Lodge.

1.2 This report has been prepared by Michael Barclay Partnership LLP on the instructions of, and for the sole use and benefit of, the Client. Michael Barclay Partnership LLP shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared and provided. If the Client wishes to pass copies of the report to other parties for information, the whole of the report should be copied. No professional liability or warranty is extended to other parties by Michael Barclay Partnership LLP as a result of permitting the report to be copied or by any other cause without the express written agreement of Michael Barclay Partnership L LP.

1.3 This report is to be read in conjunction with all other documents prepared by others in support of this planning application and in particular:

- Architectural Drawings by Design-NA
- Heritage Appraisal by Portico Heritage Limited
- Archaeological Desktop Assessment by Mills Whipp Projects
- Arboricultural Reports by Simon Jones Associates
- Ground Investigation Report C13390A: Ground Engineering
- Site Investigation & Geotechnical Interpretive Report J11827: Southern Testing
- Construction Management Plan by Burke Hunter Adams (BHA)

2.0 The Site

2.1 Grove Lodge is a Grade II Listed property attached to Admiral's House and located at the western end of Admiral's Walk. The site is illustrated on Design NA drawing dNA GLR 00 000. The property is located within the Hampstead Conservation Area.

2.2 The site lies at an elevation of approximately 128mAOD, close to the top of Hampstead Hill and 200m from Whitestone Pond, a man-made pond fed by artificial means.

2.3 The local topography in the vicinity of the site slopes downwards to the SW at approximately 1in 12 (approximately 5 degrees.) Surface water therefore also tends to flow in a SW direction. There are no significant slopes at the site as defined by the Camden Geological, Hydrogeological and Hydrological Study illustrated in Appendix A Fig 16

2.4 The local geology is shown on BGS London sheet No 1 SE at 1:10,560 Scale on BGS sheet No 246 North London at 1:50,000 Scale (Appendix A Fig 4). The site is shown to be underlain by the Bagshot Beds (glauconitic sand with thin beds of clay), which are underlain by the Claygate Beds (interlaminated clay, silt and sand) and the London Clay.

2.5 The geological maps suggest that the Bagshot Beds are likely to dip downwards in a SW direction at approximately 1.5 degrees. Sub-surface groundwater will also tend to flow in this general direction. The thickness of the Bagshot Beds is estimated from the map to be approximately 20m at the location of the site although this is unlikely to be precise.

2.6 Old sand pits are marked nearby on the heath to the north and in particular an area of worked ground, either wholly or partially back-filled, is marked just to the northwest of the site. However, no worked ground is marked at the location of the site.

2.7 No water courses are marked on the geological map at the location of the site. The nearest watercourse is shown on the geological maps as approximately 300m away to the west. This watercourse has a source near the outcrop of the Claygate Beds and flows in a WSW direction and eventually becomes a tributary of the River Westbourne – One of the "Lost Rivers of London" and now linked to a combined drainage system. The Lost Rivers of London Map (see Appendix A Fig 11 taken from Burton's Book and replicated in the Camden Geological, Hydrogeological and Hydrological Study) shows the stream originating slightly closer to the site

3.0 Existing Building

3.1 The existing building is sited over four floors including ground floor, two upper floor levels and a small basement. The fabric of the property comprises load bearing masonry walls, timber floors and cut timber roofs. An intrusive structural survey has yet to be undertaken although a visual inspection has found that the fabric of the property is in reasonable condition for its age with no visible signs of distress or other causes of structural concern.

3.2 It is understood that the oldest parts of the house date from the early 18th Century and that it was substantially altered c.1910. The general footprint of the northern wing appears on the Ordnance Survey maps of 1870 and 1894 however this part of the house appears to have been almost entirely rebuilt in the early 20th Century. The east elevation of this wing is constructed of Fletton bricks suggesting further mid-20th Century modifications

3.3 The garden at the rear of the property contains two small sheds, a small green house and a small loggia. The garden buildings are single storey light-weight structures.

3.4 There are a number of trees around the perimeter of the site and these are described in the arboricultural report by SJA

3.5 The property shares Party Walls with Admiral's House, Netley Cottage and Terrace Lodge.

4.0 Proposed Alterations

4.1 The proposed alterations are illustrated on Design-NA drawings

4.2 The proposals involve the rationalisation of the existing extensions to the southern wing including the removal of the modern games room, conservatory and garage, replacing them with a high-quality sympathetic extension. The existing garden buildings will be replaced with a single, ground floor Orangery. The garden will be sensitively re-landscaped. The interiors of the listed building will be refurbished and restored where appropriate throughout.

5.0 Desk Study

5.1 In order to inform the site investigation for the new basement and consider the impact of the project on the environment, MBP undertook a desk study using the "Landmark" search facility. The documentation obtained during this desk study has been summarised in Appendix B

6.0 Archaeological Desk-top Assessment

6.1 An Archaeological Desktop Study was undertaken by Mills Whipp Projects. The Archaeological Desktop Study is contained in a separate report by Mills Whipp Projects and accompanies this planning application.

7.0 Site Investigation

7.1 MBP instructed Southern Testing and Ground Engineering to undertake site specific ground investigations at Grove Lodge in order to establish both the ground conditions and ground water regime. This information is essential in order to design a robust basement structure and to minimise risk to the property and its neighbours through careful consideration of both the temporary and permanent works. The site investigations were undertaken in May 2014 and October 2014

7.2 The site investigations at Grove Lodge comprised three bore-holes to 15m depth in order to study carefully the recognised variability of the soils and groundwater around Hampstead Heath. The bore-holes were drilled to a depth of 15m and "divers" were installed in order to monitor groundwater levels continually. A window sample and trial pits were also dug to investigate the site boundaries.

7.3 The full scope of the site investigation, its findings and conclusions are contained in separate reports by Southern Testing and Ground Engineering and accompanying this planning application.

8.0 Review of Site Investigation

8.1 The site investigation indicates a shallow depth of made ground overlying Bagshot Sands as anticipated.

8.2 An interpretative geotechnical report is included within the site investigation report prepared by Southern Testing and accompanying this planning application.

8.3 Ground water was monitored in each of the 3 boreholes and was recorded at maximum levels of 123.7m in BH1, 122.7m in BH 2 and 122.4 m in BH3. There is nominal fluctuation in ground water levels. The ground water levels in the bore-holes have been monitored over a period approaching 12 months.

9.0 Structural Design of Proposed Basement

9.1 There is a single-storey basement extension proposed within this planning application.

9.2 The design of the proposed basement takes into account the data and recommendations obtained from the Site Investigation and Geotechnical Interpretive Report.

9.3 Structural drawings of the proposed basement construction are contained in Appendix C

9.4 In order to facilitate the construction of the extension to the existing basement it will be necessary to demolish some of the existing structure as illustrated on MBP drawing 5954/300 and Design-NA drawings. The shape and location of the new basement takes into account the root protection areas of the existing trees as discussed within the separate SJA Arboricultural Report.

9.5 The proposed basement is located close the boundary with Terrace Lodge and Admiral's House such that Party Wall Notices will need to be served in the normal manner. Highway Approval will need to be sought for the works close to the highways in the normal manner.

9.6 It is proposed to form the perimeter wall of the new basement using bored cfa piling as illustrated on MBP drawings 5954/301. This chosen method of construction minimises the plan extent of excavation and so minimises the impact on adjacent properties, trees and the highway.

9.7 The highest recorded level of perched groundwater lies only marginally above basement formation level. Consequently, although contiguous piling is likely to be successful given our extensive experience in the area, it is considered prudent to adopt a secant piling option to prevent water ingress into the excavation during construction. The wall is likely to fully penetrate the Bagshot Beds (Sand) unit and partially penetrate the relatively impermeable Bagshot Beds (Sand/Clay) unit.

9.8 In order to minimise the effect that the wall will have on the flow of groundwater flow beneath the new basement it is recommended that only the male piles are taken down to full depth and that the unreinforced female piles are terminated only a short distance below formation level. In this way there will be gaps between the male piles beneath the basement for the continued flow of ground water. If this is done, it is estimated that ground-water will be able to flow around and beneath the new basement with minimal impedance. Given that the head of water under consideration is nominal then the risk that dewatering will be required as a consequence of stopping the female piles just below the formation level is minimal and the need for temporary dewatering is extremely unlikely.

9.9 Within the envelope created by the piling / underpinning a “reinforced concrete box” will be formed and this will form a primary barrier to water ingress in the permanent works. A secondary barrier will be formed by installing a drained cavity system. The basement slab will be supported by piles so as to provide a uniform foundation and provide resistance to any uplift forces due to ground water. Heave forces are considered negligible given the shallow excavation and sandy strata

10.0 Outline Construction Sequence

10.1 The following sequence of works has been considered for the extension to the existing basement. However, the actual construction sequence adopted by the chosen contractor may vary, subject to agreement with the structural engineer taking into account the points raised in this report and accompanying documentation:

- Set up monitoring targets / Total Stations
- Demolish existing structures
- Underpin existing basement as illustrated on MBP Drawing 300 using a traditional hit & miss sequence as illustrated
- Form piling mat
- Form perimeter basement wall using cfa secant bored piling as illustrated on MBP drawing 301
- Form bearing piles and temporary piles
- Support portion of existing building on needles off temporary piles
- Form capping beam as MBP drawing 305 using "blisters" such that the props can be sited above the new GF SSL.
- Install Temporary Plan Bracing MBP drawing 305
- Reduce level dig within footprint of piling leaving berms as illustrated on MBP drawing 305
- Form Basement slab and liner walls as noted on MBP drawing 303
- Cast GF slab as illustrated on MBP drawing 302
- Remove Temporary Propping

11.0 Consideration of Ground Movement

11.1 The proposed method of construction described in this report will minimise ground movements

11.2 A detailed assessment of ground movements has been made using CIRIA C580 and is contained in Appendix D. This assessment has been made by MBP in conjunction with Ground Engineering. The piles and their propping will be designed to minimise ground movement and ensure that any predicted damage lies in the range Category 1-2 (very slight – slight) and is no worse than Category 2 (slight) according to Burland.

11.3 The installation of bored piles is known to cause ground movements as a consequence of loss of horizontal support during drilling. CIRIA C580 - Embedded Retaining Walls – Guidance for Economic Design, suggests that based on observation made in the London Area, that the installation of the bored piles will cause no more than 5mm of vertical differential settlement between the piling and the closest structure. Records of data on horizontal movement due to pile installation are known to be very limited and very scattered and in practice horizontal movements due to pile installation can be ignored.

11.4 Consideration has been given in this report to installing a stiff prop at the head of the piled wall ahead of excavation where the piles lie close to the site boundary: This method of construction is recognised as being the most effective in limiting ground movements outside of the site. The construction sequence at critical boundary sections is illustrated on drawings 306-309 Appendix C

11.5 The closest non-basement structure to the piled wall is the Terrace Lodge. A Burland Damage Assessment has been made for this property and the predicted Category of Damage for this structure is no worse than Category 2 (slight). Admiral's House is more remote and has a substantial basement within. Therefore it can be stated that the predicted category of damage for Admiral's House is Category 1 (Very Slight) or better.

11.6 The existing host building has a basement adjacent to that now proposed. Consequently the proposed works represent a lateral extension to that existing basement, at a very slightly increased depth. Therefore it is considered that the risk of ground movement causing damage to the host building due to piling is negligible.

11.7 The underpinning works to the host building are relatively shallow and will be undertaken by a Member of the Association of Specialist Underpinning Contractors so as to ensure a high standard of workmanship. Accordingly, it is widely accepted that in the site ground conditions encountered, the net settlements due to underpinning will be very small, horizontal movements will also be very small and any predicted damage should be no worse than category 1 (very slight) according to Burland.

12.0 Monitoring

12.1 A detailed movement monitoring strategy has been considered for the site as illustrated on MBP drawing 305. The monitoring strategy includes Total Station Monitoring of targets positioned on the Party Walls, Façade and Capping Beam. Additionally, Precise Levelling Stations will be located on the highways immediately adjacent to the site. Monitoring of the Party Walls and Highways will need to be agreed with Party Wall Surveyors and Statutory Authorities

12.2 Drawings 305 indicating the proposed movement monitoring points is contained in Appendix C

12.1 The existing buildings are to be monitored before works commence to establish a base-line and then monitored during and after completion of the works for displacement in the horizontal and vertical planes by an organisation independent of all parties involved in the design and construction.

12.2 Monitoring will be accomplished by using targets fixed to the boundary walls and the property itself and will be read from a fixed stationary point. Additional monitoring points will be located on the capping beam ahead of basement excavation.

12.3 It is recognized that some of the targets will become hidden as the works proceed and consequently their precise location needs to be carefully considered to ensure consistency of readings during the whole monitoring period.

12.4 Results of the movement monitoring shall be presented as graphs showing vertical and horizontal movement with time (as well as a standard tabulated format). The data shall be compiled in a report and issued to the engineer within 24 hours.

12.5 The frequency of readings shall typically be weekly during critical construction phases i.e. during underpinning, excavation and casting of the submerged RC 'box'. Monthly monitoring shall be completed for a time of 6 months following construction of the basement or until such time that any ongoing movement has ceased.

12.6 Trigger values are to be established and a traffic light warning system put into place so that the Contract Administrator, Contractor and Structural Engineer may be alerted, and necessary actions may be undertaken when recorded movement approaches trigger values.

12.7 The following table, based on the Assessment of Ground Movement lists a set of trigger values for existing elements in terms of green, amber and red limits:

Element	Green	Amber	Red
Boundary Walls	Vertical Settlement or heave up to 3mm Lateral Deflection up to 3mm	Vertical Settlement or heave up to 6mm Lateral Deflection up to 6mm	Vertical Settlement or heave up to 10 mm Lateral Deflection up to 10 mm
Capping Beam	Vertical Settlement or heave up to 3mm Lateral Deflection up to 3mm	Vertical Settlement or heave up to 6mm Lateral Deflection up to 6mm	Vertical Settlement or heave up to 10mm Lateral Deflection up to 10mm

12.8 Settlement and / or movement of the boundary structures has been predicted to be in the 'very slight to slight' 1-2 category of damage as defined by the damage category chart from CIRIA C580 (Burland category). The proposed construction sequence described in this report has been chosen to maximize restraint of the piled wall where it lies close to boundary structures and consequently limit ground movement.

12.9 Settlement of the existing host building has been predicted to be negligible provided construction workmanship is tightly controlled.

12.10 No remedial action is required if readings are all within the green zone.

12.11 Should recorded movement reach the amber zone then further excavation is to cease until following contingency has been activated:

- The frequency of monitoring is to increase to daily recordings to predict the rate of movement.

- If predicted movement is expected to exceed the upper limit of the amber zone then a strategy to minimise movement, such as jacking the structure using hydraulic struts, and adjusting the temporary works proposals is to be proposed by the Contractor for review by the Structural Engineer.

- Should recorded movement reach the red limit, work on site is to cease until a strategy to proceed is to be agreed between the Contractor and the Structural Engineer and following contingency has been activated. The frequency of monitoring is to remain as daily

13.0 Basement Impact Assessment

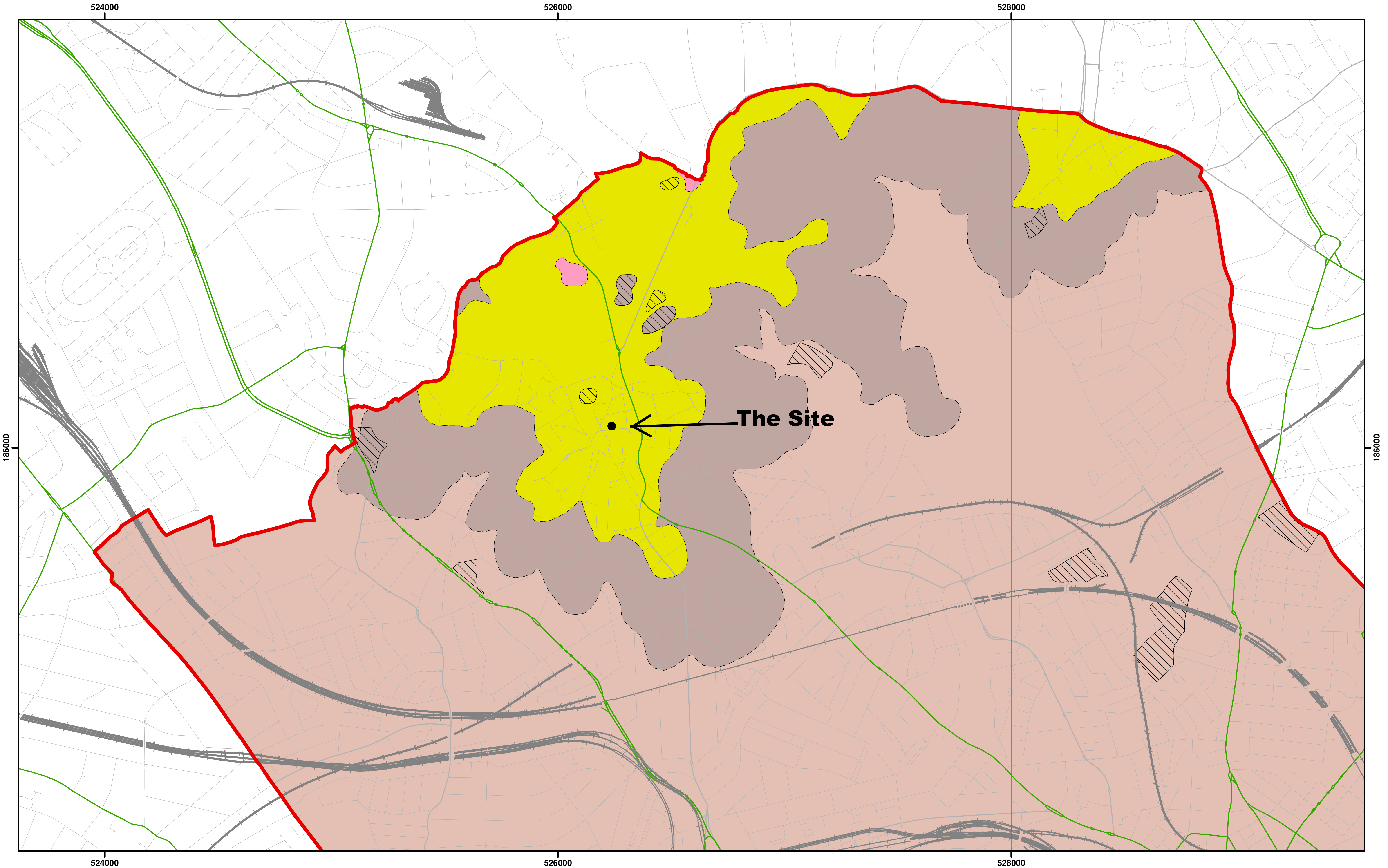
13.1 The construction of basements is increasingly popular and the London Borough of Camden (LBC) requires the preparation of a Basement Impact Assessment as part of the planning documentation.

13.2 HR Wallingford have prepared a Basement Impact Assessment for the site in conjunction with both MBP and Ground Engineering: This report forms part of the BIA.

14.0 Construction Management Plan & Traffic Management Plan

14.1 A Construction Management Plan (CMP) has been prepared for this project by BHA and is a separate document to this report.

Appendix A – Figures



Data Source: BGS Mapping - Scale 1:10,000

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Scale at A3: 1:15,000

Coordinate System:
British National Grid
GCS_OSGB_1936

0 0.25 0.5 1 1.5
Kilometers

Legend

London Borough of Camden
Railway Lines
A Roads

BGS 1:10K Artificial Ground
MADE GROUND
WORKED GROUND

BGS 1:10K Drift Geology
ALLUVIUM
HACKNEY GRAVEL FORMATION
LANGLEY SILT FORMATION
LYNCH HILL GRAVEL FORMATION
STANMORE GRAVEL FORMATION

BGS 1:10K Solid Geology
BAGSHOT FORMATION
CLAYGATE MEMBER
LAMBETH GROUP
LONDON CLAY FORMATION

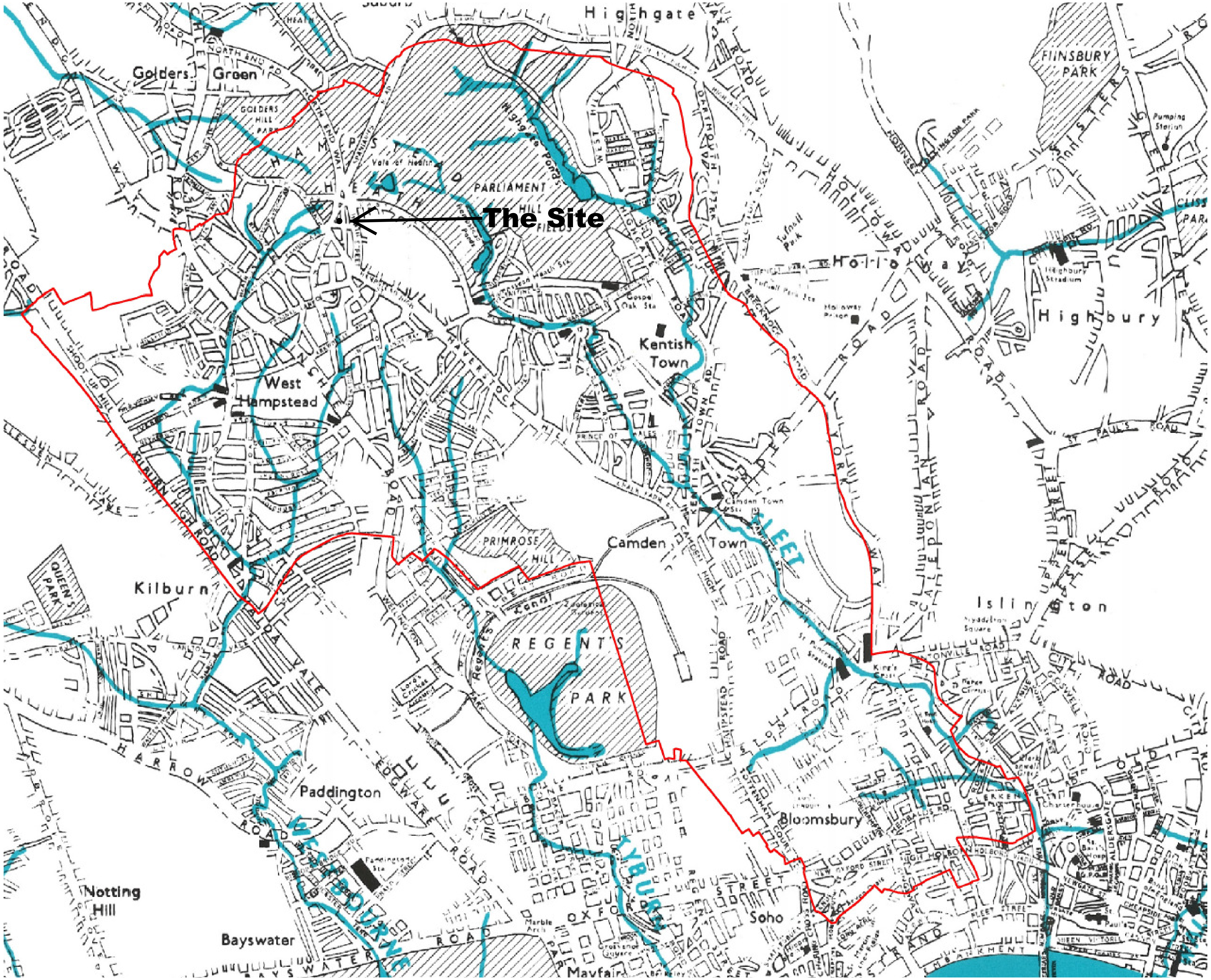
NB. Geological boundaries are largely indicative based on available geological mapping data

Camden Geological, Hydrogeological and Hydrological Study

North Camden Geological Map

213923

FIGURE 4

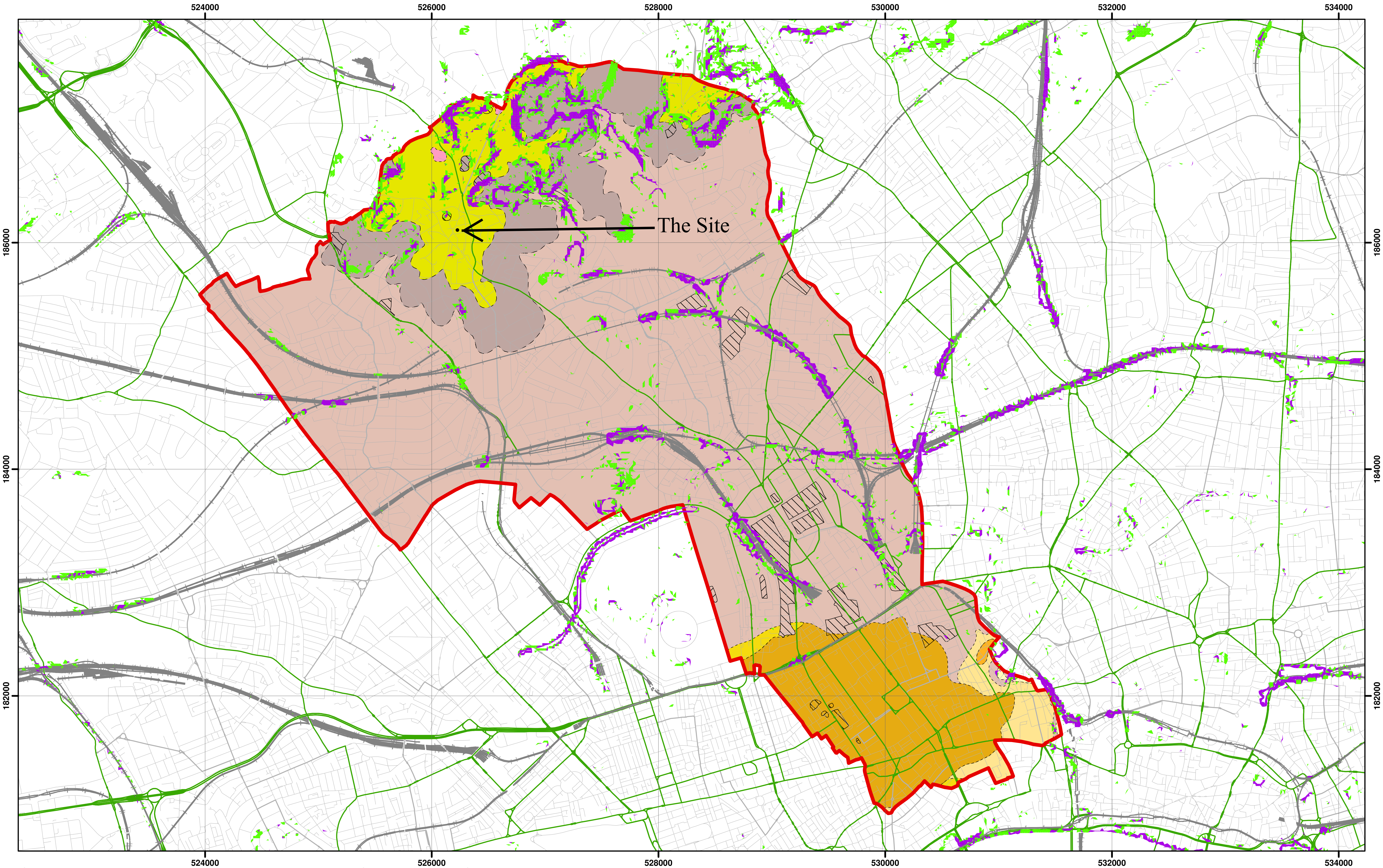


Source – Barton, Lost Rivers of London

Camden Geological, Hydrogeological and Hydrological Study
Watercourses

213923

FIGURE 11



Slope Angles calculated from Digital Terrain Model Provided By Camden Bourough Council

N

Scale at A3: 1:30,000

0 0.5 1 2 3

Kilometers

1:10,000 BGS Mapping
Coordinate System:
British National Grid
GCS_OSGB_1936

Legend

Slope

0° - 7°

7° - 10°

> 10°

London Borough of Camden

Railway Lines

A Roads

BGS 1:10K Artificial Ground

MADE GROUND

WORKED GROUND

BGS 1:10K Drift Geology

ALLUVIUM

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BAGSHOT FORMATION

CLAYGATE MEMBER

LAMBETH GROUP

LONDON CLAY FORMATION

NB. Geological boundaries are largely indicative based on available geological mapping data

Camden Geological, Hydrogeological and Hydrological Study

Slope Angle Map

213923

FIGURE 16

Appendix B – Desk Study

Geological and Hydrological Desk study - Landmark Search

1.0 INTRODUCTION

Michael Barclay Partnership LLP (MBP) instructed Landmark to undertake a “search” for historic technical data within a 500m radius of the site, focusing particularly on the geology of the area given the planned basement extension. This report summarises the findings of the search.

2.0 ENVIROCHECK DATA

2.1 GEOLOGY

Bedrock Geology – The geological maps confirm the findings of the existing borehole report for the site; that the house, and gardens are situated on a Bagshot Formation of sands and clays. This soil overlies the Claygate Beds. Below the Claygate Beds the soil becomes London Clay. The variable permeability of the soil makes it difficult to predict the level of perched or standing groundwater across the site and consequently bore-holes with data loggers were installed on the site.

Artificial Ground – An area of ground about 200m from the site has been marked as Worked Ground, indicating that the ground here has at some point been cut away. No artificial ground is recorded within the site.

2.2 AGENCY AND HYDROLOGICAL

Ground Water Vulnerability - The ground at the site has been geologically classed as a minor aquifer (variably permeable) with a soil class of HU. The soil class HU is characterised by soils of high leaching potential, with little ability to attenuate diffuse source pollutants and in which non-absorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater. The runoff potential of the soil is low.

Boreholes –Data from the boreholes and boreholes on MBP projects close to the site provide a sufficiently detailed soil profile of the site for the purposes of structural design.

Source Protection Zones – None present within or in the vicinity of the site.

Flood – The data suggests little risk of flooding within the site or close to the site.

2.3 SENSITIVE LAND USES

No sensitive land uses are recorded within or in the vicinity of the site.

2.4 MINING AND GROUND STABILITY DATA

Potential for shrinking or swelling clay within the site is classed as moderate in the Claygate Beds layer of the soil profile, but very low in the Bagshot Formation layer. The design of all below ground works near trees will need to recognise the shrinkability of the local soil although the implications for the proposed basements are minor.

Potential for running sand is classed as low on the Envirocheck maps but the presence of sands and gravels in the soil suggests a possible risk of localised running sand. Design of new structures within the depth of the water tables will take the nature of the ground into account as appropriate and as described elsewhere within this report.

Potential for landslide is classed as very low.

2.5 HISTORICAL DATA REPORT

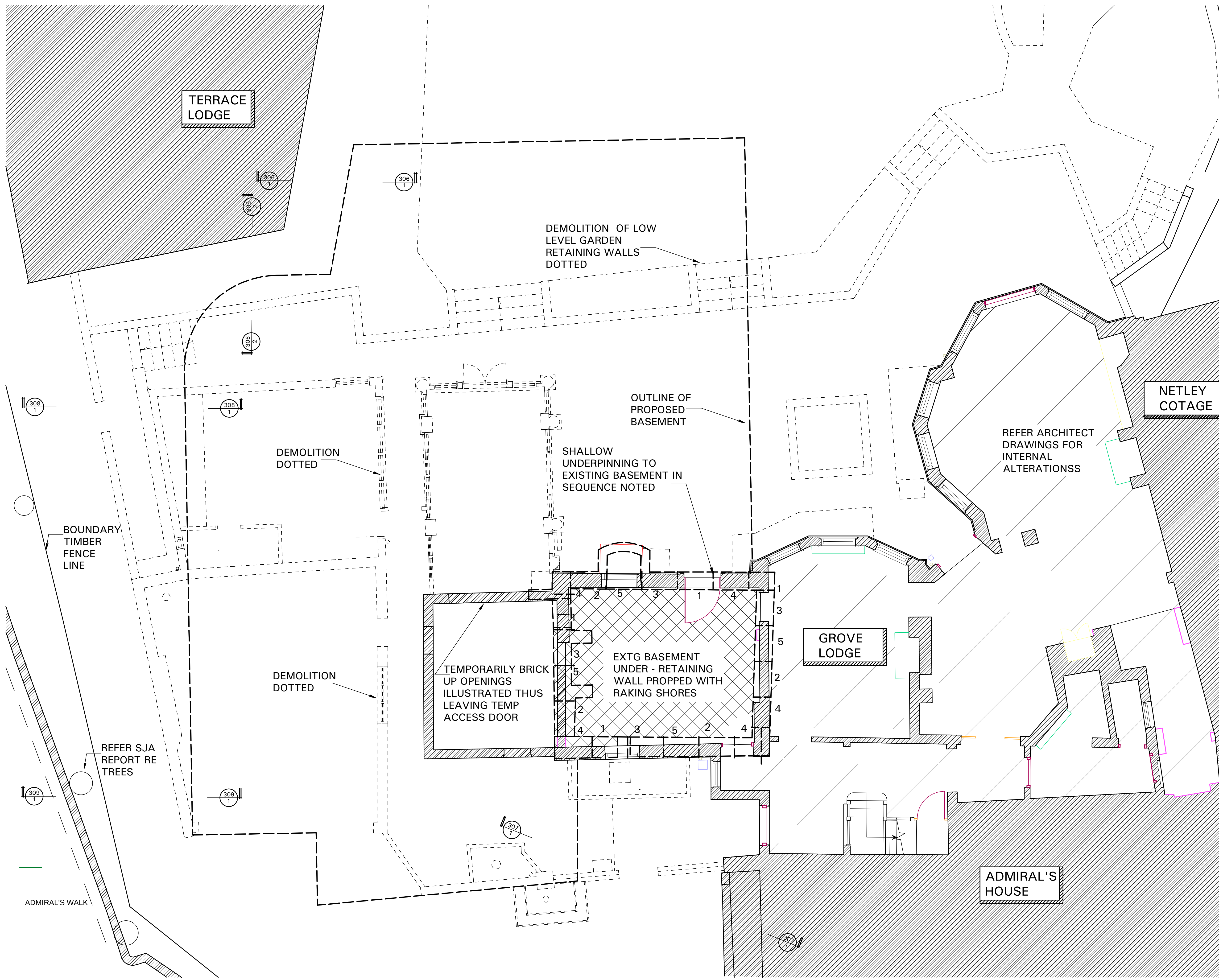
Historical Land Use – No potentially contaminative industrial uses are shown within the site.

No historical tanks or energy facilities as shown within the site.

2.6 EXISTING SERVICES

Records of existing services have been obtained and will not be impacted by the works

Appendix C – Structural Drawings, Calculations & Underpinning Specification



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Title: EXISTING GROUND FLOOR PLAN PROPOSED DEMOLITION & UNDERPINNING

Job: GROVE LODGE LONDON NW3 6RS

Scale	Date	By	Checked	Drawing Number	Revision
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Status: PLANNING

Rev	Date	Description	By
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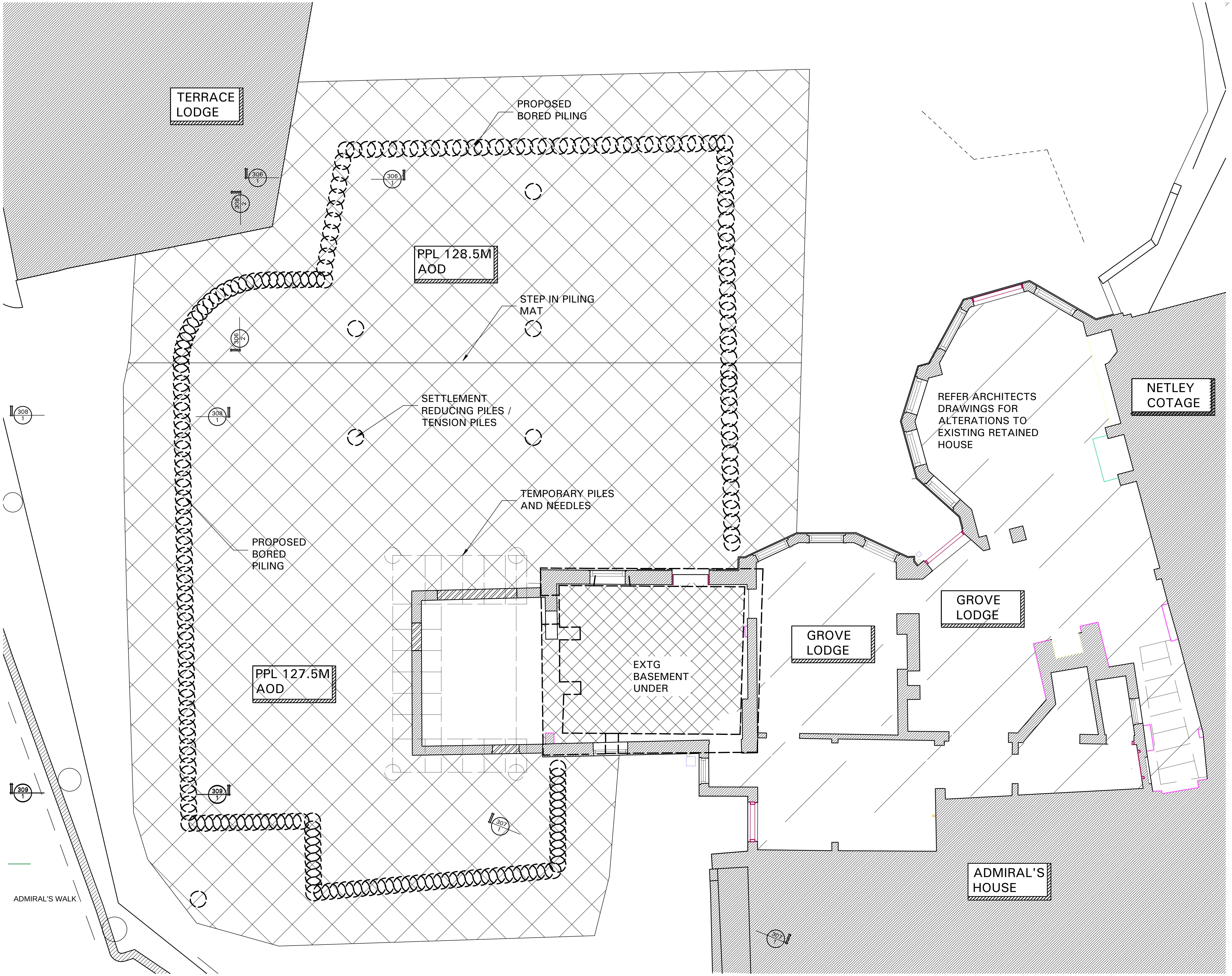

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Title
EXISTING GROUND FLOOR PLAN
PROPOSED PILING LAYOUT

Drawing Number: 5954 / 301
Revision: P1

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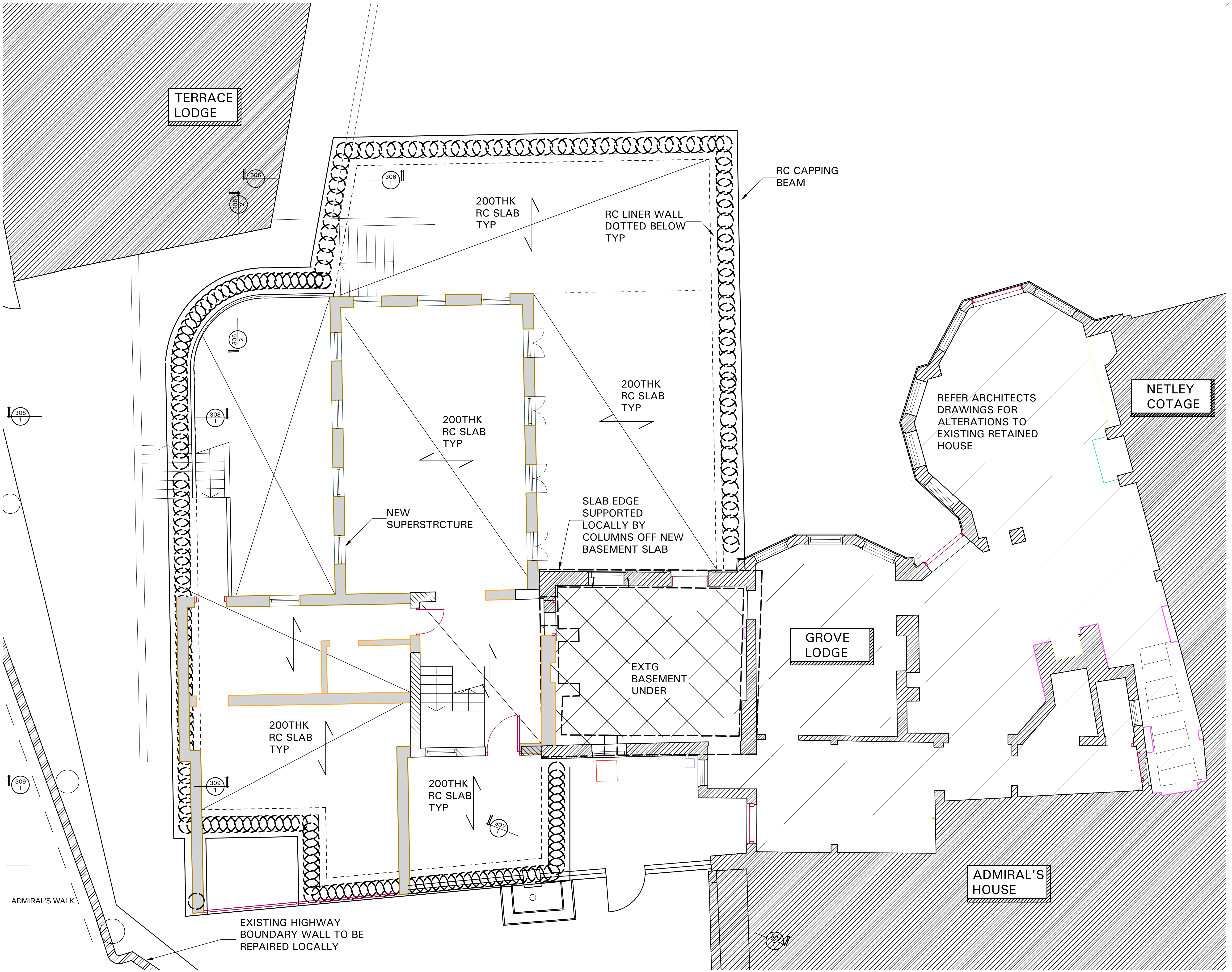

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Title
PROPOSED GROUND FLOOR PLAN

Revision
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Drawing Number
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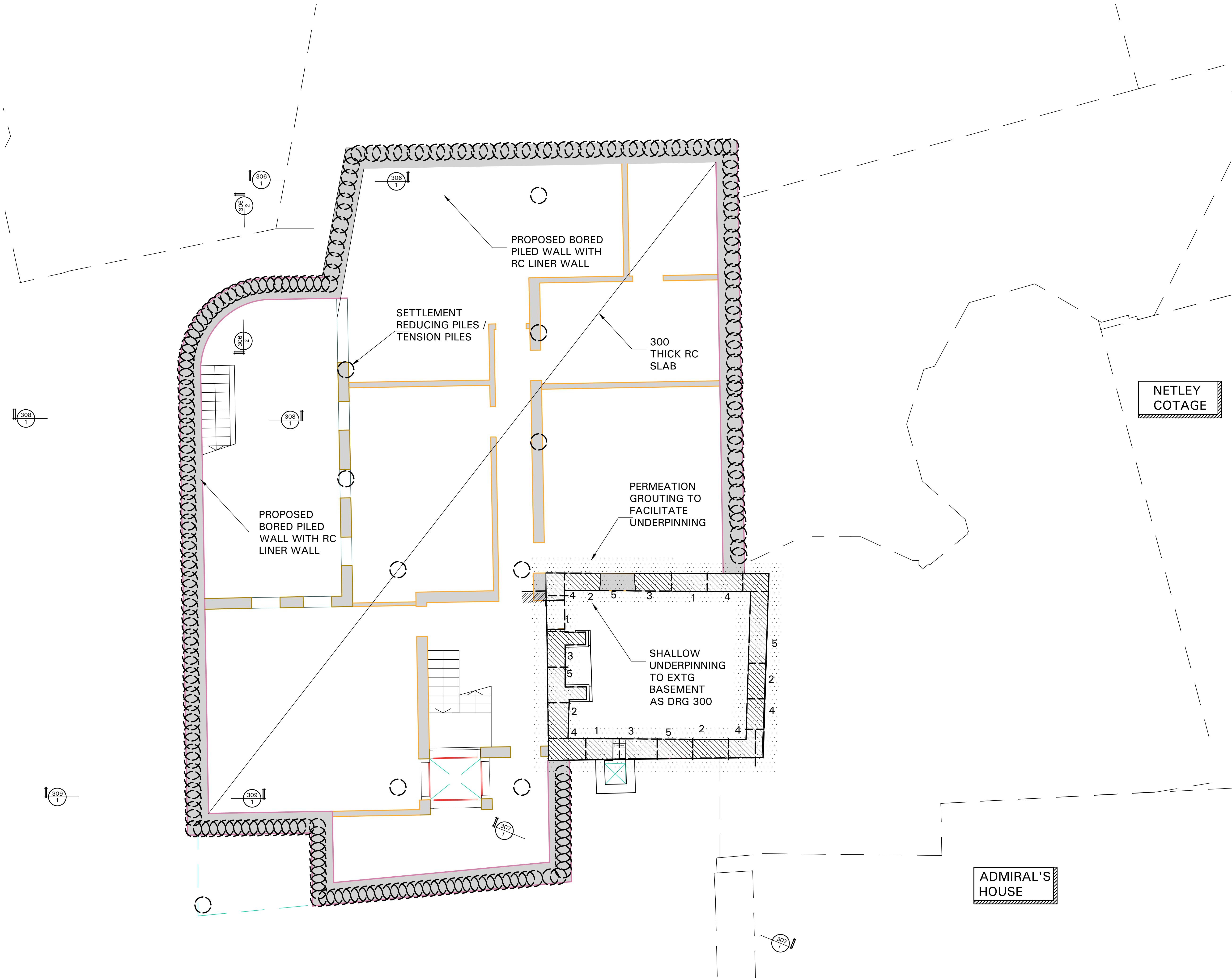

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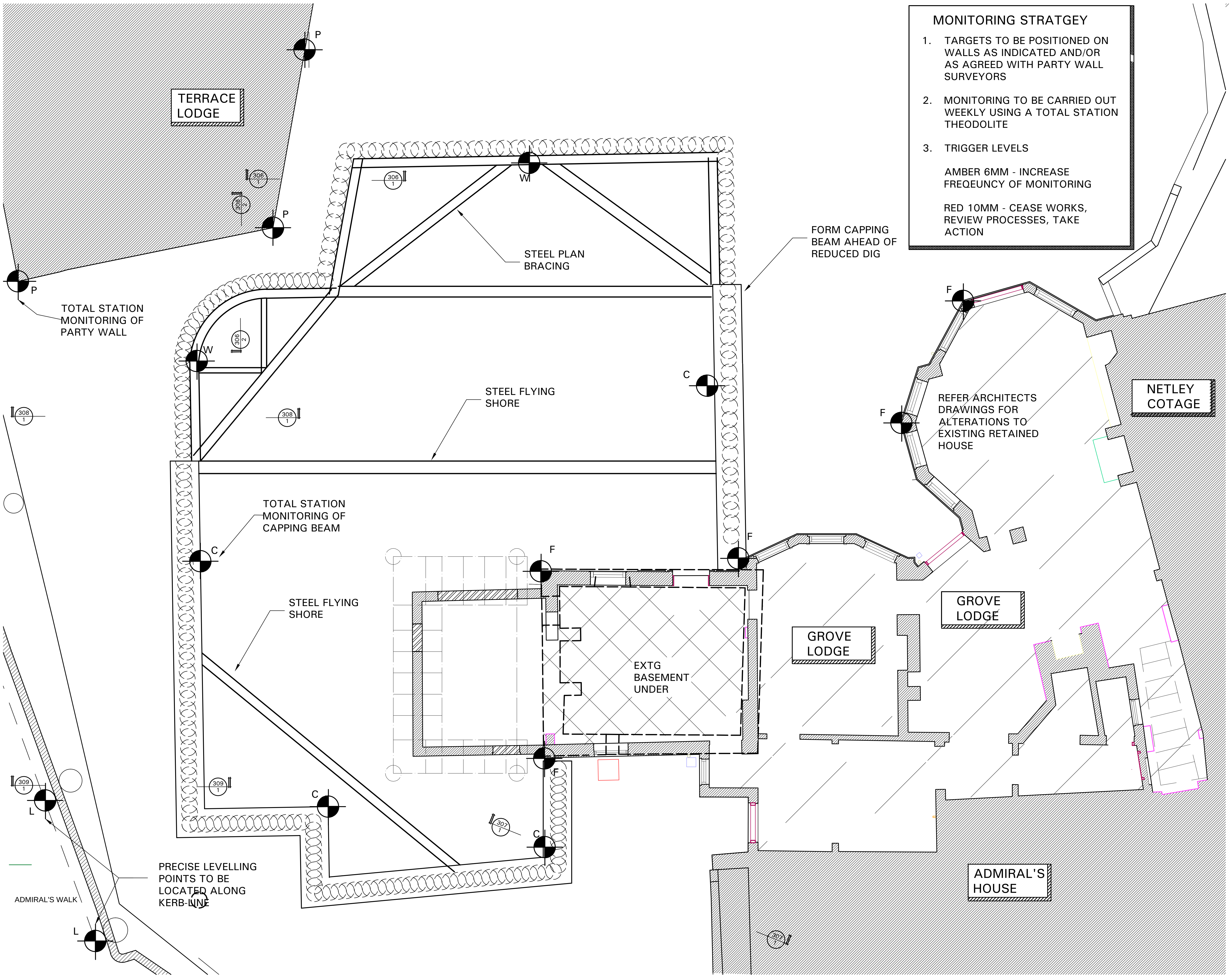

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TEMPORARY WORKS AND MONITORING

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Revision: P1
Status: PLANNING

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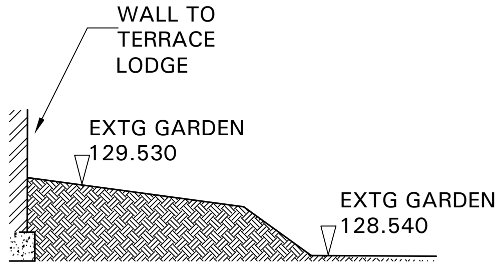

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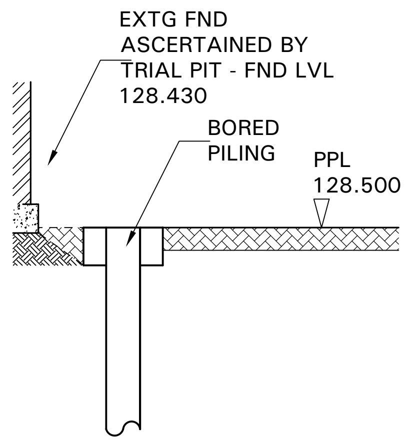
SECTION 1 - EXISTING



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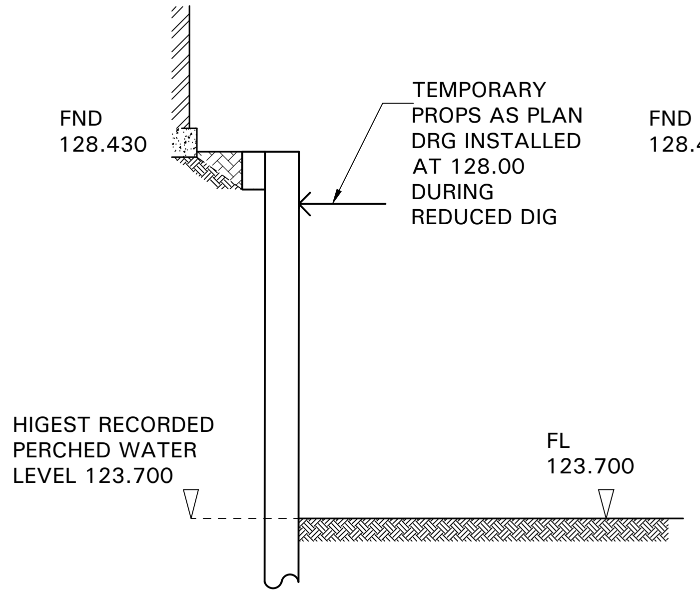
SECTION 1 - STAGE 1



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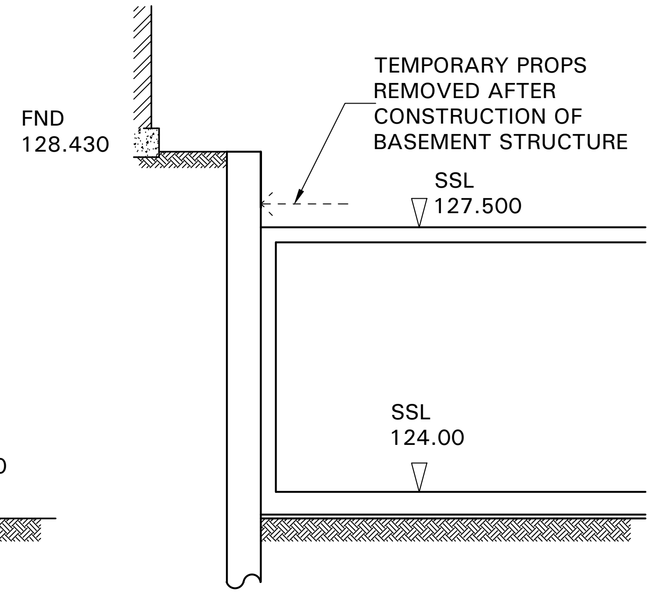

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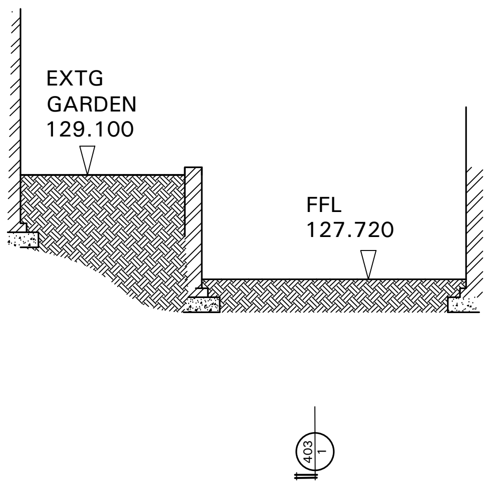

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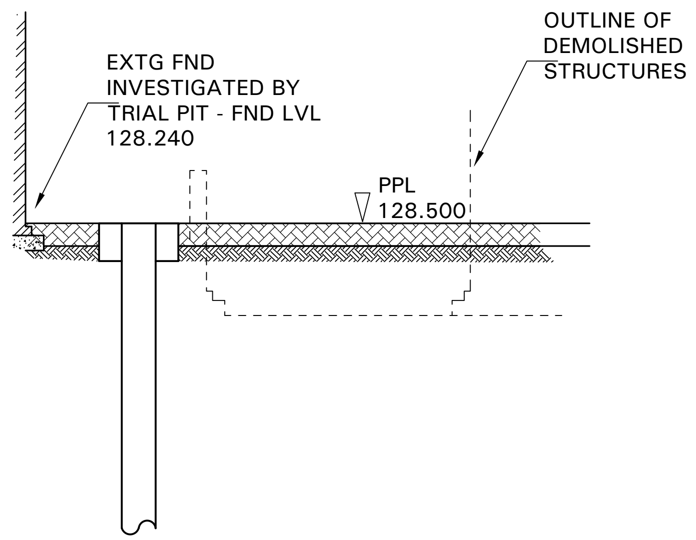

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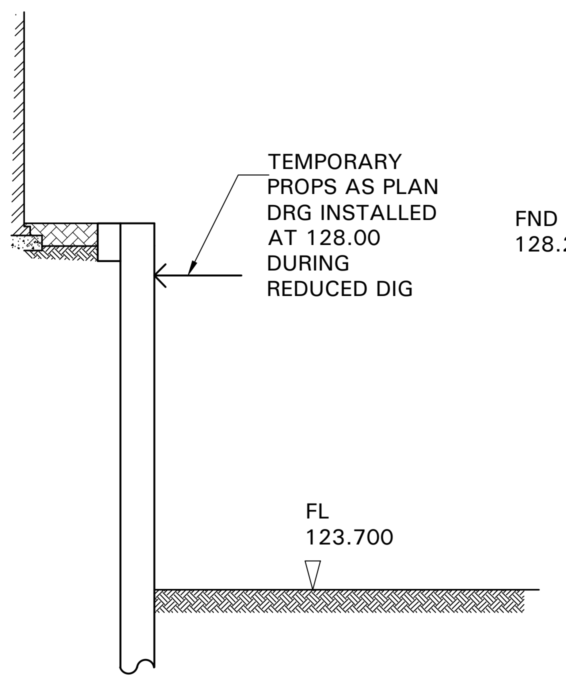

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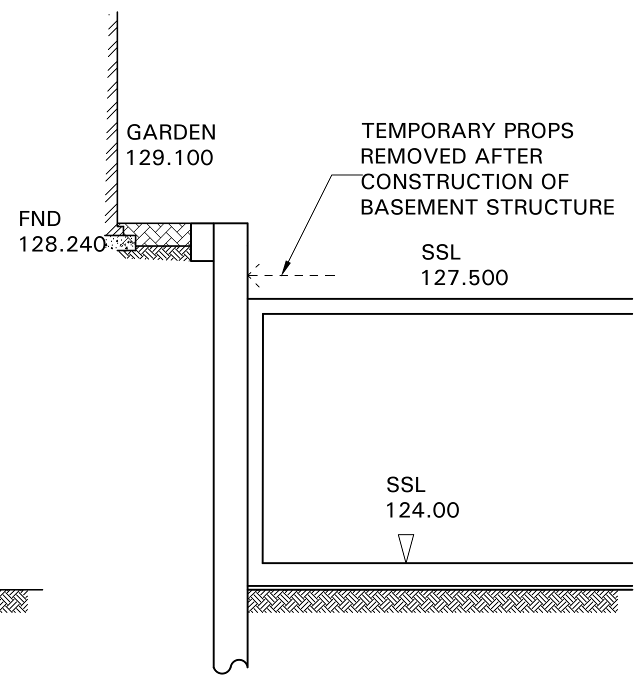

TERRACE LODGE BOUNDARY
SECTION 2 - STAGE 3

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Job
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Title
CONSTRUCTION METHODOLOGY
TERRACE LODGE X-SECTIONS

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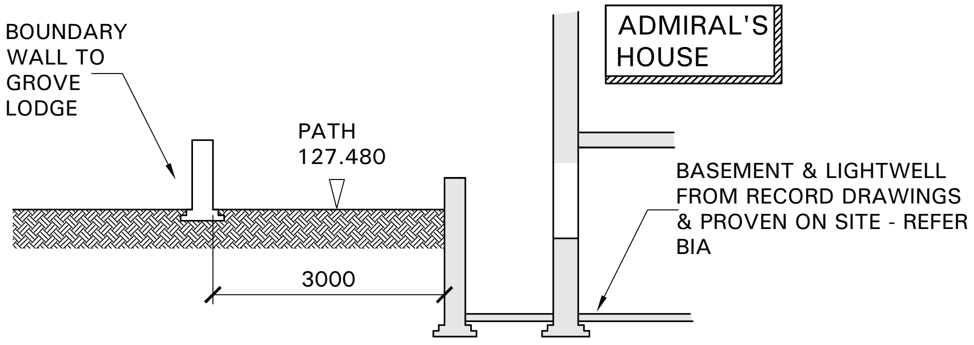
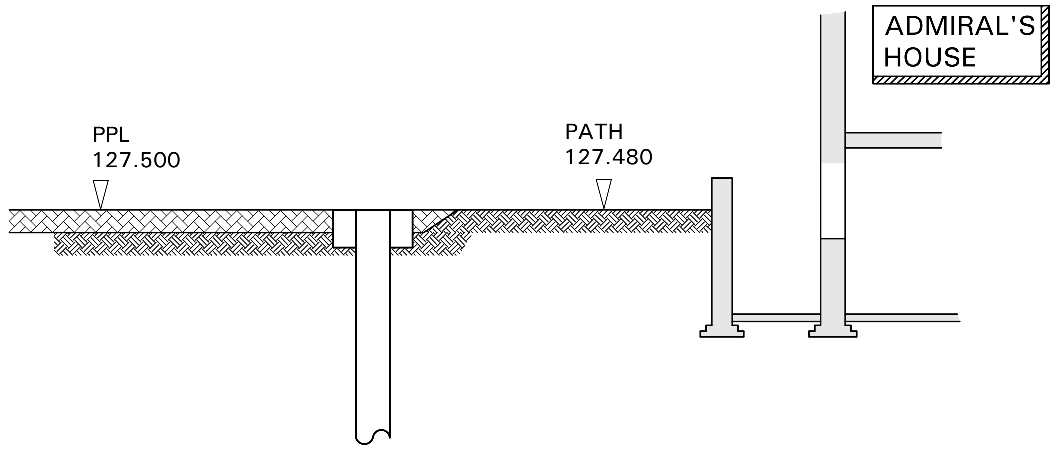
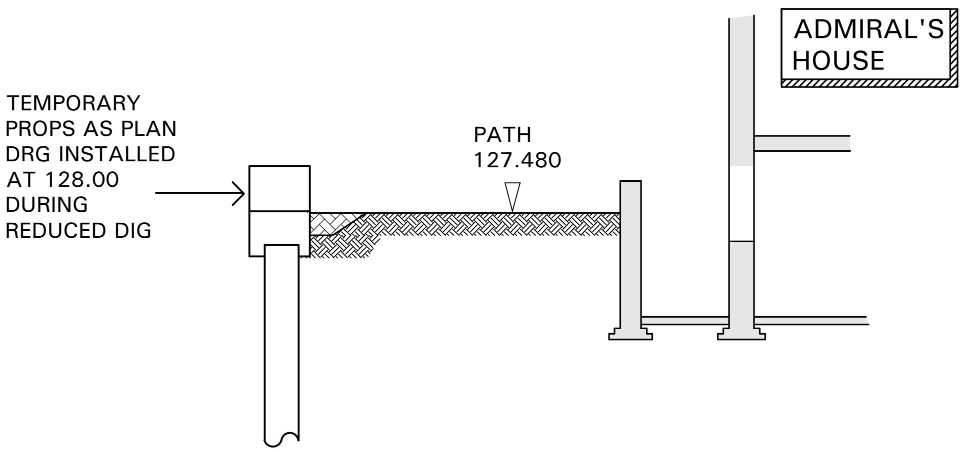


ADMIRALS HOUSE INTERFACE
SECTION 3 - EXISTING



ADMIRALS HOUSE INTERFACE
SECTION 3 - STAGE 1



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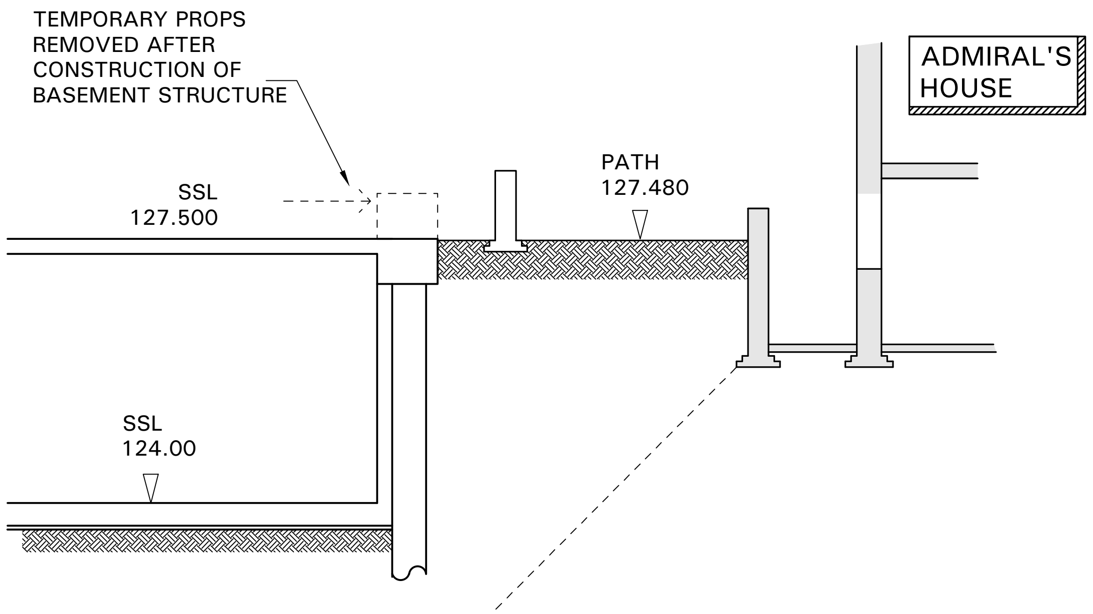
SECTION 3 - STAGE 2



ADMIRALS HOUSE INTERFACE
SECTION 3 - STAGE 3

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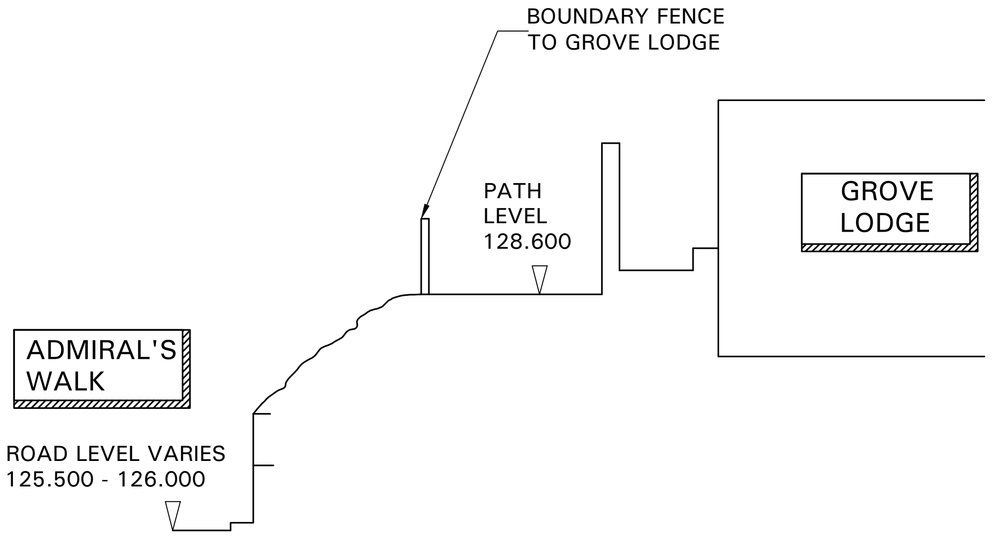
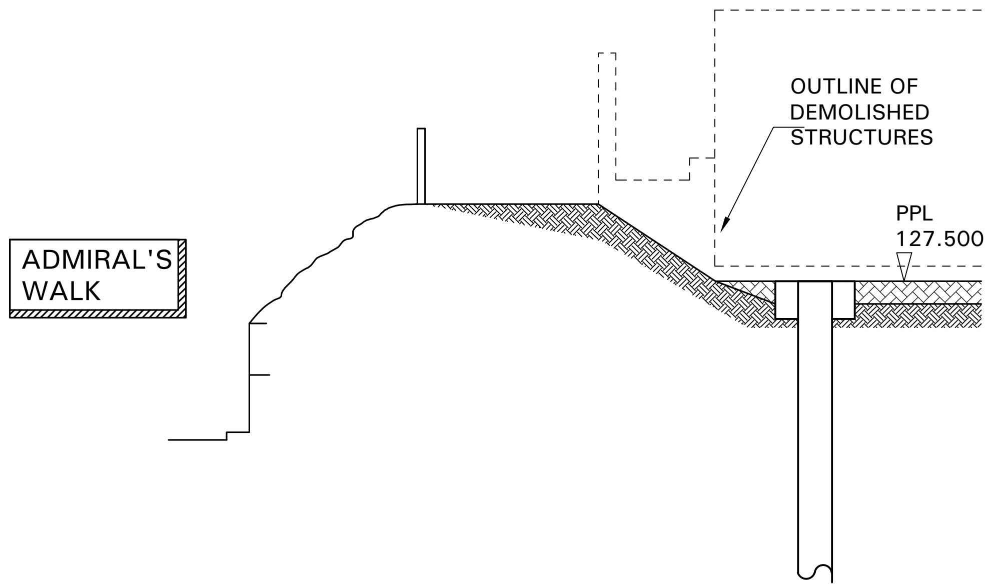


ADMIRALS WALK INTERFACE
SECTION 4 - EXISTING



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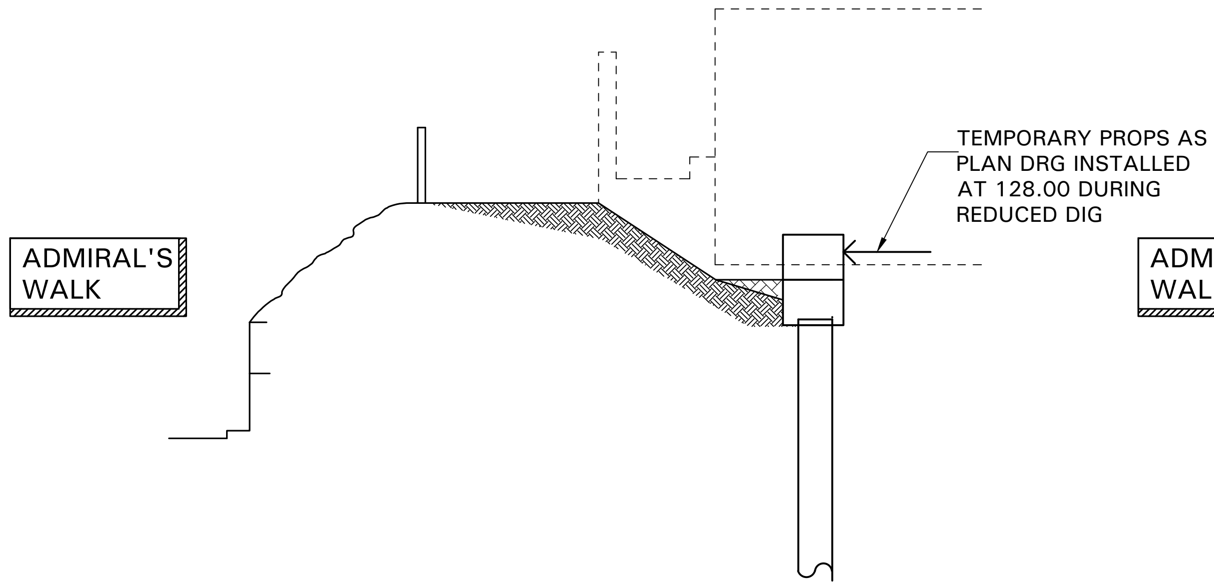
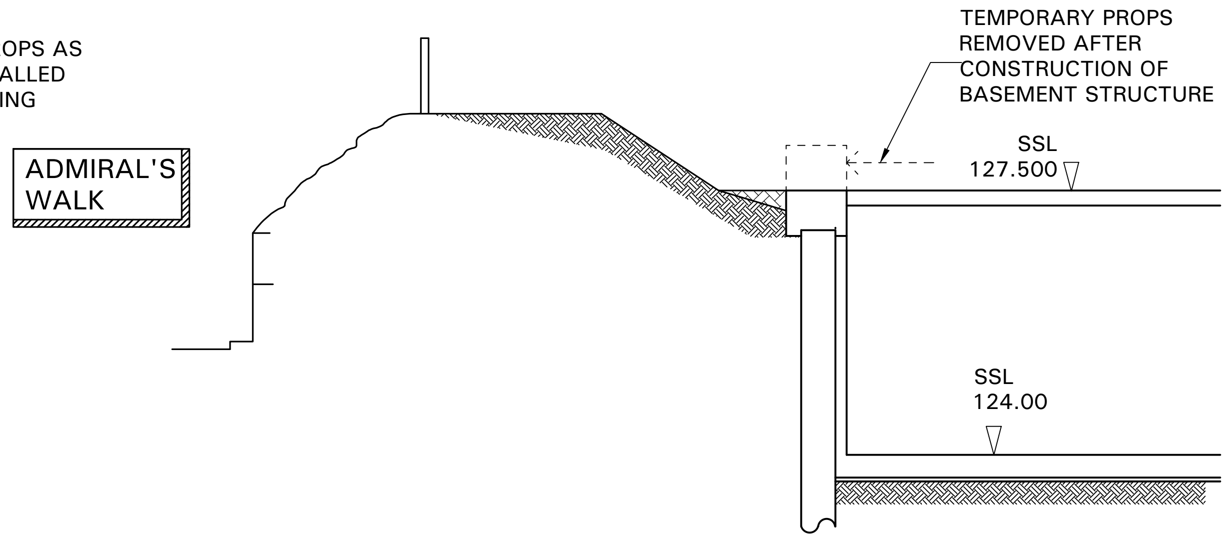
SECTION 4 - STAGE 1



ADMIRALS WALK INTERFACE
SECTION 4 - STAGE 2



ADMIRALS WALK INTERFACE
SECTION 4 - STAGE 3

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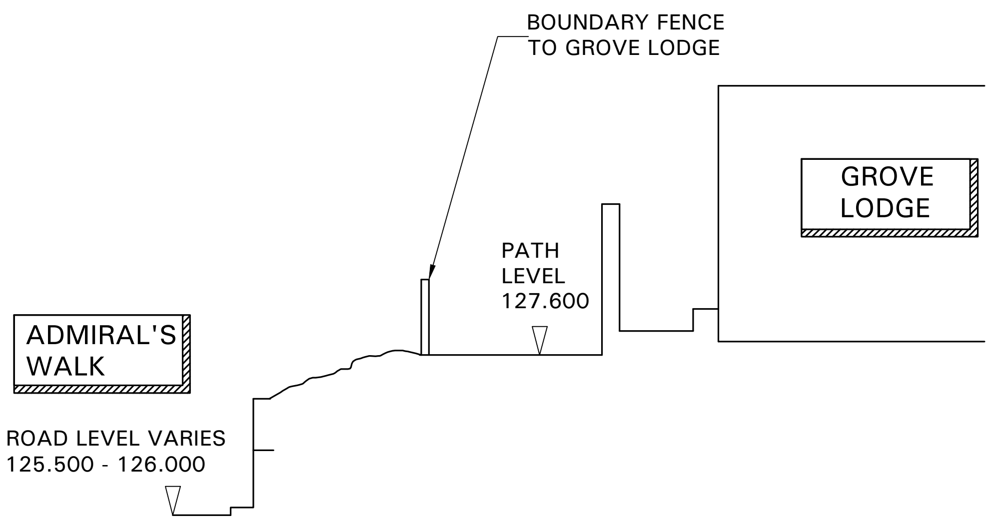

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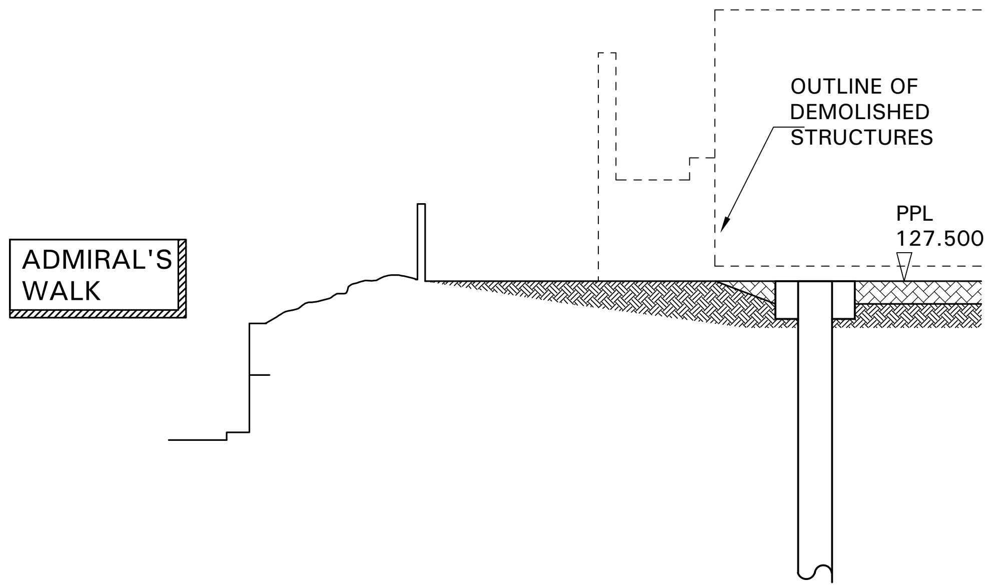
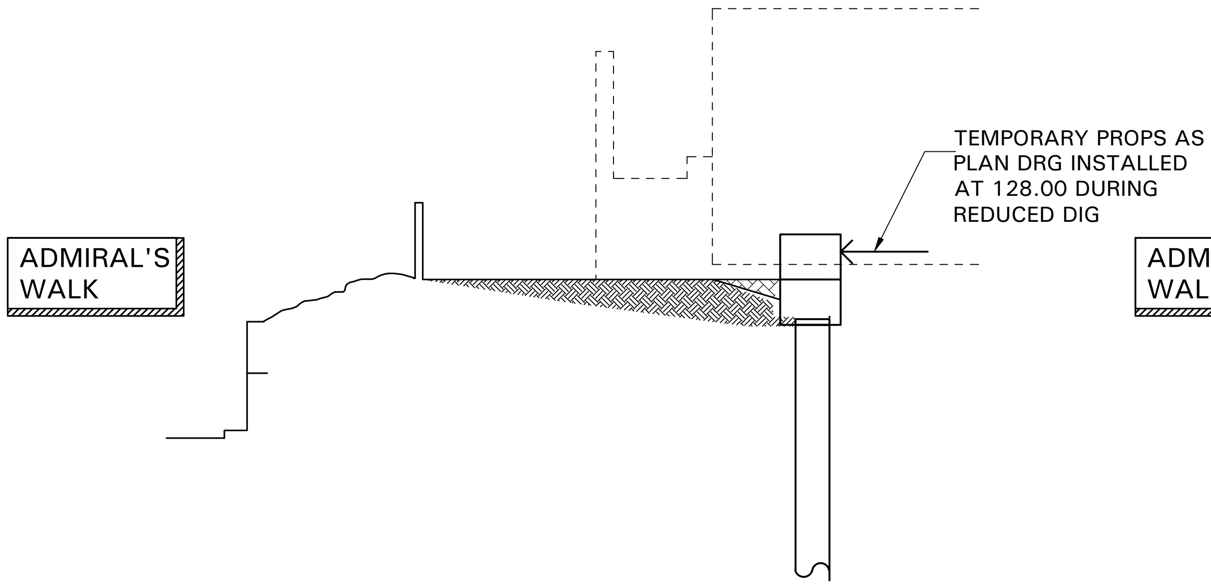
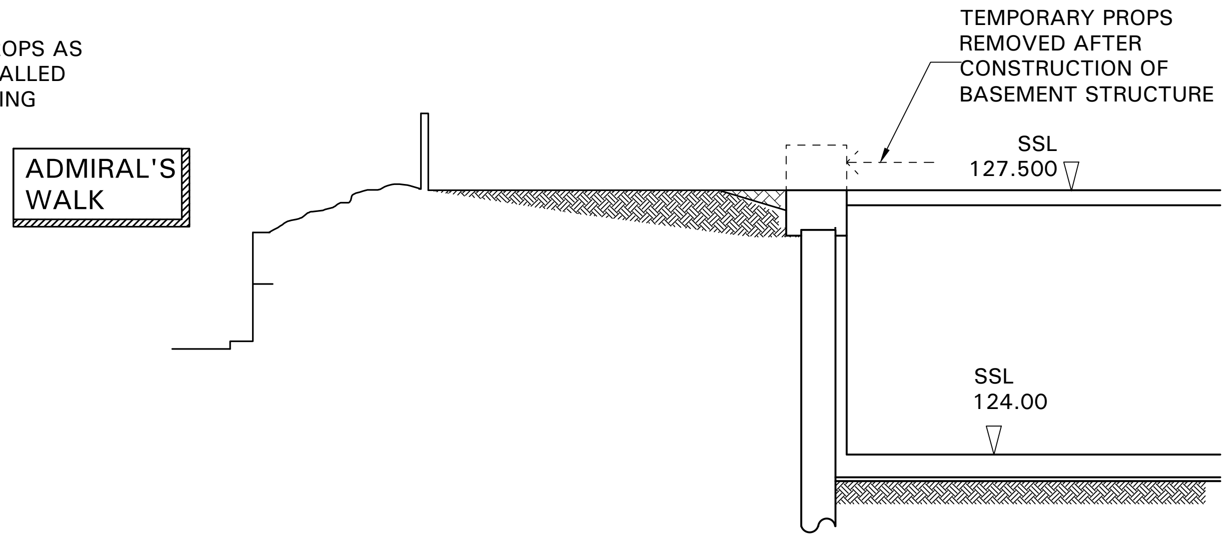
SECTION 4 - EXISTING



ADMIRALS WALK INTERFACE
SECTION 4 - STAGE 1



ADMIRALS WALK INTERFACE
SECTION 4 - STAGE 2



ADMIRALS WALK INTERFACE
SECTION 4 - STAGE 3

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ADMIRALS WALK X-SECTION SHT 2

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CONCRETE BEAM ANALYSIS

Concrete beam dimensions:-

Beam width b = **1000** mm

Beam depth h = **250** mm

Cross-section area $A = b \times h =$ **250000** mm^2

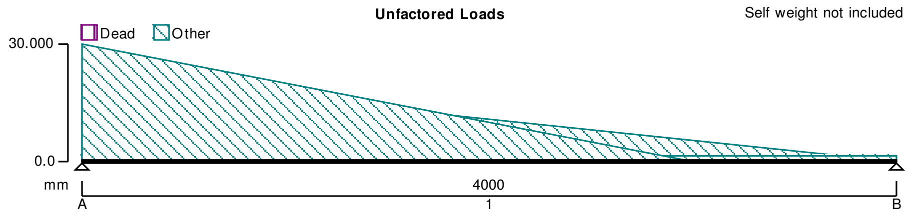
Major axis second moment of area $I_{xx} = b \times h^3 / 12 =$ **1.30×10^9** mm^4

f_{cu} = **35** N/mm^2

$E = 20$ kN/mm^2 + $200 \times f_{cu}$ = **27.0** kN/mm^2

Ref BS8110:1985:Pt 2 - Eq 17

$\rho = \rho_{C.norm}$ = **2400** kg/m^3



CONTINUOUS BEAM ANALYSIS - INPUT

BEAM DETAILS

Number of spans = **1**

Material Properties:

Modulus of elasticity = **27** kN/mm^2 Material density = **2400** kg/m^3

Support Conditions:

Support A   Vertically **"Restrained"**   Rotationally **"Free"**

Support B   Vertically **"Restrained"**   Rotationally **"Free"**

Span Definitions:

Span 1   Length = **4000** mm   Cross-sectional area = **250000** mm^2 Moment of inertia = **1.30×10^9** mm^4

LOADING DETAILS

Beam Loads:

Load 1   UDL Dead load **0.0** kN/m

Load 2   VDL Other load **21.6** kN/m to **0.0** kN/m

Load 3   UDL Other load **1.5** kN/m

Load 4   Partial VDL Other load **30.0** kN/m at **0.000** m to **0.0** kN/m at **3.000** m

LOAD COMBINATIONS

Load combination 1 - ULS

Span 1 $1.4 \times$Dead + $1.6 \times$Other

Load combination 2 - SLS

Span 1 $1 \times$Dead + $1 \times$Other

CONTINUOUS BEAM ANALYSIS - RESULTS

Support Reactions - Combination Summary

Support A   Max react = **-65.5** kN   Min react = **-104.9** kN   Max mom = **0.0** kNm   Min mom = **0.0** kNm

Support B   Max react = **-28.6** kN   Min react = **-45.8** kN   Max mom = **0.0** kNm   Min mom = **0.0** kNm

Beam Max/Min results - Combination Summary

Maximum shear = **104.9** kN

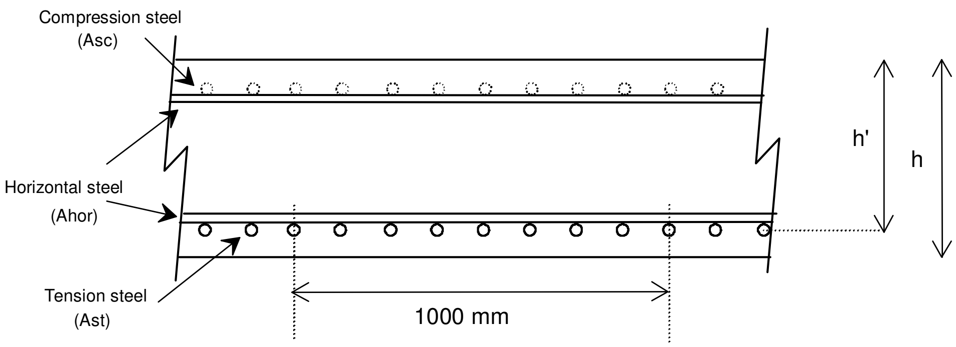
Minimum shear F_{min} = **-45.8** kN

Maximum moment = **75.9** kNm

Minimum moment = **0.0** kNm

Maximum deflection = **3.5** mm

Minimum deflection = **0.0** mm



Wall
(assumed symmetric)

RC WALL DESIGN (BS8110) WALL DESIGN TO CL 3.9.3

TEDDS calculation version 1.0.04

WALL DEFINITION

Wall thickness $h = \mathbf{250}$ mm

Cover to tension reinforcement $c_w = \mathbf{35}$ mm

Trial bar diameter $D_{try} = \mathbf{16}$ mm

Depth to tension steel

$h' = h - c_w - D_{try}/2 = \mathbf{207}$ mm

Materials

Characteristic strength of reinforcement $f_y = \mathbf{500}$ N/mm^2

Characteristic strength of concrete $f_{cu} = \mathbf{35}$ N/mm^2

Braced Wall Design to cl 3.9.3 (Simply supported construction)

Stocky check for braced walls

Wall clear height $l_o = \mathbf{4000}$ mm

Effective height factor for simply supported braced walls (assessed for a plain wall)

$\beta = \mathbf{1.00}$

$l_e = \beta \times l_o = \mathbf{4.000}$ m $l_e/h = \mathbf{16.00}$

The braced wall is slender

Braced wall slenderness check

Effective wall height $l_e = \mathbf{4000}$ mm

Slenderness limit $l_{limit} = 40 \times h = \mathbf{10000}$ mm

Slenderness limit $l_{limit1} = 45 \times h = \mathbf{11250}$ mm

Wall slenderness limit OK

Define wall reinforcement

Main reinforcement in wall

Provide 16 dia bars @ 150 centres in each face

Area of "tension" steel $A_{st} = A_{svert} = \mathbf{1340}$ mm^2/m

Area of compression steel $A_{sc} = A_{st} = \mathbf{1340}$ mm^2/m

Total area of steel $A_{wall} = A_{st} + A_{sc} = \mathbf{2680.0}$ mm^2/m

Percentage of steel $(A_{st} + A_{sc}) / h = \mathbf{1.07}$ %

HORIZONTAL WALL STEEL

Wall thickness $h = \mathbf{250}$ mm

Area of vertical steel provided $A_{wall} = \mathbf{2680}$ mm^2/m

Percentage of vertical steel $p_{vwall} = A_{wall} / h = \mathbf{1.07}$ %

Minimum diameter of horizontal steel $D_{min} = \max(D_{vert}/4 , 6 \text{ mm}) = \mathbf{6}$ mm

Minimum area of horizontal steel

A_{Hmin} = If(f$_y$>=(460 N/mm^2),if(p_{vwall}>2 %,0.13 %,0.25%),if(p_{vwall}>2 %,0.24 %, 0.30 %)) $\times$ h/2

A_{Hmin} =**313** mm^2/m

No containment links required

Define horizontal wall steel in one face

Provide 16 dia bars @ 150 centres in each face

Braced slender wall - simple construction - transverse bending and axial load

Design ultimate loading

Design ultimate axial load per m of wall $n_w = \mathbf{10}$ kN/m

Larger initial transverse end moment per m of wall $m_2 = \mathbf{5}$ kNm/m

Smaller initial transverse end moment per m of wall $m_1 = \mathbf{5}$ kNm /m

Initial moment (approx)

$m_i = \max(\text{abs}(0.4 \times m_1 + 0.6 \times m_2), \text{abs}(0.4 \times m_2)) = \mathbf{5.0}$ kNm/m

Additional moment

$\beta_a = l_e^2 / (2000 \times h^2) = \mathbf{0.128}$

Reduction factor to correct deflection for axial load

$n_{uz} = 0.45 \times f_{cu} \times h + 1/\gamma_{ms} \times f_y \times A_{wall} = \mathbf{5102.7}$ kN/m

$n_{bal} = 0.25 \times f_{cu} \times h' = \mathbf{1811.3}$ kN/m

$K = \min((n_{uz} - n_w)/(n_{uz} - n_{bal}), 1.0) = \mathbf{1.00}$

$a_u = \beta_a \times K \times h = \mathbf{32.0}$ mm

$m_{add} = n_w \times a_u =$ **0.3** kNm/m

Minimum design moments

$m_{min} = \min(0.05 \times h, 20\text{ mm}) \times n_w =$ **0.1** kNm/m

Design moments

$m_{design} = \max(\text{abs}(m_2), \text{abs}(m_i) + m_{add}, \text{abs}(m_1) + m_{add}/2, m_{min}) =$ **5.3** kNm/m

<u>CHECK OF DESIGN FORCES - SYMMETRICALLY REINFORCED WALL SECTION</u>

<u>NOTES</u>

h is the wall thickness

h' is the depth from the more highly compressed face to the "tension" steel.

<u>Tension steel yields</u>

Determine correct moment of resistance

$n_R = \text{if}(x_{calc}<h/0.9, n_{R1}, n_{R2}) =$ **26.9** kN/m

$m_R = \text{if}(x_{calc}<h/0.9, m_{R1}, m_{R2}) =$ **112.2** kNm/m

Applied axial load

$n_w =$ **10.0** kN/m

Check for moment

$m_{design} =$ **5.3** kNm/m

Moment check satisfied

<u>The wall vertical reinforcement defined in each face is H16 dia bars @ 150 centres</u>

<u>CHECK MIN AND MAX AREAS OF STEEL</u>

Overall thickness of wall $h =$ **250** mm

Vertical steel

Total area of concrete per m run of wall $A_c = h =$ **250000** mm^2/m

$A_{st\_min} = 0.4\% \times A_c =$ **1000** mm^2/m

$A_{st\_max} = 4\% \times A_c =$ **10000** mm^2/m

Total vertical steel in wall $A_{wall} =$ **2680** mm^2/m

Area of vertical steel in wall provided OK

Horizontal steel

Percentage of vertical steel $p_{vwall} = A_{wall} / h =$ **1.07** %

Diameter of horizontal steel $D_{hor} =$ **16** mm

Minimum diameter of horizontal steel D_{min} = max(D_{vert}/4,6 mm) = **6** mm

Diameter of horizontal steel in wall OK

Area of horizontal steel in one face A_{shor} = **1340** mm²/m

Minimum area of horizontal steel

A_{Hmin} = If(f_y>=(460 N/mm²),if(p_{vwall}>2 %,0.13 %,0.25%),if(p_{vwall}>2 %,0.24,0.30 %)) × h/2

A_{Hmin} =**313** mm²/m

Area of horizontal steel in wall provided OK

Shear Resistance of Concrete Walls - (cl 3.8.4.6)

Wall thickness h = **250** mm

Effective depth to steel h' = **207** mm

Area of concrete A_{conc} = h = **250000** mm²/m

Design ultimate shear force through thickness per m of wall v_w = **105** kN/m

Characteristic strength of concrete f_{cu} = **35** N/mm²

Is a check required? (3.8.4.6)

Axial load per m of wall n_w = **10.0** kN/m

Major axis moment per m of wall m_w = **75.9** kNm/m

e = m_w / n_w = **7590.0** mm

e_{limit} = 0.6 × h = **150.0** mm

Actual shear stress v_x = v_w / h' = **0.5** N/mm²

Allowable stress $v_{allowable}$ = min ((0.8 $N^{1/2}$/mm) × √(f_{cu}), 5 N/mm²) = **4.733** N/mm²

Shear check required

Design shear stress to clause 3.4.5.12

f_{cu_ratio} = if (f_{cu} > 40 N/mm² , 40/25 , f_{cu}/(25 N/mm²)) = **1.400**

Design concrete shear stress

v_c = 0.79 N/mm² × min(3,100 × A_{st} / h')$^{1/3}$ × max(1,(400 mm) / h')$^{1/4}$ / 1.25 * $f_{cu\_ratio}^{1/3}$

v_c = **0.721** N/mm²

v_c' = v_c + 0.6 × n_w / h × min(abs(v_w) × h / m_w, 1.0) = **0.7** N/mm²

$v_{allowable}$ = min ((0.8 $N^{1/2}$/mm) × √(f_{cu}), v_c' , 5 N/mm²) = **0.729** N/mm²

Actual shear stress

v_x = **0.5** N/mm²

Shear reinforcement not necessarily required in wall

Shear stress - OK

Appendix D – Analysis of Predicted Ground Movement

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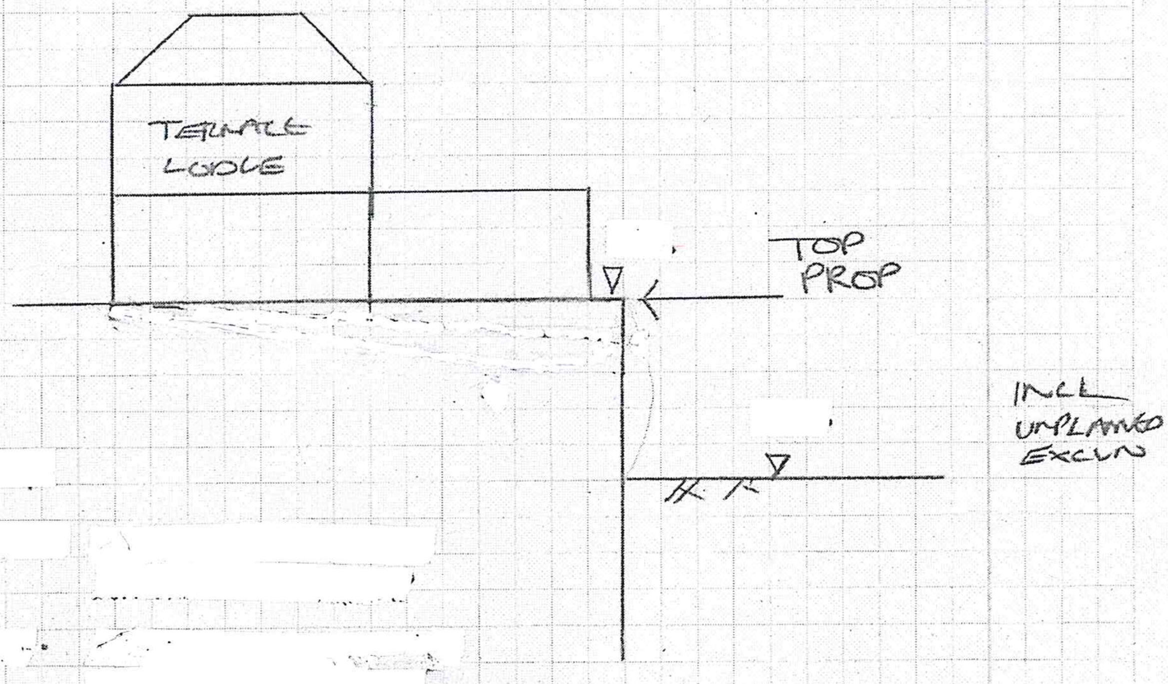
Job title	Job number	Sheet number	Revision
GROVE LODGE	5954	01	
Calculation/Sketch title	**Date**	**Author**	**Checked**
GROUND MVMNT ASSESSMENT AT TERRACE LODGE	JUN 15	AJB	

CIRIA C580



CONSIDER NEAR EXTENSION

$L/H = 6000/3000 = 2$

$\Delta/L = 3.5+2.5/6000 = 0.1\%$

$\varepsilon_L = 7/13000 = 0.05\%$

CONSIDER MAIN HOUSE

$L/H = 7000/7000 = 1$

$\Delta/L = 9.5/7000 = 0.13\%$

$\varepsilon_L = 7/13000 = 0.05\%$

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Calculation/Sketch title	**Date**	**Author**	**Checked**
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