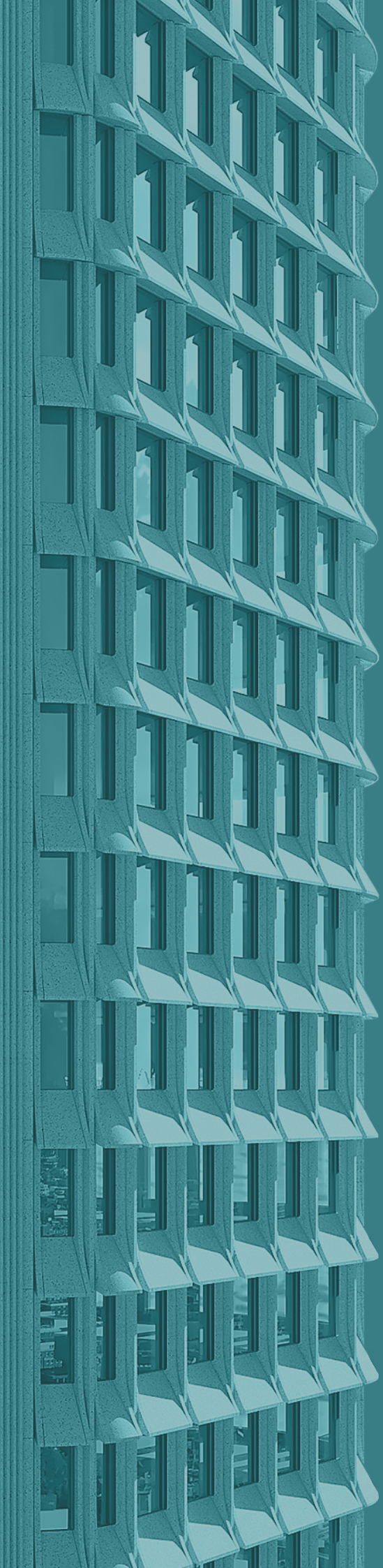


EUSTON TOWER

Basement Impact Assessment

December 2024

British Land

ARUP

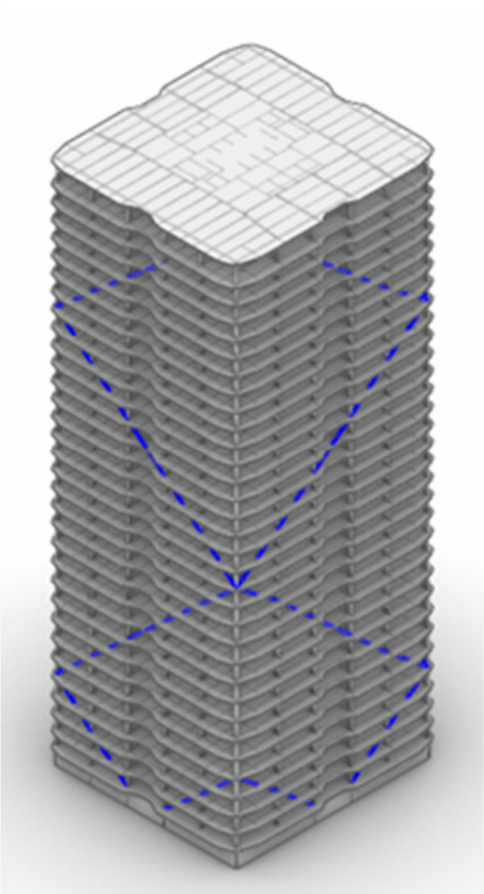
British Land Property Management Limited

Euston Tower, 286 Euston Road

Basement Impact Assessment

Reference: 281835-GEO-RP-00003

P07 | 10 December 2024



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Document Verification

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		Description	First issue for project team review.

	Prepared by	**Checked by**	**Approved by**
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Signature			

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		Signature			
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		Description	Sixth issue following comments from Herbert Smith Freehills.		
			Prepared by	**Checked by**	**Approved by**
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		Signature			
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		Description	Seventh issue following comments from British Land.		
			Prepared by	**Checked by**	**Approved by**
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		Signature			

Issue Document Verification with Document ✓

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Non-technical summary

This Basement Impact Assessment (BIA) report has been prepared by Ove Arup and Partners Ltd (Arup) on behalf of British Land Property Management Limited in support of a planning application (ref. 23/5240/P) at Euston Tower, 286 Euston Road, London NW1 3DP, submitted in December 2023.

The Applicant has undertaken extensive consultation during both the pre-application and determination stages and has sought to respond positively to the responses received. The scheme has been revised in response to feedback from Officers, local stakeholders and residents, including the Regents Park Conservation Area Advisory Committee and statutory consultees, including Historic England and The Greater London Authority.

This BIA report has been revised to incorporate revisions to the pending scheme (the "Proposed Development") and supersedes the previous revisions. Ground movement and impact assessments on neighbouring buildings have been updated in this BIA report following changes to proposed building massing, B1 slab lowering, Basement 02 geometry and new foundations.

The Description of Development for the Proposed Development, in light of the 2024 Revisions, has been updated to the following:

"Redevelopment of Euston Tower comprising retention of parts of the existing building (including central core, basement and foundations) and erection of a new building incorporating these retained elements, to provide a 32-storey mixed-use building providing offices and research and development floorspace (Class E(g)) and office, retail, café and restaurant space (Class E) and Enterprise space (Class E/ F) at ground and first floors, and associated external terraces; public realm enhancements, including new landscaping and provision of new publicly accessible steps and ramp; short and long stay cycle storage; servicing; refuse storage; plant and other ancillary and associated work."

A new steel structural frame and new floorplates will be constructed, with the foundations and central core being reused. New supplementary foundations will be constructed to support the new superstructure where it extends beyond the extent of the existing piled raft. A local Basement 02 level is proposed underneath the existing single level basement to accommodate a water tank and plant room. The proposed local Basement 02 level has a plan dimension of approximately 5.5m x 34m (187 sqm), located to the west of existing pinwheel piled raft. The proposed B2 FFL is approximately +19.77mOD in relation to the general single level basement level of +23.9mOD.

The assessment presented in this BIA report is based on guidance provided in the following documents (listed in hierarchy order):

- Camden Local Plan - Policy A5 'Basements' (Camden 2017).
- Camden Planning Guidance (CPG) on Basements (Camden, 2021); and
- Camden geological, hydrogeological, and hydrological study. Guidance for subterranean development (Camden, 2010).

A screening assessment has been carried out in accordance with Camden geological, hydrogeological, and hydrological study. Guidance for subterranean development (Camden, 2010). It is concluded that the proposed development is unlikely to result in any groundwater or surface water issues. This basement impact assessment complies with the requirements of the Camden Local Plan - Policy A5 'Basements' (Camden, 2017) and the latest Camden Planning Guidance on Basements (Camden 2021).

Preliminary ground movement assessment carried out in this report indicated that the neighbouring 1 Triton Square and 2 Triton Square do not fall within the zone of influence for ground movements associated with the proposed development. The southern façade of neighbouring North East Quadrant (10-30 Brock Street) falls within the zone of influence. However, the potential impact of the long-term settlements on 10-30 Brock Street is calculated to fall within damage category 0 'negligible' on the Burland scale. This does not exceed category 1 'very slight' on the Burland scale and is compliant with Camden Planning Guidance (CPG) on Basements (Camden, 2021).

The previous version of this BIA report has undergone audit process (see CampbellReith Basement Impact Assessment Audit, Report ref..: SSkb14006-59-230424-Euston Tower_D1, 2024). In response to comments raised, a technical note was prepared (see Arup Basement Impact Assessment Audit [2023/5240/P] File Note, Ref: 281835-07, 2024).

A comparison of the previous and current basement impact assessment results is summarised in Section 7. There is a small reduction in long term settlements calculated for neighbouring 10-30 Brock Street. The Burland damage category calculated is unchanged at damage category 0 ‘negligible’ on the Burland scale.

The site falls within the 2015 Crossrail 2 Safeguarding Directions and is located to the west of Northern and Victoria line tunnels, to the north of St Johns Wood to Back Hill deep cable tunnel and Hammersmith & City, Circle and Metropolitan line tunnel). Third party consultation and engagement with the respective asset owners is in progress. Ground movement assessments will be carried out in separate standalone technical assessments for review by the respective third parties ahead of the proposed development as required.

1. Introduction

Ove Arup and Partners Ltd (Arup) have been commissioned by British Land Property Management Limited to carry out a Basement Impact Assessment to support the planning application (ref. 23/5240/P) at Euston Tower, 286 Euston Road, London NW1 3DP, submitted in December 2023.

The Applicant has undertaken extensive consultation during both the pre-application and determination stages of the Proposed Development and has sought to respond positively to the responses received. The scheme has been revised in response to feedback from Officers, local stakeholders and residents, including the Regents Park Conservation Area Advisory Committee and statutory consultees, including Historic England and The Greater London Authority.

This BIA report has been revised to incorporate revisions to the pending scheme (the "Proposed Development") and supersedes the previous revisions. Ground movement and impact assessments on neighbouring buildings have been updated in this BIA report following changes to proposed building massing, B1 slab lowering, Basement 02 geometry and new foundations.

Euston Tower is the last largely unaltered building constructed as part of the Euston Centre estate for developer DE & J Levy between the years 1962-1972. The estate was designed by architect Sidney Kaye, Eric Firmin & Partners, and the structural engineer for the tower was John De Bremaeker & Partners who are believed to have designed both the sub and super-structure. The Euston tower superstructure was constructed by contractor George Wimpey between approximately 1965 and 1970; it is unclear whether they also constructed the substructure and foundations. The podium was refurbished at the turn of the millennium by architects Sheppard Robson with structural engineers Arup.

The proposed development comprises redevelopment of Euston Tower, including the retention of parts of the existing building (including central core, basement and foundations) and erection of a new building incorporating these retained elements, to provide a 32-storey mixed-use building providing offices and research and development floorspace (Class E(g)) and office, retail, café and restaurant space (Class E) and Enterprise space (Class E/ F) at ground and first floors, and associated external terraces; public realm enhancements, including new landscaping, and provision of new publicly accessible steps and ramp; short and long stay cycle storage; servicing; refuse storage; plant and other ancillary and associated works.

A new steel structural frame and new floorplates will be constructed, with the foundations and central core being reused. New supplementary foundations will be constructed to support the new superstructure where it extends beyond the extent of the existing piled raft. A local Basement 02 level is proposed underneath the existing single level basement to accommodate a water tank and plant room. The proposed local Basement 02 level has a plan dimension of approximately 5.5m x 34m (187 sqm), located to the west of existing pinwheel piled raft. The proposed B2 FFL is approximately +19.77mOD in relation to the general 1 level basement level of +23.9mOD.

The assessment presented in this report is based on guidance provided in the following documents (listed in hierarchy order):

- Camden Local Plan - Policy A5 'Basements' (Camden 2017);
- Camden Planning Guidance (CPG) on Basements (Camden, 2021); and
- Camden geological, hydrogeological and hydrological study. Guidance for subterranean development (Camden, 2010).

This BIA report is prepared by Arup as structural/ geotechnical and services designer of the proposed development. The report has been prepared or checked by a Chartered Civil Engineer (member of the Institution of Civil Engineers) and approved by a Chartered Civil Engineer (Fellow of the Institution of Civil Engineers.)

2. The site

2.1 Site location

Euston Tower (the site) is situated within the London Borough of Camden and the ward of Regent's Park. The site is bounded by Euston Road (south), Hampstead Road (east), Brock Street (north) and Regent's Place (west). The site covers an area of 7,963sqm, comprised of a single, ground plus an existing 36-storey tower. The tower has been largely vacant for several years, predominantly comprising office uses on the upper floors, however there are still retail uses currently in operation at ground floor level.

The site does not fall within a conservation area (CA); however, Fitzroy Square CA and Bloomsbury CA are both located in close proximity (south). There are no elements of the site that are statutory or locally listed. A Certificate of Immunity from listing has been submitted and at the time of submission is still pending in respect of the existing tower. There are several buildings located within a close radius of the site that are Grade I, Grade II, and Grade II* listed. The site has a PTAL rating of 6b indicating 'excellent' transport connectivity. The site is mainly served by Watten Street Underground Station (south), Euston Square Underground Station (east) and Great Portland Street Underground Station (west). There are also several bus routes that serve the site along Euston Road (south) and Hampstead Road (east).

The land surrounding the site consists of a range of uses. The site is designated within the Knowledge Quarter Innovation District (KQID), home to world-class clusters of scientific and knowledge-based institutions and companies specialising in life-sciences, data and technology and creative industries. The neighbouring Regents' Place comprises commercial, office and cultural land uses, as well as pedestrianised streets and public realm incorporated into the space. The closest residential properties are located along Drummond Street (north) and Hampstead Road (east).

The building is part of the mixed-use Regent's Place Estate, currently managed by British Land, as shown in Figure 1.

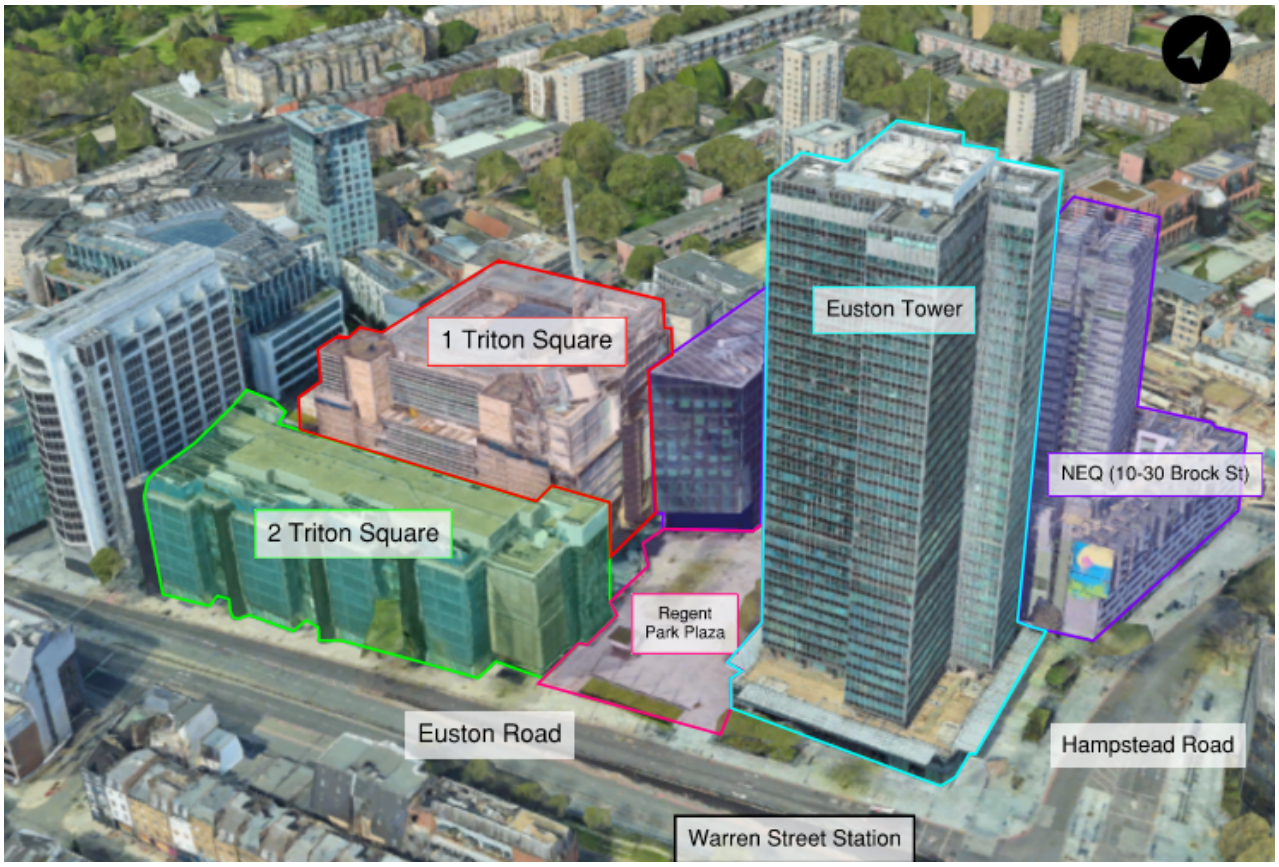


Figure 1: Site location plan (Google Earth, 2022)

2.2 Existing Euston Tower

Euston Tower is a 36-storey tall building standing on the northern edge of central London, situated in the south-west of the London Borough of Camden.

Located on the corner of Euston and Hampstead Road, at the top of Tottenham Court Road, the tower shares a busy intersection with the UCL Hospital campus and is directly opposite Warren Street Station. The current tower has a prominent presence, given its status as the tallest building in the borough aside from the nearby BT Tower, and as such acts as a physical landmark for London Euston, Euston Square and Warren Street stations as well as wayfinding for the wider neighbourhood.

Completed in 1970, Euston Tower is designed in the 'International Style'. Above a two-storey extruded glazed podium, the tower has a pinwheel plan clad in aluminium curtain walling with green reflective tinted glazing. It was designed as an office building to provide cellular office accommodation typical of the period and formed part of a wider masterplan known as The Euston Centre. It now stands on the eastern edge of the pedestrianised Regent's Place Estate.

Since its completion, the Euston Tower has undergone a small refurbishment, but beyond this its external form and façade remain as originally constructed. These elements of the building are in a generally poor condition, due to a combination of wear in use and the quality of the original detailing. Gradually it has been vacated, and since 2021, except for the retail at grade level, the building is entirely disused.

There is a large single-storey shared basement across Regents Place Estate, which is bounded by Drummond Street to the north, Hampstead Road to the East, Euston Road to the South and by Osnaburg Street to the west. Euston Tower is located in the southeast corner as indicated in Figure 2.

The basement will be retained as part of the new works. Reference can be made to the Structural Report (Arup, 2023) contained within the planning application for further details on the existing building structure and proposed modifications.

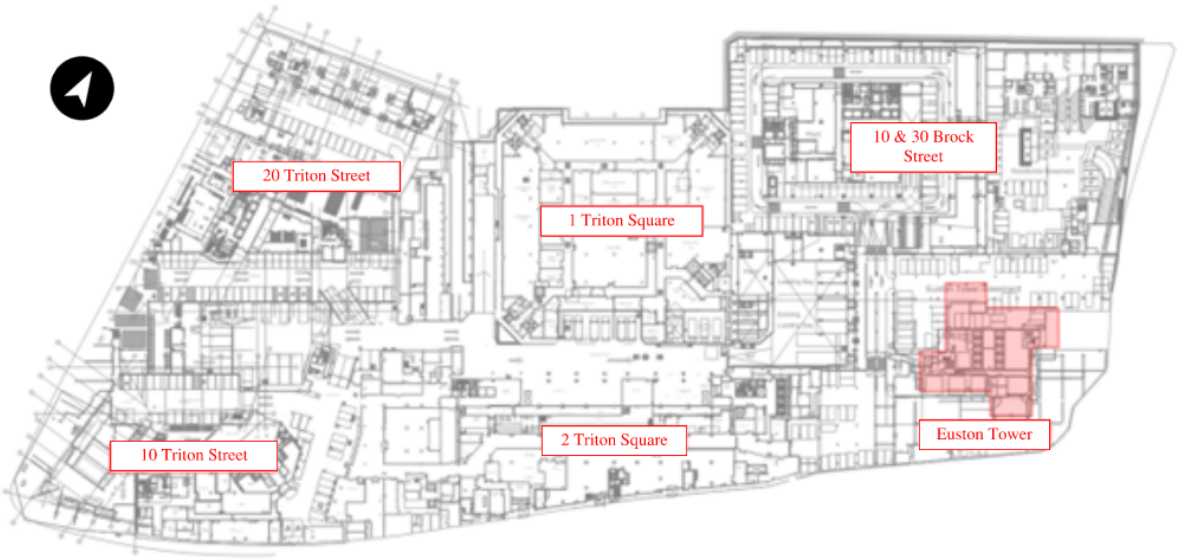


Figure 2: Large single-storey shared basement across Regents Place Estate

2.3 Site history

A geotechnical desk study has been carried out to determine the historical development of the site. Sources of information reviewed as part of the desk study are summarised as below:

- Envirocheck site history search.
- Historical Ordnance Survey mapping.
- Aerial/historic image searches.

- Publicly available information regarding tunnels including safeguarded alignments.
- Available drawings and reports from Arup project archives and those received from British Land.
- Historical maps, records, and fire insurance plans (Goad plans).
- Enquiries with parties involved with the original Euston Tower construction (or successors); and
- Archive searches for Euston Tower.

The historical development of the site is briefly summarised in Table 1. Based on available information, Euston Tower is understood to have different commercial uses in the past. Some notable previous uses include Capital Radio broadcasting centre and government communications centre.

Table 1: Summary of site historical development

Year	Historical developments
c.1746	Greenfield. The site is not developed.
c. 1813	First development of the site with the majority of site being covered by terraced buildings. By 1989, the properties comprised shops, a pawnbroker, and vacant three-storey terrace buildings with single level basements in the south.
c. 1936	The vacant properties in the south are now occupied with a surgical instrument factory, a sign factory, and a toilet requisite factory.
c. 1957	A sheet metal works now occupies most of the southern plots with miscellaneous shops and units occupying the north.
c. 1963	Clearance of the southern area of site (Euston Road to Eden Street).
c. 1966	Construction of Euston Road/ Hampstead Road underpass (south of Euston Tower).
c. 1966-1970	Euston Centre development. Construction of Euston Tower (then known as Euston Centre Block A), comprising the existing 36-storey concrete framed tower with two-level podium and a single level basement carpark (common level basement, spanning across the site).
c. 1971	Euston Tower completed.
c. Late 1960s/ early 1970s	Construction of Euston Centre Block F immediately to the west of Euston Tower (Euston Centre Block A)
c. 1972-1974	Construction of buildings to the north of Euston Tower, 10-30 Brock Street.
c. 1990s	Demolition of 2 Triton Square area, including the connecting two-storey podium structure, in early-mid 90s, current adjacent building completed by 2006.
c. 2010-2012	Demolition and construction of buildings to the north of Euston Tower (Northeast Quadrant 10-30 Brock St).

2.4 Topography

The ground level public realm across the site footprint is relatively flat at approximately +28.0 metres above Ordnance Datum (mOD) as shown in the Plowman Craven topographic survey dated June 2018. The drawings are included in Appendix A.

The single level basement slab level at the site is typically around +23.9mOD SSL or 4.1 metres below ground level (mbgl). Towards 1 Triton Square situated west of the site, the basement slab level drops down to approximately +21.7mOD via a step, to allow access for larger service vehicles via a loading bay.

2.5 Neighbouring buildings and assessment methodology

Camden Planning Guidance (CPG) on Basements (Camden, 2021) states that the anticipated damage category for neighbouring structures should not exceed category 1 'very slight' on the Burland scale. The Burland assessment methodology referenced in the CPG has been adopted for projects internationally and has been used by the Building Research Establishment and the Institution of Structural Engineers, London.

The classification system is based on the ease of repair of potential damage. Burland Scale categories 0 ('negligible'), 1 ('very slight'), and 2 ('slight') refer to aesthetic damage, category 3 ('moderate') and 4 ('severe') relate to serviceability and function, and 5 ('very severe') represents damage which relates to stability. Further details are provided within the CPG on Basements (Camden, 2021) guidance document.

Neighbouring structures are identified below and described in the following sections.

- 10-30 Brock Street – Northeast Quadrant (NEQ)
- 1 Triton Square
- 2 Triton Square

The zone of influence for ground movements refers to the area with calculated vertical ground movements greater than +/-1mm. A screening ground movement assessment has been carried out to identify the zone of influence.

- A limited extent of the Northeast Quadrant (10-30 Brock Street) southern façade falls within the zone of influence, and is assessed in this report.
- The assessment showed that 1 Triton Square and 2 Triton Square do not fall within the zone of influence for ground movements associated with the proposed redevelopment.

For further details of the methodology for ground movement assessment, refer to Section 6 of this report.

2.5.1 1 Triton Square

An eight-storey reinforced concrete frame commercial building with a single-level service basement which connects to wider basement for Euston Tower and under Regent's Park Plaza. The superstructure is located approximately 50m west from the Euston Tower superstructure. 1 Triton Square was originally developed in the early 1990s and was substantially modified to provide additional storeys by 2021.

Figure 3 shows the view of 1 Triton Square, looking west from Euston Tower.

Figure 3: 1 Triton square looking west from Euston Tower (image taken 10/11/2023, Arup)

2.5.2 2 Triton Square

A seven-storey concrete frame commercial building with a single level basement located southwest of Euston Tower. It is currently the head office for Santander UK. The building was completed in 2001. Figure 4 shows a view of 2 Triton Square looking west from Euston Tower.

Figure 4: 2 Triton Square looking west from Euston Tower (image taken 10/11/2023, Arup)

2.5.3 10-30 Brock Street - North East Quadrant (NEQ)

Situated immediately north of Euston Tower, NEQ (as shown in Figure 5) covers 10 and 20-30 Brock Street where development began in late 2000s and was completed in 2013.

- 20-30 Brock Street (The Triton Building) comprises a 26-storey residential tower with accompanying eight-storey block. 20-30 Brock Street has a double-level basement connecting to the single-level basement under Euston Tower.
- 10 Brock Street is commercial office space and comprises a part-9, part-11, and part-16 storey block. 10 Brock Street has a double-level basement which connects to the single-level basement under Euston Tower.

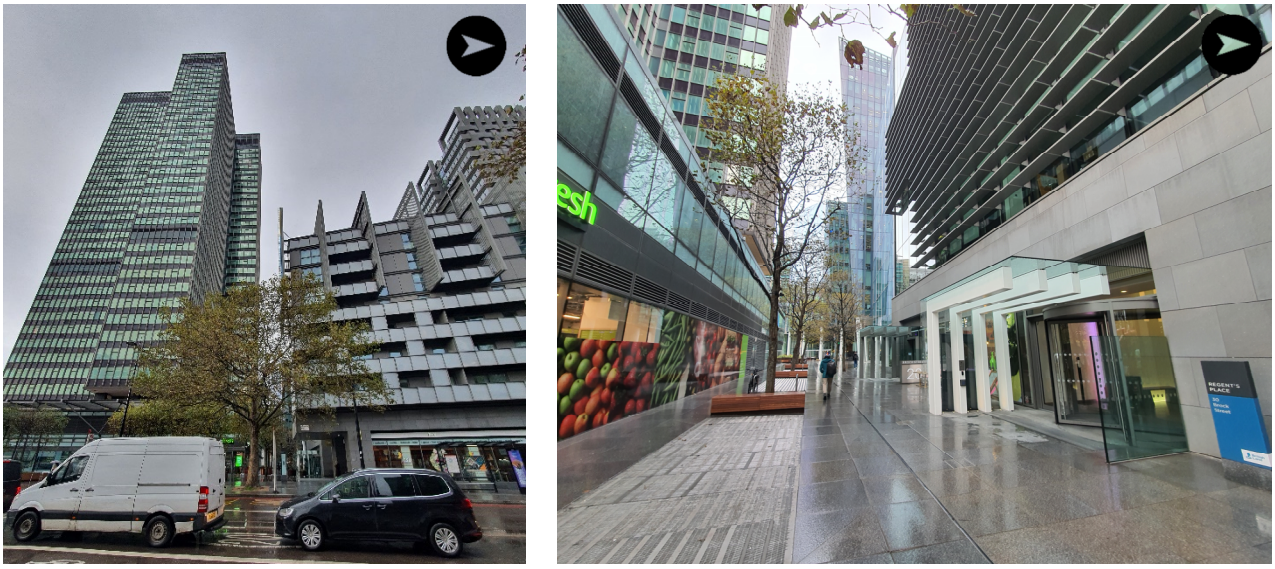


Figure 5: a) 10-30 Brock Street (North East Quadrant) looking west from Hampstead Road; b) 10-30 Brock Street pedestrian zone (images taken 10/11/2023, Arup)

2.6 Neighbouring highway assets

A review of publicly owned land in immediate proximity to the site has been carried out using the "Mayor of London – Map of Publicly Owned Land" GIS web app. The map, as presented in Figure 6, indicates land owned by Transport for London to the south of the site boundary under Title number: NGL375743, including the Euston Road, highway underpass structure and the public realm. A further small parcel of land (NGL375743) is indicated to be within TfL ownership immediately adjacent to the south-east corner of the existing building.

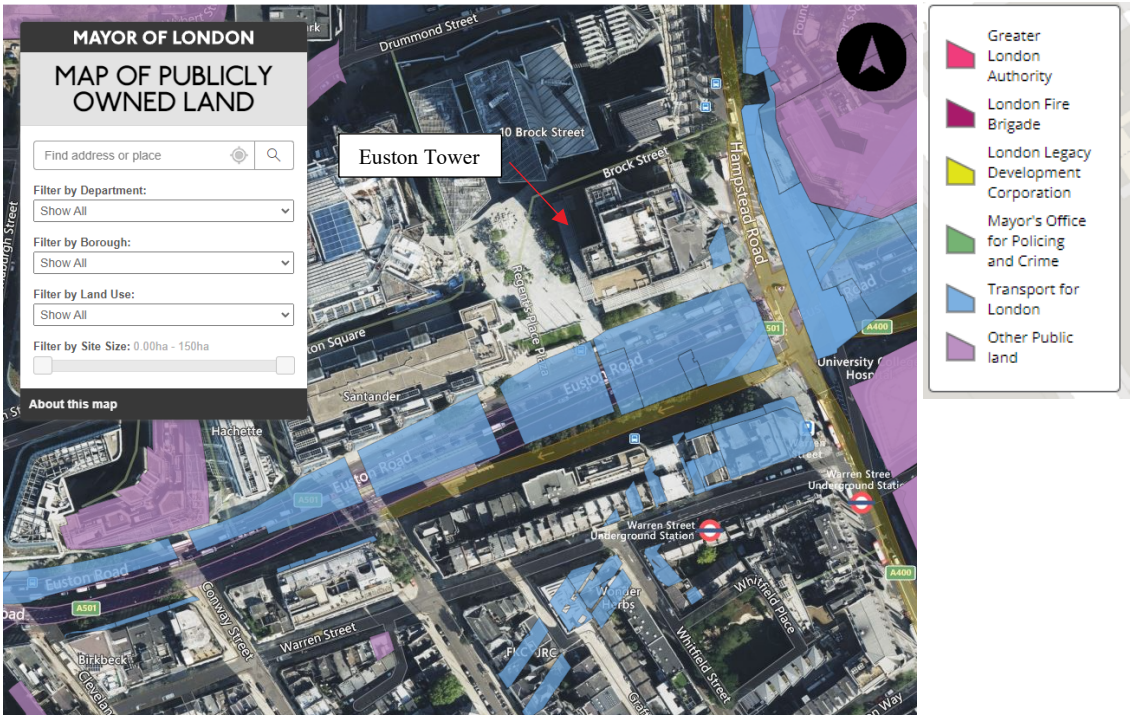


Figure 6 - Map of publicly owned land (source https://apps.london.gov.uk/public-land/ accessed 16/1/22)

The Euston Road underpass is an approximately 20m deep diaphragm wall underpass underneath the intersection with Hampstead Road and is located approximately 14m from the basement of the Euston Tower site. The underpass was constructed around 1961-1966 as part of public realm and highway improvements to dual Marylebone to Euston Road. The location is slightly to the north of the original location of Euston Road to avoid conflict with the London Underground Limited (LUL) cut and cover tunnels (Hammersmith City & Metropolitan lines) and involved demolition of Eden Street.

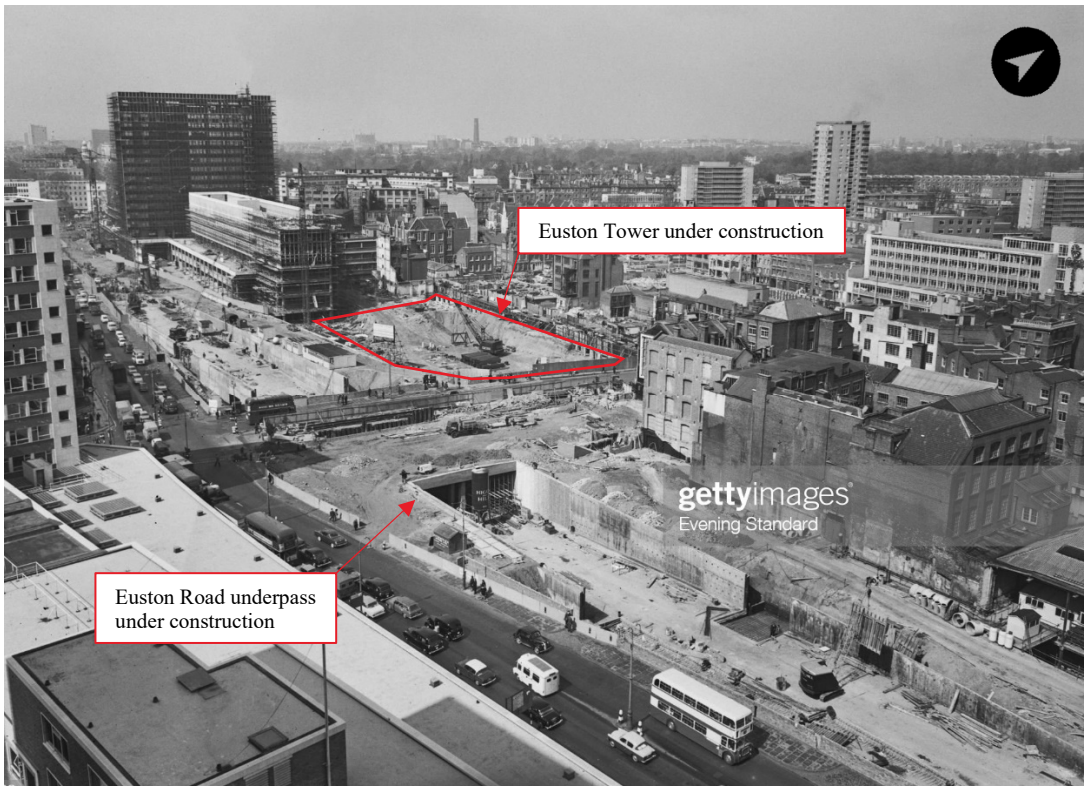


Figure 7 - Euston Road underpass under construction (Evening Standard, 1965)

Figure 8 - Euston Road Underpass under construction ~1966 Source- A London Inheritance/ London Metropolitan Archives https://alondoninheritance.com/london-streets/a-lost-bank-and-the-adam-and-eve-pub-on-the-corner-of-euston-road-and-hampstead-road/attachment/eus

2.7 Tunnels and utilities

Various utilities are identified as present east and south of the site boundaries, as shown in the Plowman Craven topographic survey dated June 2018 (see Appendix A). A Groundwise statutory utility search was commissioned by Arup in December 2019 (Report ref. URO6731.1DM).

A summary of the assets identified is provided in Table 2. Site constraints plans showing tunnels and utilities are included in Appendix B.

The following deep tunnels have been identified in proximity to the site:

- A cable route between St Johns Wood and Back Hill runs under Euston Road west-east, approximately 6m south of the site, with a crown level at approximately +11.0mOD.
- The Northern line and Victoria line are located approximately 8m east and 31m south-east of the site respectively at track levels of approximately +1mOD (27mbgl) and -5mOD (34mbgl) respectively; and
- The Hammersmith and City, Circle & Metropolitan lines run underneath Euston Road, 37m south of the site at a track level of approximately +18mOD (10mbgl).

Table 2 - Summary of tunnels and utilities identified from statutory search.

Asset	Provider	Details
Sewers	Thames Water	Large brick sewers between 1143mmx762mm (4m south of basement, under Euston Road) and 1372mmx864mm (7m east of basement, under Hampstead Road)
Water mains		Water mains of trunk 18" & 8" (possibly cast-iron based on dimensions), Indicated in the search response to be at approximately 1.0m depth. Unknown pressure at the time of writing.
Electricity	UK Power Networks	Multiple cables and contain HV and LV at approximately 0.5m depth with diameter unknown along the east side on

Asset	Provider	Details
		Hampstead Road, round the corner onto Euston Road heading west.
Gas	Cadent	A low pressure (LP) main at approximately 1.3m depth mains running along the east side on Hampstead Road, round the corner onto Euston Road heading west. Diameter is 125mm polyethylene within 200mm ductile iron.
Telecommunications	BT, Colt, Instalcom Ltd, SSE, Verizon, Virgin Media, Vodafone	Indicated in the search response to be at approximately between 0.2 and 1.0m below ground level. Diameter unknown.
Transport	LUL/Transport for London (TfL) power assets	Traffic control cables up to 0.5m depth. HV and LV track and road cables also present along Euston Road and up to Hampstead Road
	London Underground lines	Victoria line Northern line Hammersmith & City, Circle & Metropolitan Line.

Figure 9 shows the location of TfL assets as identified within a statutory utility search (deep tunnels) during November 2019.

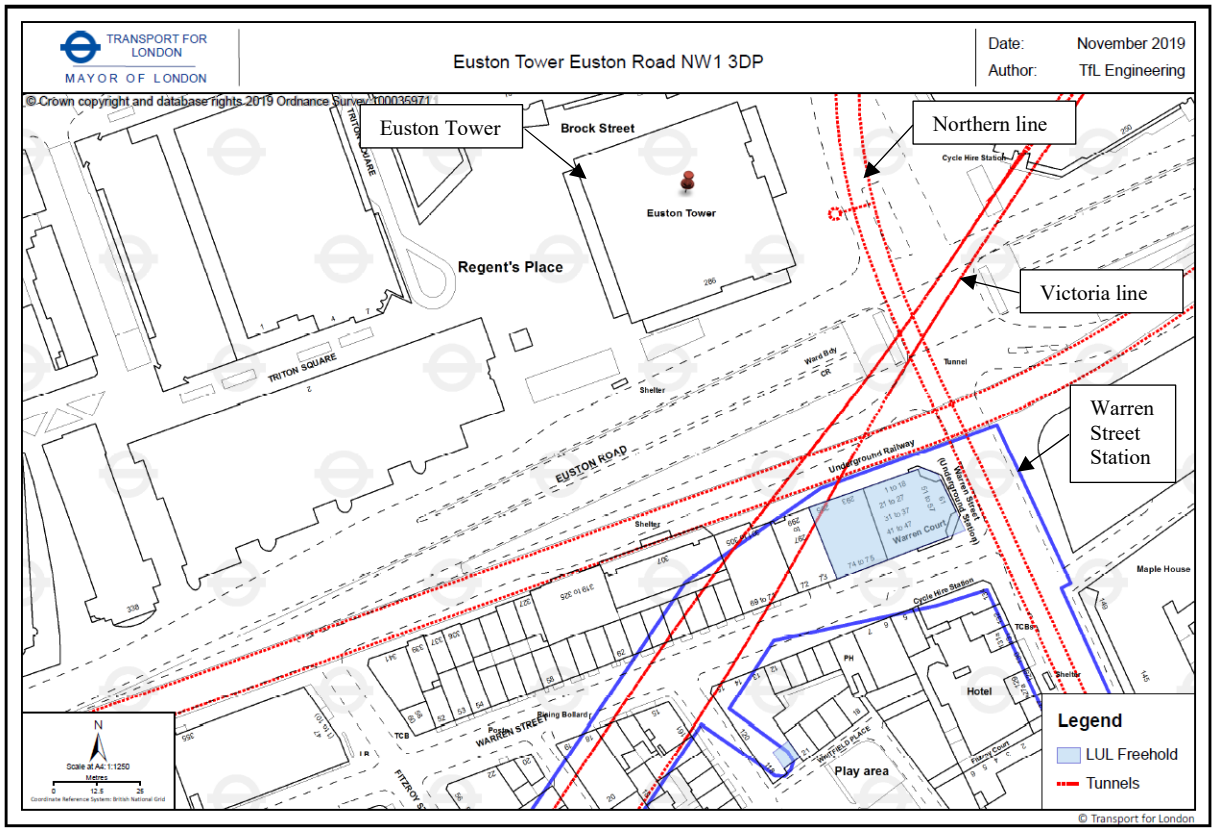


Figure 9 – TfL/LUL Statutory utility search response dated 7 November 2019, obtained via Groundwise. The location of Warren Steet station is shown in blue.

An initial meeting with the TfL Infrastructure Protection team took place on 3rd November 2023 to discuss the proposed development of Euston Tower and to seek initial feedback on the scheme proposals. TfL Infrastructure Protection team have no objection in principle to the planning application but requested

several conditions to be discharged in a phased manner as and when they are completed (see Appendix F for the TfL consultation response).

2.8 Future infrastructure

The Crossrail 2 safeguarded zone provides the anticipated route of the tunnels, as well as land at ground level, that may be used for the future construction of the tunnels, station, and shafts. The safeguarded route was published in 2015 together with notes for guidance. The site location and safeguarding limits (2015) defined in the 2015 safeguarding directions are shown in Figure 10. Further details can be found at: https://crossrail2.co.uk/discover/safeguarding/.

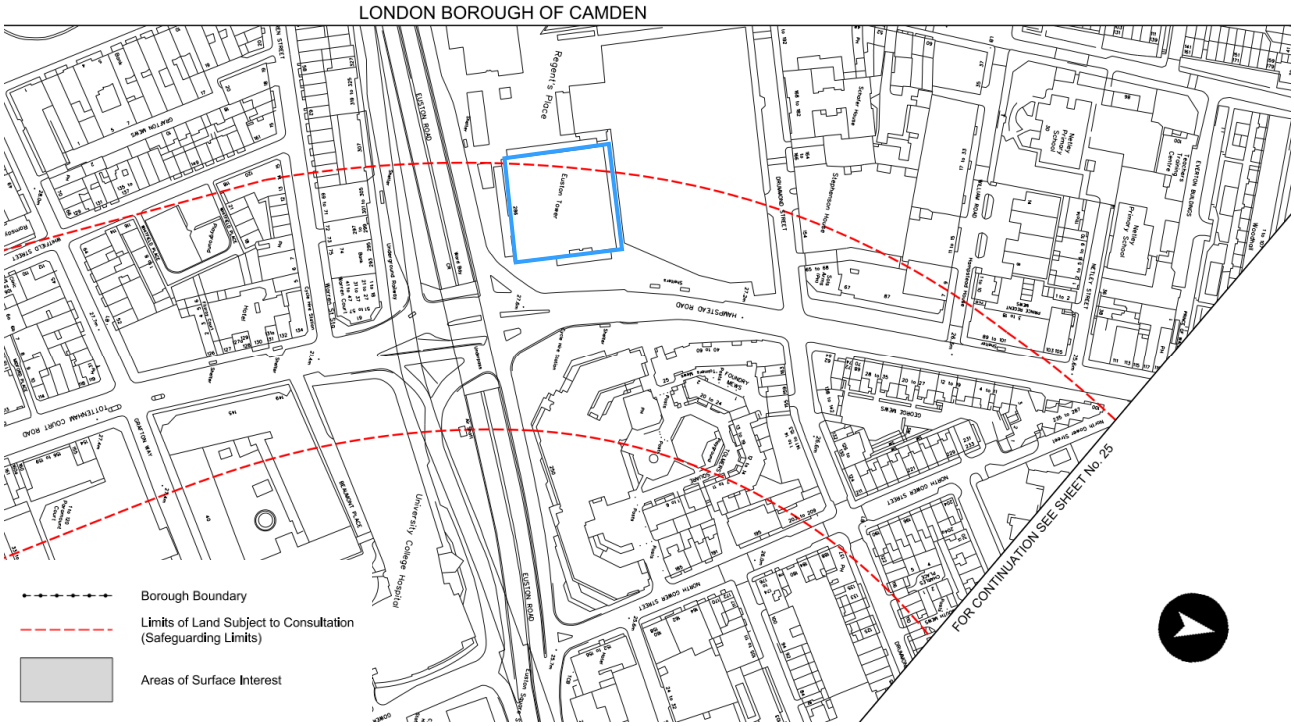


Figure 10 - Crossrail 2 safeguarding directions Sheet No24. March 2015. [MMD-307346-C-DR-SG-XX-1124]

The safeguarded limits of Crossrail 2 (2015) shown on the Crossrail 2 interactive map is shown in Figure 11a. The safeguarded limits crosses most of the Euston Tower site and the alignment is shown to cross the south-eastern corner of the junction of Euston Road and Hampstead Road. The viewer and further details can be found at the following URL:

https://cr2.maps.arcgis.com/apps/webappviewer/index.html?id=21a7f72dfd0c443db5733bd81a707a67.

It is understood that the route alignment has evolved since the safeguarding directions were published in 2015 and the latest route alignment iteration has been requested from the Crossrail 2 Safeguarding Manager. The latest Mk20.1 alignment received from the Crossrail 2 Safeguarding Manager on 9/10/2023 is shown in Figure 11b. The proposed alignment is slightly closer to the location of Euston Tower than that shown in the publicly available webmap presented as Figure 11a, however shows that the proposed alignment is to the east of the location of Euston Tower beneath Hampstead & Euston Roads, and that the proposed development is not located within the tunnel exclusion zone or alignment adjustment zone.

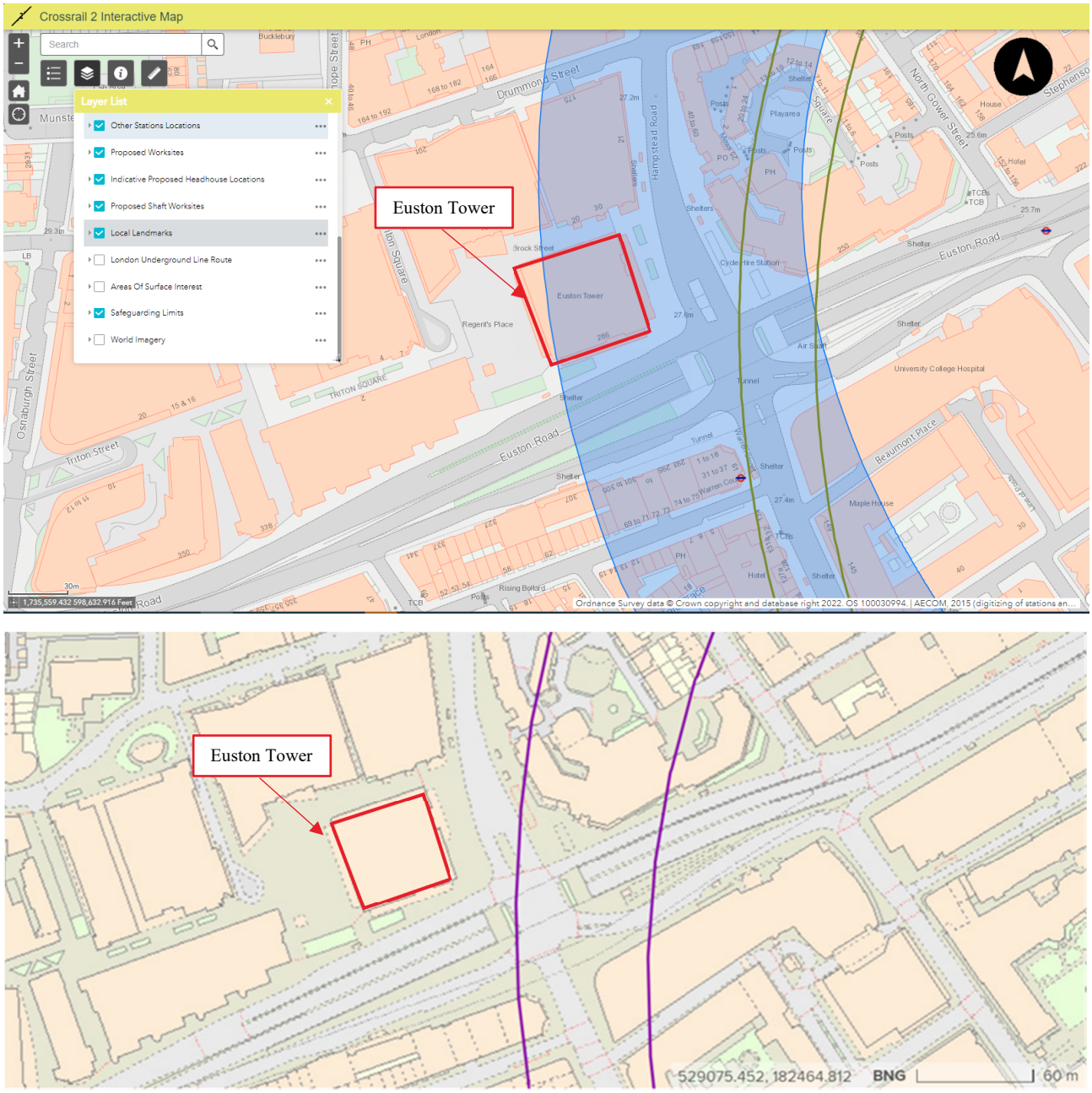


Figure 11 - Crossrail 2 safeguarding map extract – a) accessed 13/1/2023 b) Mk20.1 provided by CR2 9/10/23.

The safeguarding processes for Crossrail 2 require vertical and horizontal exclusion zones for future tunnels to be maintained, together with a technical approval process for consenting schemes within this zone. Details of the exclusion zone definition and alignment adjustment zone are given in the Information for Developers (April 2021) and reproduced in Figure 12. It is anticipated that the future Crossrail 2 tunnel will be deeper than the existing London Underground lines and have a diameter of ~8m.

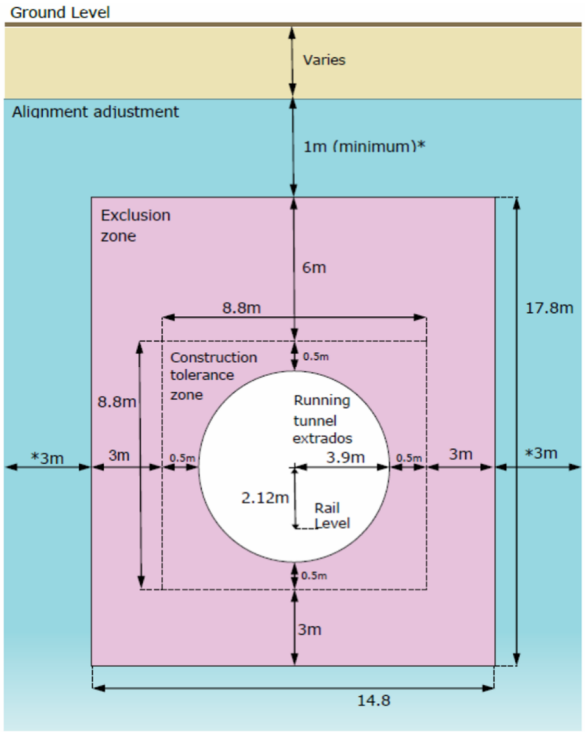


Figure 12 - Exclusion zone section from the Crossrail 2 Information for Developers, (April 2021)

As a result of future Crossrail 2 train services, there is the potential for vibrations to be transmitted to the buildings which could be re-radiated as ground borne noise within the building.

Engagement is in progress with TfL & Crossrail 2 to confirm the latest alignment proposals and to inform the subsequent design process. It is anticipated that Crossrail 2 would be a consultee to any planning application at the site. An initial meeting with the Crossrail 2 Safeguarding Manager took place on 3rd November 2023 to discuss the proposed development of Euston Tower, to confirm the principles of the safeguarding process and to determine the latest alignment information.

2.9 Unexploded ordnance

Assessment for the potential of encountering unexploded ordnance is outside the remit of this report. Based on the London Metropolitan Archives bomb damage map (shown in Figure 13), the Euston area was recorded as subject of bombing during World War II with most of the site receiving blast damage. Buildings which suffered damage beyond repair and total destruction were located within the eastern portion of site and immediately to the south of the site respectively. A review of UXO risk maps provided online by Zetica indicated the site as 'high risk'.

A detailed UXO risk assessment is recommended ahead of intrusive works at the site.

Figure 13 - Layers of London Bomb damage map from the London Metropolitan Archives webmap (https://www.layersoflondon.org/ accessed 17/01/2023)

2.10 Flood risk assessment

A flood risk assessment (FRA) has been carried out by Arup relating to this application. The document assesses the flood risk at the site from various sources and presents the proposed drainage strategy for the redevelopment. For the detailed assessment please refer to the Flood Risk Assessment report (Arup, 2024, Report ref.: 281835-ARP-XX-XX-RP-CD-0001) and Flood Risk Assessment Addendum (Arup, 2024, Report ref. 281835-ARP-XX-XX-TN-CD-0001).

The key findings of the FRA are outlined as follows:

- The site is located within Flood Zone 1, an area of low probability of flooding.
- Flood risks from tidal/ fluvial sources, pluvial sources, groundwater, artificial sources, and infrastructure failure are all considered to be low.
- Considerations have been given to both risk to the site, and potential offsite risk as a result of the proposed redevelopment, in accordance with the requirements of Chapter 14 of the National Planning Policy Framework (NPPF).
- Based on current understanding of site setting and the proposals, it is considered that the redevelopment can be carried out and operated safely and would not increase flood risk elsewhere.

3. Ground conditions and ground model

3.1 Regional geology

Published British Geological Society (BGS) 1:50,000 series solid and drift geological mapping is presented in Figure 1 of Appendix C. The superficial geology at the location of the site consists of Lynch Hill Gravel (part of the River Terrace Deposits). The outcrop of the boundary between Lynch Hill Gravel and Langley Silt ('Brickearth') is located approximately 200m to the north of the site. No indication of faults, drift-filled hollows ('scour hollows') or other distinct geological features are identified on the available mapping in the immediate vicinity of the site.

The BGS 1920s edition of the solid and drift geological map is shown in Figure 2 of Appendix C. This map does not show the outcrop of Langley Silt but shows a direct transition between the River Terrace Deposits and London Clay approximately 300m to the north of the site. Approximately 150m to the east of the site a stream or watercourse is indicated. The Lost Rivers of London by Barton (1992) was reviewed to determine the presence of former river features in proximity to the site.

Figure 3 of Appendix C presents an indicative section of the London basin from 1994 BGS 1: 50,000 series geological map, consisting of River Terrace Deposits overlying London Clay, Lambeth Group, Thanet Sand and Chalk.

Contour maps from the more recent BGS 1:50,000 series geological maps presented in Figure 4 of Appendix C indicate that the base of London Clay is expected to be between 0mOD and -5mOD and the top of the Upper Chalk is at around -30mOD.

3.2 Site investigations

Previous project site investigations researched and available in the vicinity of Euston Tower include:

- 12 no. boreholes (BH1 to BH12) and 9 no. trial pits (TP1 to TP9) – Regents Place and Triton Square Geotechnical Investigation Report, Laing Technology Group Limited (LTG), dated April 1995. The site location plan and two closest logs (BH12 and TP8) are included in Appendix D.
- 1 no. borehole (BH1) at 1 Triton Square- Related to the recent refurbishment and foundation strengthening project undertaken by British Land, dated 2017; and,
- 6 no. boreholes (BH1 to BH 6) – Tolmers Square Geotechnical Investigation Report, dated 1977. The site location plan and borehole logs have been included in Appendix D.

In relation to the proposed development at Euston Tower, an initial intrusive foundation and geotechnical investigation has been undertaken between February and July 2022.

- The aim of the investigation was to determine the suitability of a foundation re-use scheme and to investigate the existing piled foundations, ground, and groundwater conditions local to the Euston Tower.
- Excavations were carried out to the toe level of several existing piles to confirm the length and soil stratigraphy and properties, and to obtain samples for laboratory testing.
- Samples of the substructure steel and concrete were taken for examination and testing.

3.3 Stratigraphy

Figure 14 presents a west to east geological cross-section, summarising existing previous local borehole information from Regents Place, Tolmers Square together with stratigraphy encountered from the 2022 foundation investigation.

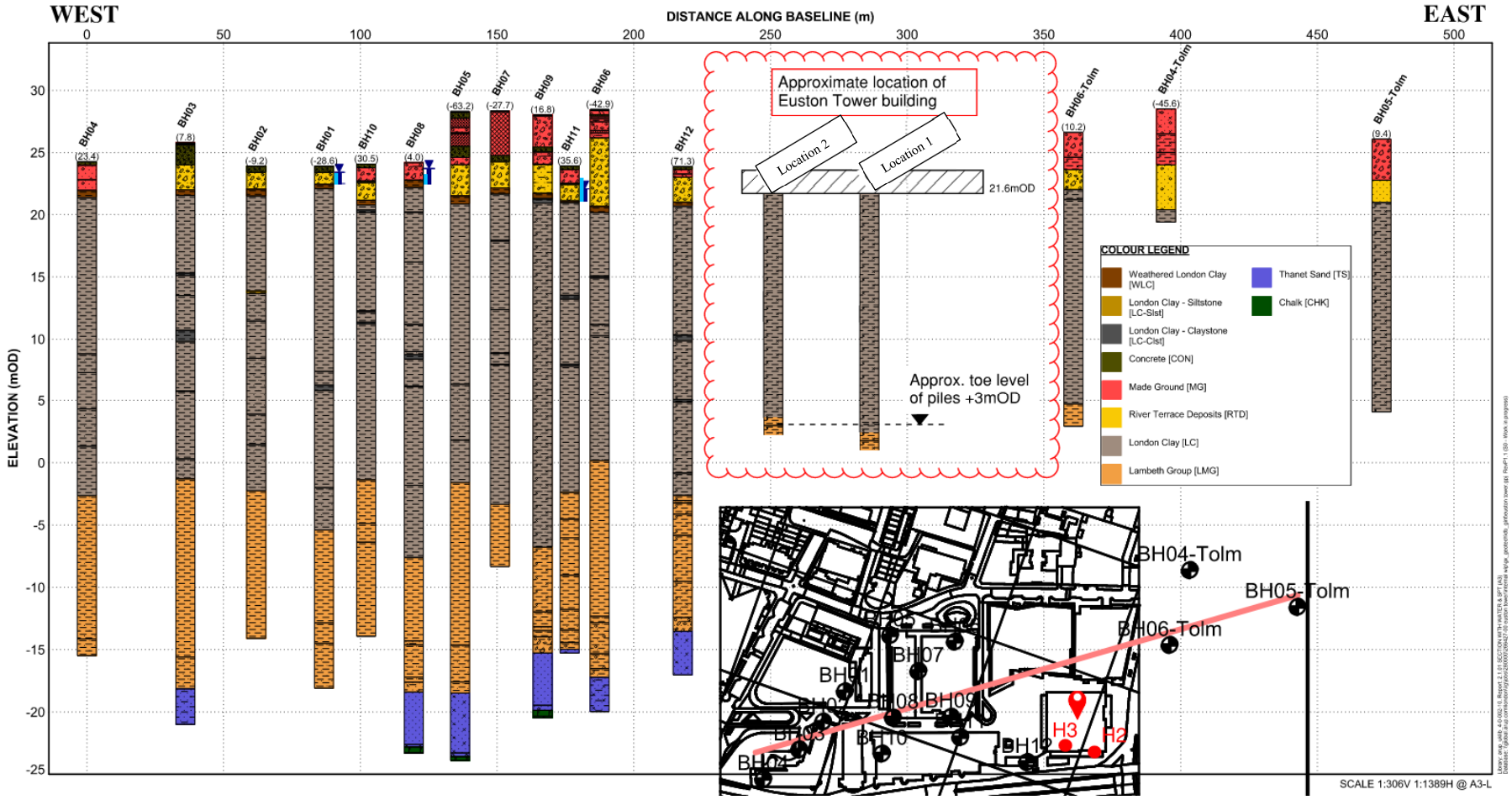


Figure 14 - West-east geological cross-section

Table 3 shows the stratigraphy encountered at the nearest investigation locations. The anticipated stratigraphy adopted for design and assessment is presented in Table 4.

Table 3: Summary of encountered stratigraphy from nearby site investigations.

Stratum	Euston Tower foundation investigation Locations 1 & 2[1]			BH12[2]			BH6[3]		
	Depth (mbgl)	Top of stratum level (mOD)	Thickness (m)	Depth (mbgl)	Top of stratum level (mOD)	Thickness (m)	Depth(mbgl)	Top of stratum level (mOD)	Thickness (m)
Fill / Made Ground	0	+28.0	4.4	0.25	+23.62	0.6	0	+26.62	3
River Terrace Gravel	4.4	+23.6	1.6	0.85	+23.02	2	3	+23.62	1.6
London Clay (weathered)	6	+22.0	0.5	2.85	+21.02	0.35	4.6	+22.02	0.8
London Clay	6.5	+21.5	16.9	3.2	+20.67	23.3	5.4	+21.22	16.5
Lambeth Group Formation	23.4	+4.6	*	26.5	-2.63	10.9	21.9	+4.72	>1.8*
Thanet Sand	-	-	-	37.4	-13.53	>3.5*			
End of hole	-	-	-	40.9	-17.03	n/a	23.7	+2.92	n/a

Notes:

* Borehole/Trial pit terminated within stratum. Thickness not determined.

1. Euston Tower Foundation Investigation Locations 1 & 2 undertaken between February and July 2022 in relation to the proposed development.

2. Regents Place and Triton Square Geotechnical Investigation Report, Laing Technology Group Limited (LTG), dated April 1995.

3. Tolmers Square Geotechnical Investigation Report, dated 1977.

Table 4: Anticipated site stratigraphy

Stratum	Description	Thickness (m)	Top of stratum level (mOD)
Ground level	-	-	+28.0
Fill / Made Ground	SAND and GRAVEL with demolition and building waste (brick and mortar cobbles)	0.3	+28.0
River Terrace Gravel	Medium dense, yellow-brown, fine to coarse SAND and sub-angular to rounded, fine to coarse flint GRAVEL. Medium to coarse orange-brown sand and fine to medium gravel	1.6	+23.6
London Clay (weathered)	Firm, brown and yellow-brown mottled Silty CLAY	0.5	+22.0
London Clay	Stiff to very stiff dark grey, brown Silty CLAY. Occasional grey green silt veins/pockets and shell debris. Clay is very to extremely closely fissured. Interbedded claystone's. Becoming very stiff from 10.8m below top of London clay. Becoming very sandy from 22.3m below top of London Clay.	17.5	+21.6
Lambeth Group Formation (formerly known as Woolwich and Reading Beds)	Very stiff, grey mottled red and brown Silty CLAY with occasional bands of fine to medium grained sand. Becoming very stiff to hard. Becoming hard Sandy CLAY 6.9m below top of layer.	17.5	+4.0
Thanet Sand	Very dense, grey, fine to medium grained sand. Occasional interbedded pockets of silt/clay	3.5*	-13.5
Note: * Borehole terminated at 40.9mbgl within Thanet Sand. Layer thickness and underlying strata not proven within available investigations.			

3.4 Ground model

For the purposes of the Basement Impact Assessment presented in this report, a preliminary ground model has been adopted for ground movement assessment, as shown in Table 5. The formation level of existing basement was taken at +21.6mOD, based on the 2022 foundation investigation findings is taken as the upper ground surface.

Table 5: Preliminary ground model adopted for ground movement assessment.

Stratum	Top of stratum level	Undrained shear strength	Vertical undrained Young's modulus	Vertical drained Young's modulus
	(mOD)	(kPa)	(MPa)	(MPa)
London Clay Formation	+21.6 (Underside level of existing basement)	$80 + 5z^1$	$E_{u,v} = 40 + 2.5z^1$ $(E_{u,v} = 500\ c_u)$	$E'_v = 25.6 + 1.6z^1$ $(E'_v = 320\ c_u)$
Lambeth Group	+4.0	$168 + 5z^2$	$E_{u,v} = 84 + 2.5z^2$ $(E_{u,v} = 500\ c_u)$	$E'_v = 53.8 + 1.6z^2$ $(E'_v = 320\ c_u)$
Thanet Sand	-13.5	-	-	$E'_v = 200$
Chalk	-20.0	Assumed to be rigid boundary		

Notes:

1. z^1 denotes depth in metres below London Clay Formation surface.
2. z^2 denotes depth in metres below Lambeth Group surface.
3. The undrained shear strength and stiffness profiles for Lambeth Group (Clay) are assumed to be a continuation from the respective overlying London Clay Formation profiles.

Figure 15 shows the supporting undrained shear strength results from UT100 unconsolidated undrained (UU) triaxial tests.

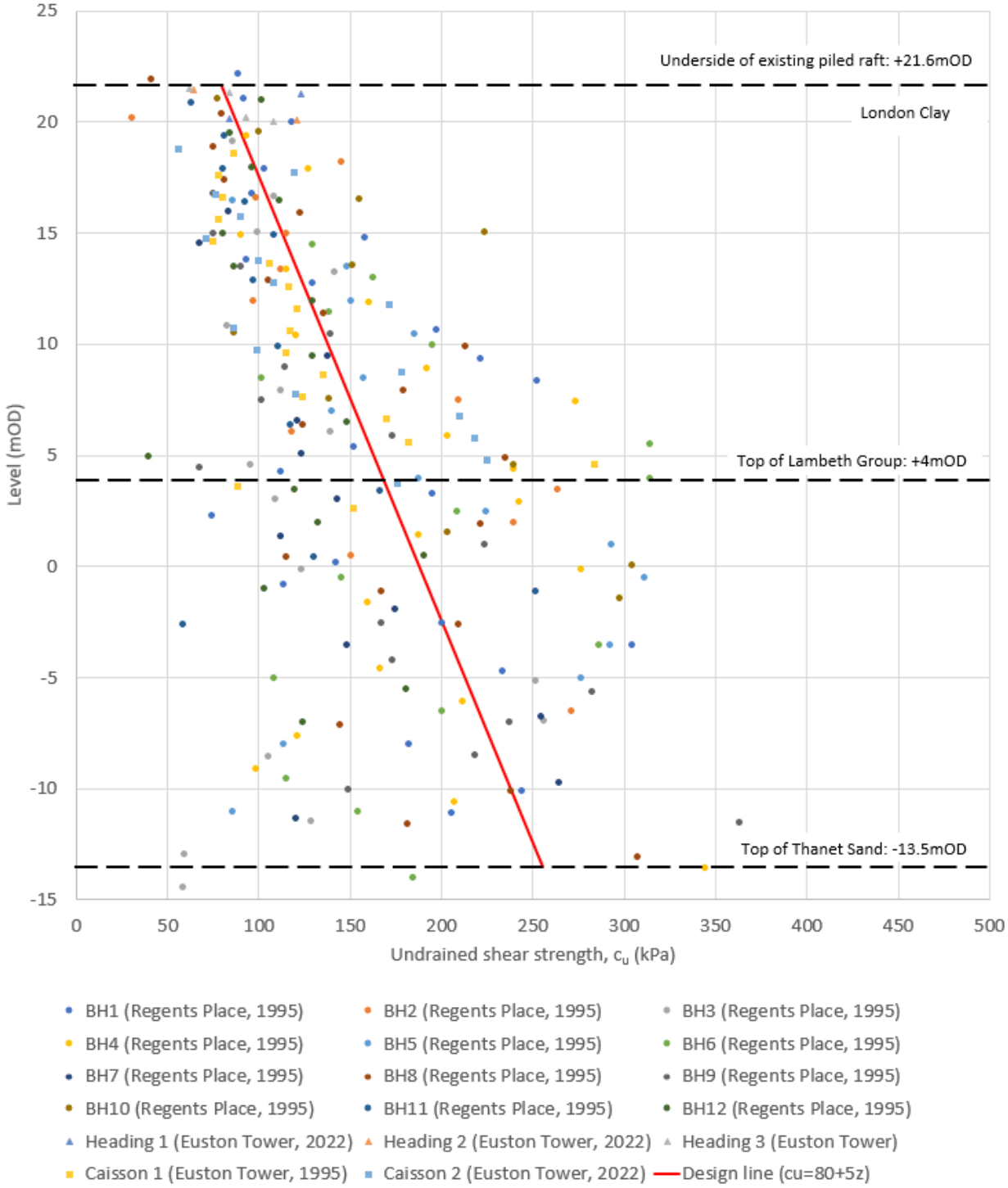


Figure 15: Undrained shear strength from Undrained Unconsolidated triaxial results on 100mm diameter samples.

3.5 Groundwater

A map of the Lost Rivers of London is shown in Figure 16. There are no lost rivers recorded within the site extent.

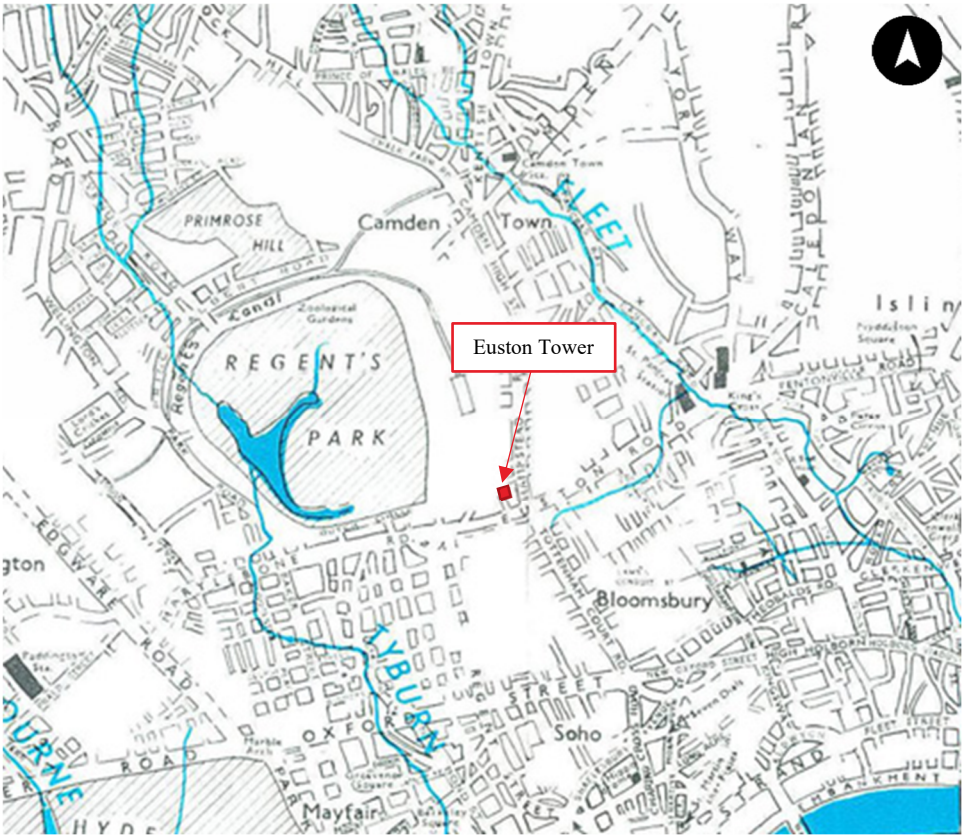


Figure 16 - Lost rivers of London (https://www.hiddenhydrology.org/, accessed 17/01/2023)

As relevant to the basement impact assessment, groundwater is anticipated in the shallow aquifer within the superficial deposits (principally the River Terrace Deposits). Groundwater is expected to be either in continuity within the aquifer or encountered as perched, due to variation in the surface of impermeable strata (clays and/or by the presence of buried man-made structures).

A summary of groundwater readings from nearby investigation locations are included below in Table 6. The groundwater readings are typically between 1m (+22.87mOD) and 1.8m (+22.07mOD) below top of the basement slab (+23.87mOD) at the location of BH12. These readings relate to the development of 1 Triton Square within the Regents Place estate.

Table 6: Monitored groundwater levels from nearby site investigations.

BH	Monitored Groundwater Level (mOD)	Source (refer notes)
BH12 (water strike)	+22.87	(1) – year 1995
TP08 (water strike & recharge)	+22.62	(1) – year 1995
CH03 (standpipe)	+22.5	(2) – year 2017
CH02 (standpipe)	+22.4	(2) – year 2017
BH101 (standpipe)	+22.25	(2) – year 2017
CH01 (standpipe)	+22.10	(2) – year 2017
BH11 (standpipe)	+22.07	(1) – year 1995
Notes:		

BH	Monitored Groundwater Level (mOD)	Source (refer notes)
(1) Regents Place and Triton Square Geotechnical Investigation Report, LTG, April 1995 (2) 1 Triton Square Geotechnical Report, Arup, 2017		

Groundwater was also encountered in the River Terrace Deposits during recent foundation strengthening works carried out at 1 Triton Square (2018-2019). Water levels were generally controlled for raft and pile cap construction works by localised temporary works and pumping.

During the 2022 foundation investigation at Euston Tower, water was encountered within the superficial deposits and was controlled by localised temporary works and pumping.

4. Screening assessment

4.1 Screening assessment methodology

The screening assessment criteria used to guide this Basement Impact Assessment is taken from London Borough of Camden guidance for subterranean development 'the Arup Report' (Camden, 2010). The screening assessment including potential impact and mitigation is set out in the tables under the following Sections 4.2 to 4.4. A summary of the key impacts and proposed mitigation is presented in Section 4.5.

4.2 Subterranean Screening Assessment

Question	Response	Proposal/ Mitigation
1a. Is the site located directly above an aquifer?	Yes. Made Ground and River Terrace Deposits are present outside and beneath the existing basement footprint.	The proposals do not include widening the plan extent of existing basement. Localised deepening within the River Terrace Deposits and London Clay underneath the existing basement is proposed to construct Basement 02 level plant/tank space and deepen areas of the existing B1.
1b. Will the proposed basement extend beneath the water table surface?	Yes. Groundwater is present within Made Ground and River Terrace Deposits.	Proposed local Basement 02 plant/tank level beneath the existing single level basement involve localised excavation within River Terrace Deposits and London Clay. Provision for temporary water control and retaining wall should be made.
2. Is the site within 100m of a watercourse, well (used/ disused) or potential spring line?	No.	N/A
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No.	N/A
4. Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	No.	N/A
5. As part of the site drainage, will more surface water (e.g., rainfall and run-off) than at present be discharged to the ground (e.g., via soakaways and/ or SUDS)?	No.	N/A Refer to Flood Risk Assessment report (Arup, 2024, Report ref.: 281835-ARP-XX-XX-RP-CD-0001), Flood Risk Assessment Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0001), Drainage & SuDS Strategy (Arup, 2024, Report ref.: 181835-ARP-XX-XX-RP-CD-0002) and Drainage and SuDS Strategy Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0002).
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local point (not just the pond chains on Hampstead Heath) or spring line?	Yes	A portion of the local B02 basement proposed as part of the application will be below the water table. This will be waterproofed by design to resist water ingress to the space, tied in to the existing basement.

4.3 Stability Screening Assessment

Question	Response	Proposal/ Mitigation
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No.	N/A
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No.	N/A
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No.	N/A
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No.	N/A
5. Is the London Clay the shallowest stratum at the site?	No. However, existing pile cap for tower building founded directly on London Clay.	N/A
6. Will any trees be felled as part of the proposed development and/ or are any works proposed within any tree protection zones where trees are to be retained?	Yes, the tree planting is to be adjusted as part of the development, however trees are located within engineered tree pits.	The existing and proposed trees are within engineered tree planting troughs and/or otherwise not expected to cause ground movement at the basement formation level due to depth.
7. Is there a history of seasonal shrink-swell subsidence in the local area and/ or evidence of such effects at the site?	London Clay stratum present is susceptible to shallow shrink swell effects generally, following established guidance.	The foundations/basements for the development are at greater than 5m depth below ground, and trees are located within engineered tree pits.
8. Is the site within 100m of a watercourse or potential spring line?	No.	N/A
9. Is the site within an area of previously worked ground?	Yes. Made Ground is present on site and has been modified over site's development history.	Existing basement has removed majority of Made Ground so extent remaining is limited. Further investigations are recommended if fill is to be considered as a bearing stratum in design.
10a. Is the site within an aquifer?	Yes. Made Ground and River Terrace Deposits are present outside existing basement footprint.	The existing basement within the site is directly underlain by London Clay. The proposals do not include widening the plan extent of existing basement.
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Yes.	Temporary water control provisions are recommended for proposed Basement 02 excavation within the River Terrace Deposits and London Clay.
11. Is the site within 50m of Hampstead Heath ponds?	No.	N/A
12. Is the site within 5m of a highway or pedestrian right of way?	Yes. The edge of existing basement is located within 3m of existing pedestrian walkways.	Contractor to agree proposed hoarding line to minimise impact on public right of way and agree with Camden planning authority.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes. The proposed Basement 02 level will be deeper than the existing single level basement. However, 2-level basements are present at neighbouring 10-30 Brook Street, so this will be	Ground movement assessment has been carried out in Section 6.

Question	Response	Proposal/ Mitigation
	less deep than adjoining basements.	
14. Is the site over (or within the exclusion zone of) any tunnels, e.g., railway lines?	Yes. The site falls within the 2015 Crossrail 2 Safeguarding Directions (see Appendix E for correspondence from Crossrail 2). The site is located to the west of Northern and Victoria line tunnels, to the north of St Johns Wood to Back Hill deep cable tunnel and Hammersmith & City, Circle and Metropolitan line tunnel)	Third party consultation and engagement with Crossrail 2 will be carried out. A preliminary ground movement assessment will be carried out separately to assess the impact of proposed redevelopment on existing and future tunnels.

4.4 Surface Flow and Flooding Screening Assessment

Question	Response	Proposal/ Mitigation
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No.	N/A
2. As part of the proposed site drainage, will surface water flows (e.g., volume of rainfall and peak run-off) be materially changed from the existing route?	No.	N/A
3. Will the proposed basement development result in a change in the proportion of hard surfaced/ paved areas?	No.	N/A
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No.	N/A
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No.	N/A
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature.	No. The site is located in flood zone 1 – an area of low probability of flooding.	N/A

4.5 Summary of potential impacts and mitigations

The following key potential impacts have been identified from the screening assessment. Recommendations for further assessment are made:

Subterranean screening assessment:
An aquifer is present at the site location. The proposed local B02 basement would introduce local cut-off of the shallow aquifer to the London Clay aquiclude through the River Terrace Deposits (upper aquifer). However, the size of the local B02 basement is not significant in relation to the site footprint.
Refer to the Flood Risk Assessment report (Arup, 2024, Report ref.: 281835-ARP-XX-XX-RP-CD-0001), Flood Risk Assessment Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0001), Drainage & SuDS Strategy (Arup, 2024, Report ref.: 181835-ARP-XX-XX-RP-CD-0002) and Drainage and SuDS Strategy Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0002) for assessment of surface water and SUDS.

Stability Screening Assessment:
Ground movement assessments for assets falling within the zone of influence associated with the proposed redevelopment are recommended. The zone of influence for ground movements refers to area with calculated vertical ground movements greater than +/-1mm.

The relative depth of the proposed Basement 02 is deeper than the existing single level basement for the Euston Tower building. Ground movements that will impact neighbouring buildings are to be assessed (presented in Section 6.)

The site falls within the 2015 Crossrail 2 Safeguarding Directions and therefore consultation is expected to be required. The site is located to the west of Northern and Victoria line tunnels, to the north of St Johns Wood to Back Hill deep cable tunnel and Hammersmith & City, Circle and Metropolitan line tunnel.

In relation to TfL and utility assets, third party consultation and engagement with the respective asset owners will be carried out. A preliminary ground movement assessment will be carried out separately to assess the impact of proposed redevelopment on existing and future assets.

Surface flow and flooding

Refer to the Flood Risk Assessment report (Arup, 2024, Report ref.: 281835-ARP-XX-XX-RP-CD-0001), Flood Risk Assessment Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0001), Drainage & SuDS Strategy (Arup, 2024, Report ref.: 181835-ARP-XX-XX-RP-CD-0002) and Drainage and SuDS Strategy Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0002)

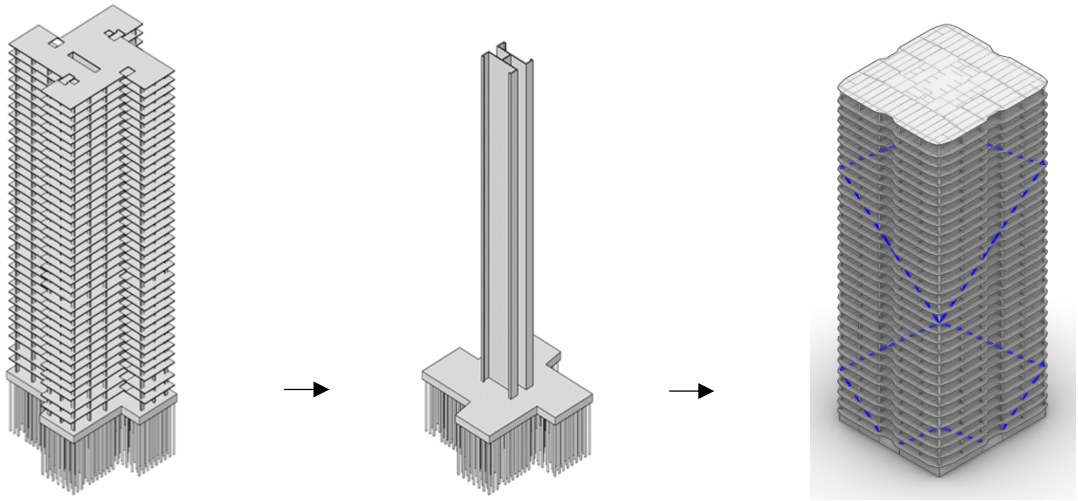
The cumulative effects of basement development are not considered to be significant or require assessment.

5. Basement design

5.1 Proposed development

The proposed development of Euston Tower involves the deconstruction of the existing floorplates from roof to ground floor level, with the central core, foundations and basement retained. A new structural frame and new floorplates will be constructed, with the foundations and central core being reused. New supplementary foundations will be constructed to support the new superstructure where it extends beyond the extent of the existing pile cap.

Figure 17 illustrates the general proposed redevelopment stages for Euston Tower in outline.



a) Existing tower structural model

b) Retained core, basement, and foundation after partial deconstruction

c) New proposed structural model

Figure 17: Proposed redevelopment of Euston Tower building

5.2 Proposed basement geometry

The existing single level basement between the Euston Tower building and surrounding the building is to be retained and locally deepened. A local Basement 02 level is proposed underneath the existing single level basement to accommodate a water tank and plant room. The proposed Basement 02 level has a plan dimension of approximately 5.5m x 34m (187 sqm), located to the west of existing pinwheel piled raft as illustrated in Figure 18. The proposed B2 FFL is approximately +19.77mOD in relation to the general 1 level basement level of +23.9mOD.

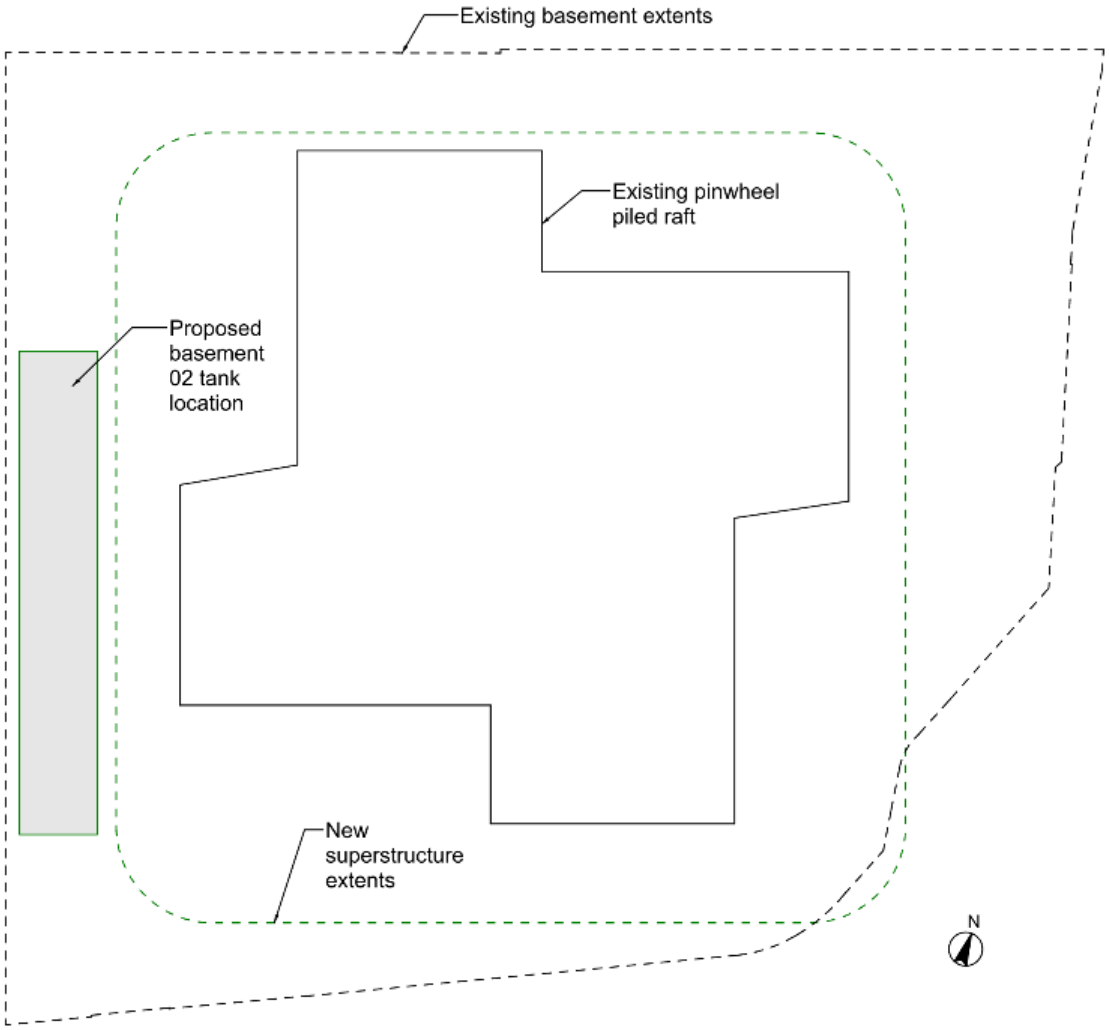


Figure 18: Proposed Basement 02 plan (extract from 3XN drawing no.: ET_DR-A_20098)

5.2.1 Proposed B2 retaining wall

The Basement 02 temporary embedded wall is assumed to be 600mm diameter contiguous pile wall with c/c pile spacing of 1.2m. The contiguous pile toe level is assumed to be at +14mOD. The B02 formation level has been taken at +19.3mOD. An unplanned excavation of 0.5m has been considered in the ultimate limit state analysis.

Oasys FREW software have been used to carry out the proposed Basement 02 embedded retaining wall analysis. FREW is a pseudo-FE analysis which models the soil structure interaction for excavation in front of retaining walls. FREW analyses the behaviour for each stage of the construction sequence. FREW calculates wall displacement, shear forces, bending moments, and earth and water pressures on both sides of wall at each construction stage.

The pile wall bending stiffness short and long term EI are calculated as $0.7E_0I$ and $0.5E_0I$ respectively, where E_0=34GPa. A temporary prop stiffness of 40,000kN/m/m has been assumed.

A variable surcharge of 10kPa has been adopted during construction on the active side of the wall. The future B1 slab permanent and variable surcharges behind the contiguous wall are taken to be 45 kPa and 10 kPa respectively.

The envisaged Basement 02 construction stages modelled in FREW are summarised as below:

Stage 0: Initial condition

Stage 1: Install wall

Stage 2: Cast B1 slab

Stage 3: Partial excavation to +20.5mOD

Stage 4: Install temporary prop at +22.4mOD

Stage 5: Excavation to formation level at +19.3mOD

Stage 6: Cast B02 slab wet concrete (weight as surcharge)

Stage 7: Cast B02 slab (apply stiffness)

Stage 8: Cast B1 roof slab (apply stiffness)

Stage 9: Remove temporary prop

Stage 10: Long term drained soil conditions

*Stage 11: Apply concrete relaxation to 0.5E_0*I.

Further details on the calculations for proposed B2 retaining wall are provided in Appendix G.

5.3 Foundations

5.3.1 Existing foundations

The 2022 foundation investigation demonstrated that piles are arranged in groups beneath the columns and structural cores. Figure 19 illustrates the understanding of pile arrangements under the tower. The reinforced concrete piles were discovered to be straight shafted with diameter of 2ft (610mm) and were approximately 19m long. Intrusive investigations have found the piles to be reinforced to full pile depth.

The pinwheel raft/ pile cap was found to be 2.8m thick, with a structural thickness of 2.4m. The raft extends over the entire footprint of the existing tower and is used to spread the load from individual columns into the pile groups. The piled raft was found to be in good condition given its age, despite being sparsely reinforced compared to current modern standards. No corrosion of reinforcing steel has been observed.

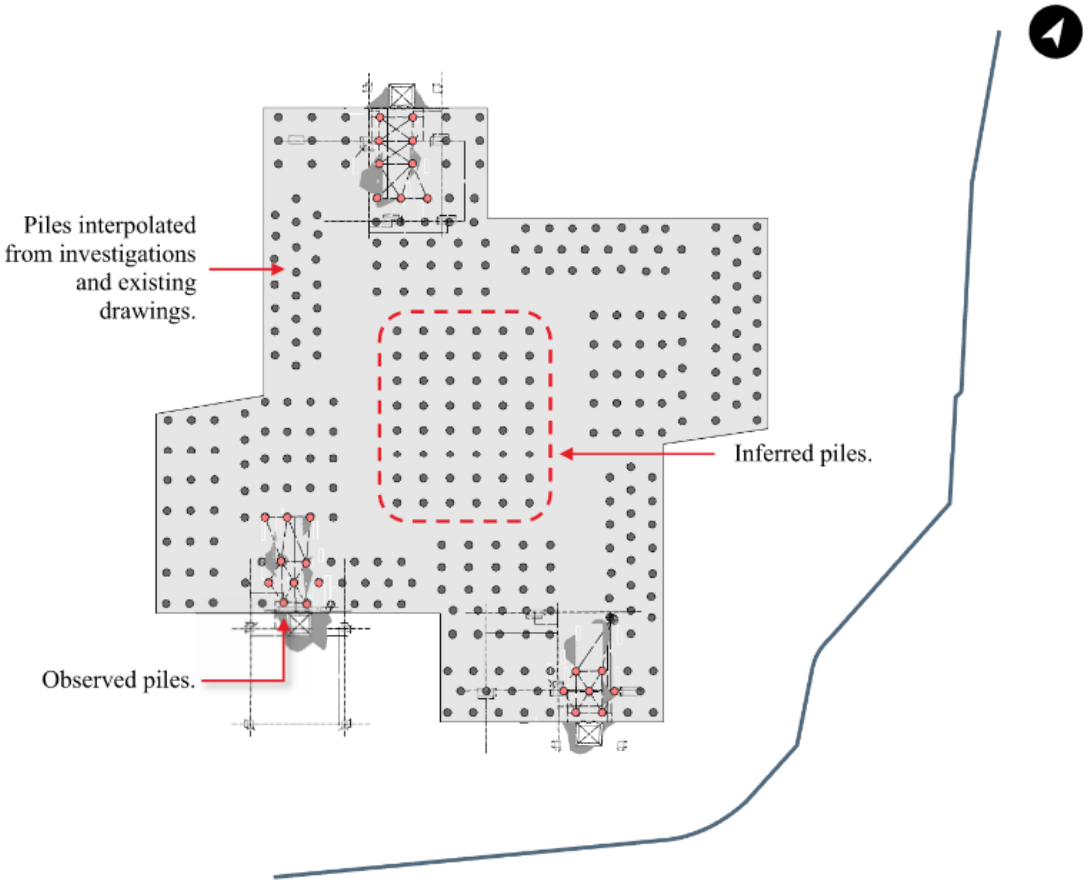


Figure 19: Plan showing anticipated existing foundations of Euston Tower

5.3.2 New foundations

Due to the limited knowledge of the existing foundations, a load balance approach is to be adopted where the new applied loading on the existing foundation is kept less than or equal to the existing loading regime. Basement load spreading structures are proposed to transfer loading from new column locations to the previous column locations in the basement.

New 1500mm thick pile caps with 900mm diameter piles are proposed to support new columns landing outside of the existing pinwheel piled raft, as shown in Figure 20. Options for foundations in the southeast corner to support new column load are currently under development. Pile groups or a single hand dug caisson are being considered due to the close proximity to the existing retaining wall. The new B1 slab will be lowered by approximately 0.5m, over the zone set inwards from the B1 perimeter to retain the toe of the existing retaining wall, as illustrated in Figure 20. The new B1 slab will cover the new pile caps and where removed and replaced to install new foundations, reinstate the diaphragm provided by the existing B1 slab.

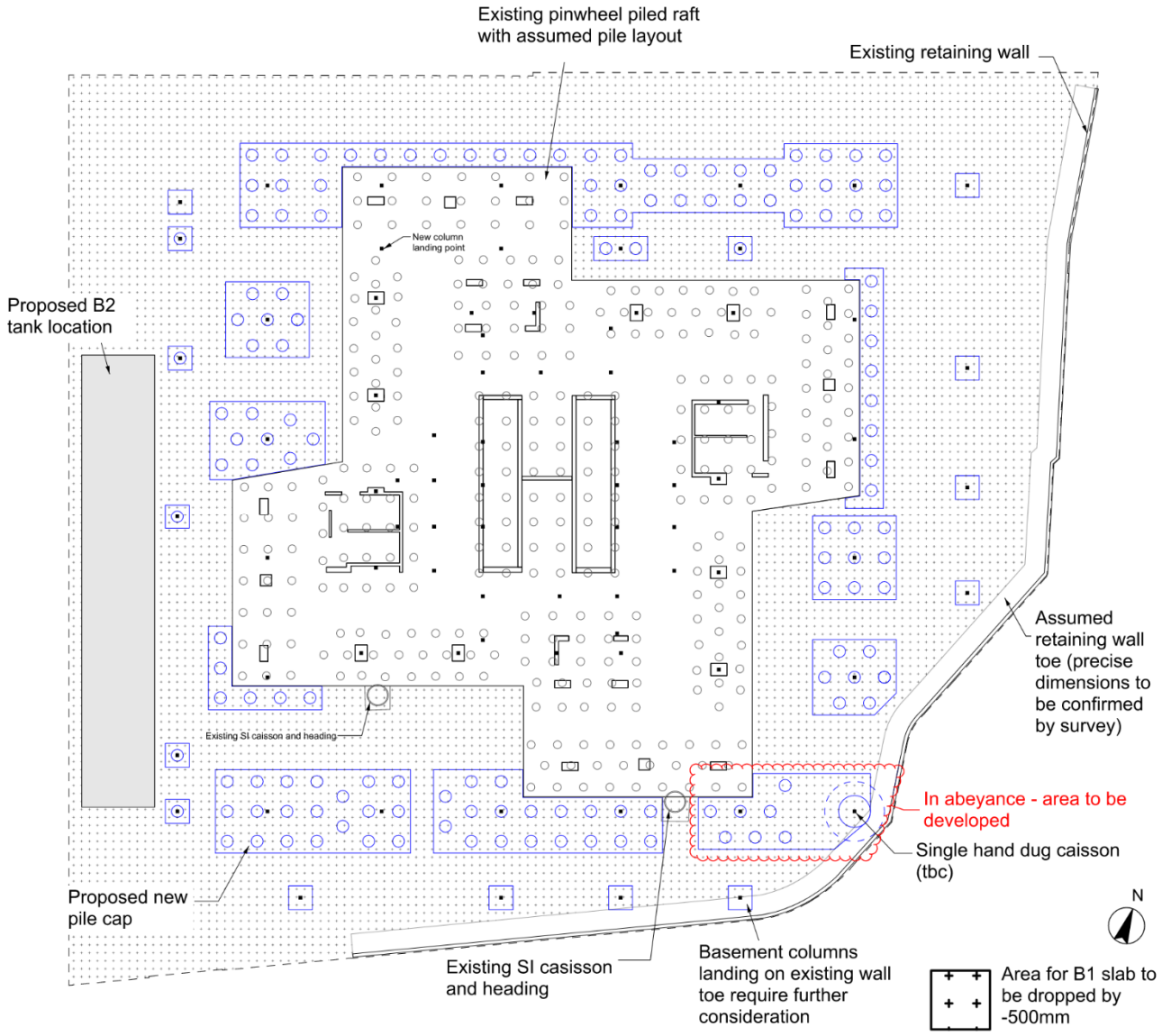


Figure 20: New foundations showing existing piled raft, and new pile caps.

5.4 Construction sequence

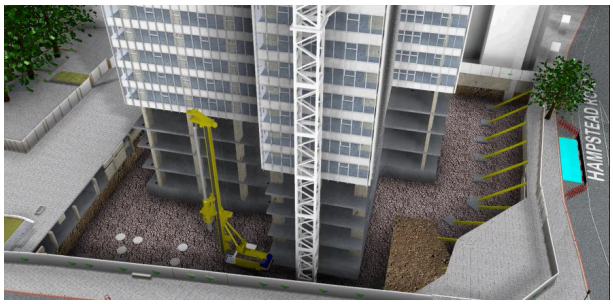
For the purposes of the basement impact assessment presented in this report, the currently anticipated construction sequence for the proposed redevelopment is illustrated in Figure 21 and outlined below in summary:

- Site enabling works.
- Deconstruction of Euston Tower floorplates starting from roof level downwards.
- Deconstruction of ground floor slab and installation of temporary props to support the existing retaining wall.
- Earthworks to provide piling platform level within basement for new foundations.
- Installation of foundation piles for new building superstructure and temporary retaining wall (contiguous piled wall or sheet pile wall) around proposed local Basement 02.
- Localised excavation to Basement 02 formation level with temporary propping as necessary.
- Construction of new B1 slab & substructure (including new pile caps).
- Construction of ground floor slab and new building floorplates above.

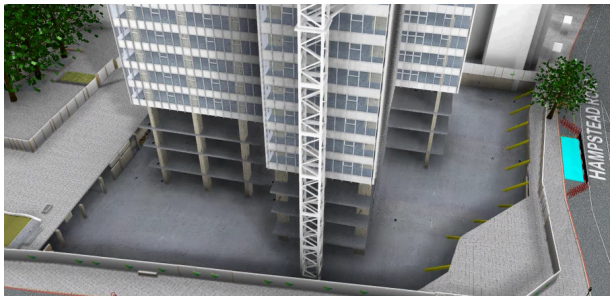
A 'bottom-up' traditional construction of the proposed local Basement 02 and temporary retention of the existing basement to enable local deepening using high support temporary propping is proposed. The temporary works and construction sequence will be further developed at later design stage and following engagement with specialist contractors and temporary works designers.

For further details refer to the Construction Management Plan included with the application.

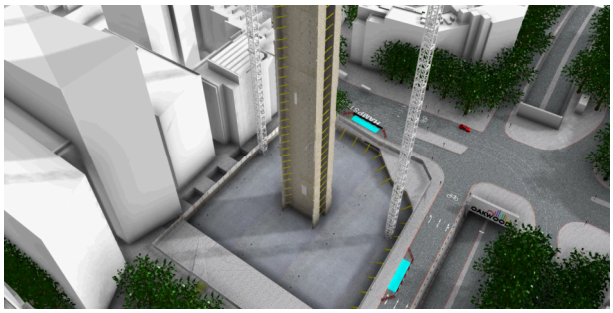
a) Deconstruction of floorplates starting from roof level downwards. Removal of ground floor slab and installation of temporary props to support the basement wall.



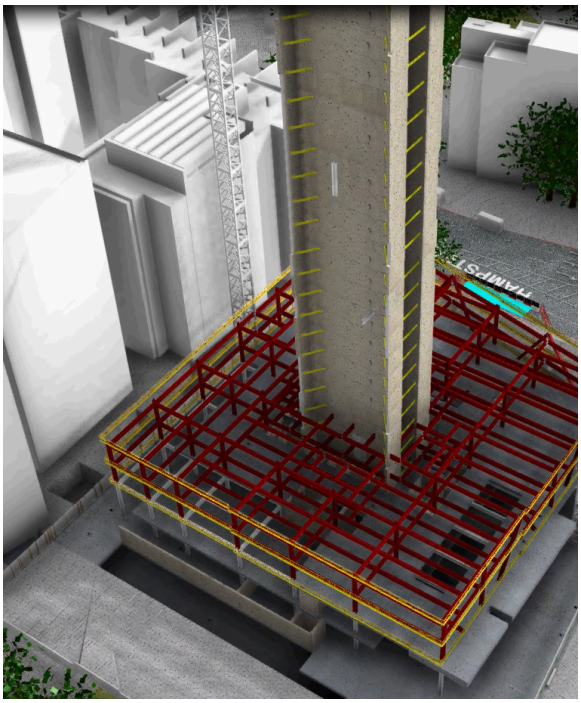
b) Installation of additional foundation piles within the basement (concurrent to demolition)



c) Casting of new B1 basement slab (localised deepening for local proposed Basement 02 beneath not shown), concurrent to demolition.



d) completion of floorplate deconstruction to ground level



e) Construction of ground floor slab and new floorplates above to building completion

Figure 21: Current anticipated indicative construction sequence (extract from indicative proposal)

6. Preliminary ground movement assessment

6.1 Scope of the assessment

A preliminary ground movement assessment for the proposed development has been carried out within this Basement Impact Assessment. The zone of influence for ground movements associated with the proposed development has been determined, followed by assessment of potential impact on neighbouring buildings. Camden Planning Guidance (CPG) on Basements (Camden, 2021) and Policy A5 on basement states that the anticipated damage category for neighbouring structures should not exceed category 1 'very slight' on the Burland scale. The ground movement assessment is described further in the following sections.

The impact of ground movements on third party utility assets (Thames Water, Gas, London Underground and Future Crossrail 2 etc) will be assessed in separate technical assessments for review by the respective third parties ahead of the proposed development.

6.2 Ground movements

6.2.1 Introduction

Ground movements arising from change in loading to the ground have been quantified and considered cumulatively to assess the impact on neighbouring buildings. It is noted that the principal cause of ground movement is the unloading and reloading of the ground from partial deconstruction and construction of new development. The new local B02 basement construction is a small proportion of the calculated ground movement and the zone of influence does not extend outside the site boundary. The unloading due to lowering of the B1 slab is small relative to unloading due to partial deconstruction. The following sections describe the methodology and results of the ground movement assessment undertaken.

The horizontal movement of the retaining walls to form the B02 local basement area are not considered in the assessment as the surrounding basement of the building encompasses a 45-degree influence zone, expressed from the base of the excavation. Therefore, the effect of the basement construction considered is limited to the unloading/reloading of the ground.

6.2.2 Ground movement assessment

Sources of ground movements arising from the development due to change in loading are outlined as follows:

1. Unloading due to partial deconstruction of existing superstructure
2. Unloading due to localised excavation of proposed local Basement 02.
3. Unloading due to lowering of B1 slab.
4. Loading due to addition of new superstructure

Oasys PDISP, analysis software, has been used to calculate ground movements in the short and long-term using undrained and drained conditions respectively. Settlements and/or heave are calculated in PDISP by using a linear elastic soil model and the Boussinesq method for stress distribution. The Boussinesq method calculates the stresses in the soil due to applied loads using equations derived by Boussinesq (1885). In the analysis, settlements/ heave above the applied load is conservatively assumed to be the same as that at the level of applied load. Soil structure interaction effects are not considered in the analysis.

Three key stages have been considered for ground movement assessment and are presented in Table 7.

Table 7: Key stages considered for ground movement assessment.

Considered key stages	Changes in loading	Soil conditions
During construction	Partial deconstruction unloading + B2 basement excavation unloading +B1 slab lowering (unloading)	Undrained
End of construction (short term)	Partial deconstruction unloading + B2 basement excavation unloading + B1 slab lowering (unloading) + new superstructure loading	Undrained
End of construction (long term)	Partial deconstruction unloading + B2 basement excavation unloading + B1 slab lowering (unloading) + new superstructure loading	Drained

An assessment has been carried out to estimate changes in loading as mentioned above, to determine the net unloading/ loading applied to the ground. Figure 22 and Figure 23 illustrate the net unloading/ loading applied at different areas and levels. Unloading due to partial deconstruction of existing superstructure and loading due to new superstructure are assumed to be transferred down the piles within London Clay and applied onto an equivalent raft area empirically determined at 2/3 of the pile depth using a 1H:4V spread.

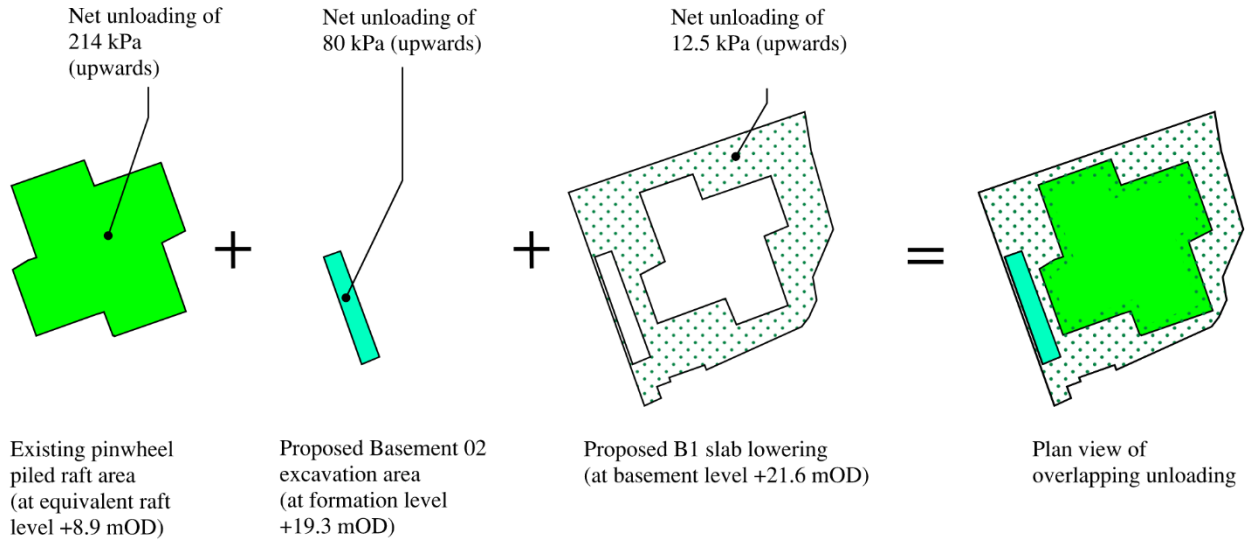


Figure 22: Net unloading applied in Oasys PDISP model, resulting from partial superstructure deconstruction, proposed B2 excavation and B1 slab lowering.

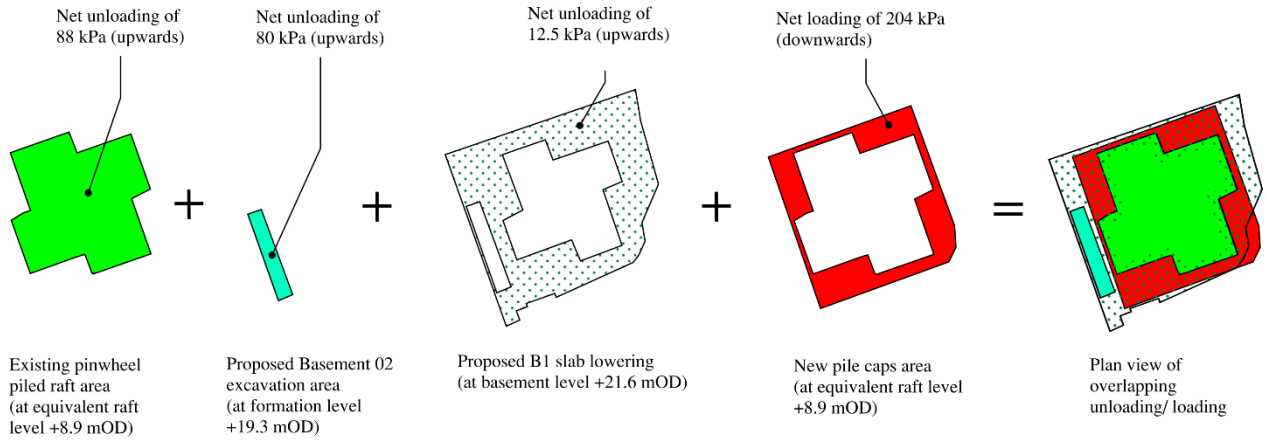


Figure 23: Net unloading/ loading applied in Oasys PDISP model, resulting from partial superstructure deconstruction, proposed B2 excavation, B1 slab lowering and new superstructure loading.

6.2.3 Ground movement results

Short and long term vertical ground movements associated with the considered key stages (see Table 7) are presented in Figure 24 to Figure 26. Zone of influence for ground movements refers to area with calculated vertical ground movements greater than +/-1mm. Downward movements are presented as +ve. Further details on ground movement calculations are provided in Appendix H.

1 Triton Square and 2 Triton Square do not fall within the zone of influence for ground movements associated with the proposed redevelopment.

The calculated ground movements indicate that in the long term, the southern façade of Northeast Quadrant (10-30 Brock Street) would experience settlements between 1mm and 8mm.

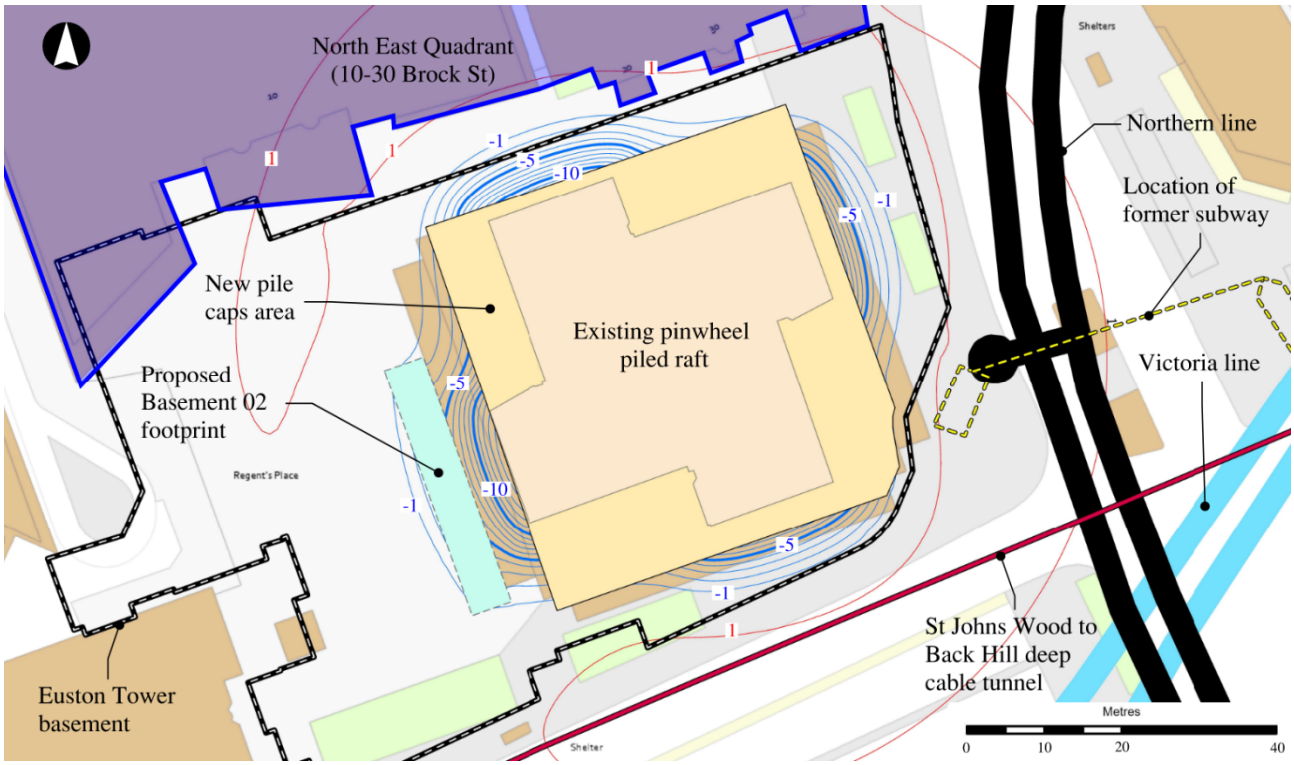


Figure 24: Calculated short term ground movement (mm) at basement level +21.6mOD resulting from partial superstructure deconstruction, proposed Basement 02 excavation and B1 slab lowering (downward movements are presented as +ve).

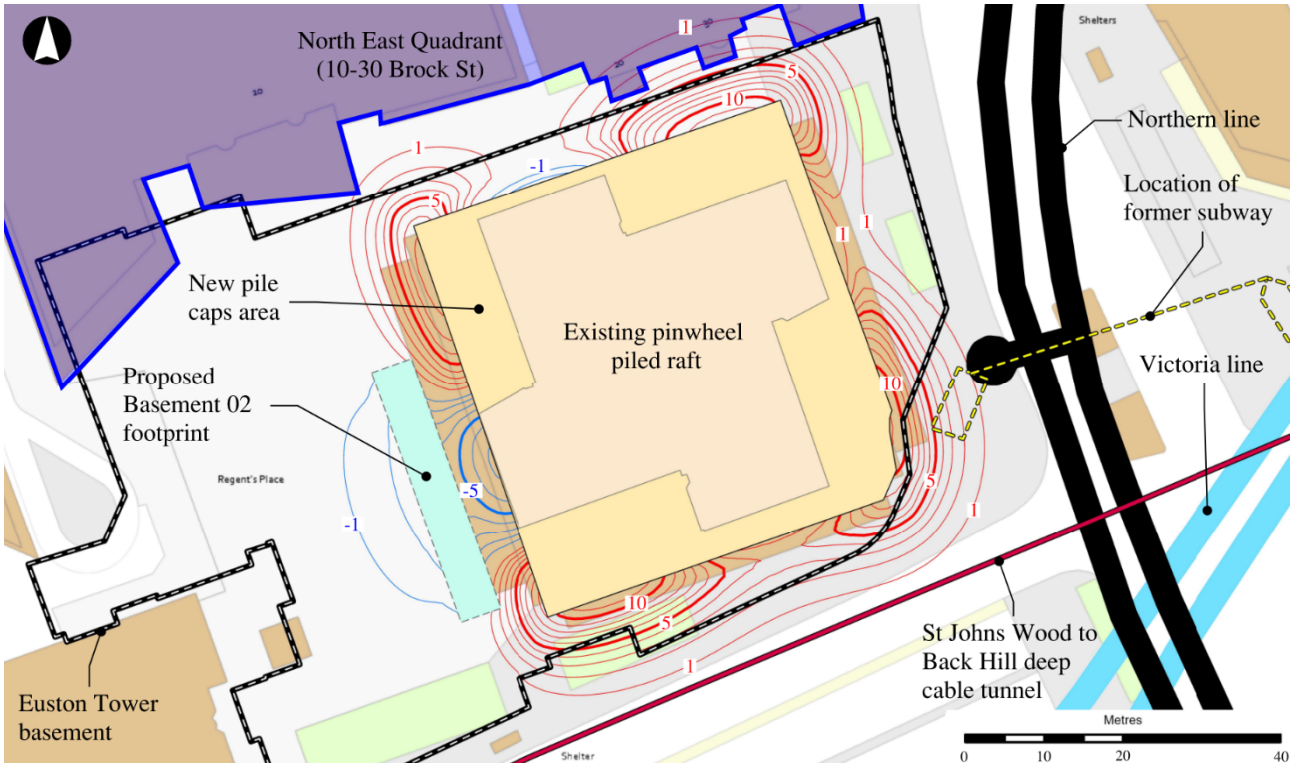


Figure 25: Calculated short term ground movement (mm) at basement level +21.6mOD resulting from partial superstructure deconstruction, proposed Basement 02 excavation, B1 slab lowering and new superstructure loading (downward movements are presented as +ve).

Figure 26: Calculated long term ground movement (mm) at basement level +21.6mOD resulting from partial superstructure deconstruction, proposed Basement 02 excavation, B1 slab lowering and new superstructure loading (downward movements are presented as +ve).

6.3 Impact on Northeast Quadrant (10-30 Brock Street)

The calculated ground movements described in Section 6.2 have been used to carry out Burland building damage assessment of the neighbouring buildings due to calculated ground movements. Building section lines (10-30 Brock Street) shown in Figure 27 have been taken for assessment.

For each structure, the effect of ground movement has been considered using the Burland (1995) method. This uses vertical deflections and horizontal strains, assuming that the building follows greenfield ground movements (without benefit from the stiffness of the structure itself), in order to derive a building damage category that is related to observed crack width and ease of repair. The damage categories are summarised in Figure 29. Burland damage category 0,1, and 2 refer to aesthetic damage, category 3 and 4 relate to serviceability and function and category 5 refers to stability related damage. The assessment does not account for soil-structure interaction.

For the preliminary building damage assessment, the potential damage criteria are taken to not exceed Category 1 (Very slight) as defined by Burland (1995). Category 1 (Very slight) can be defined as:

- ‘Slight’ damage consisting of ‘fine cracks that can easily be treated during normal decoration.;
- Perhaps isolated slight fractures in building;
- Crack in external brickwork visible upon inspection; and
- The approximate crack width is less than 1mm.

Damage is a function of strain within a building due to flexure and elongation/ compression. The ground movement impact has been assessed based on the buildings being in good condition with no significant existing defects. Figure 28 illustrates the relationship between impact category, deflection ratio and horizontal tensile strain.

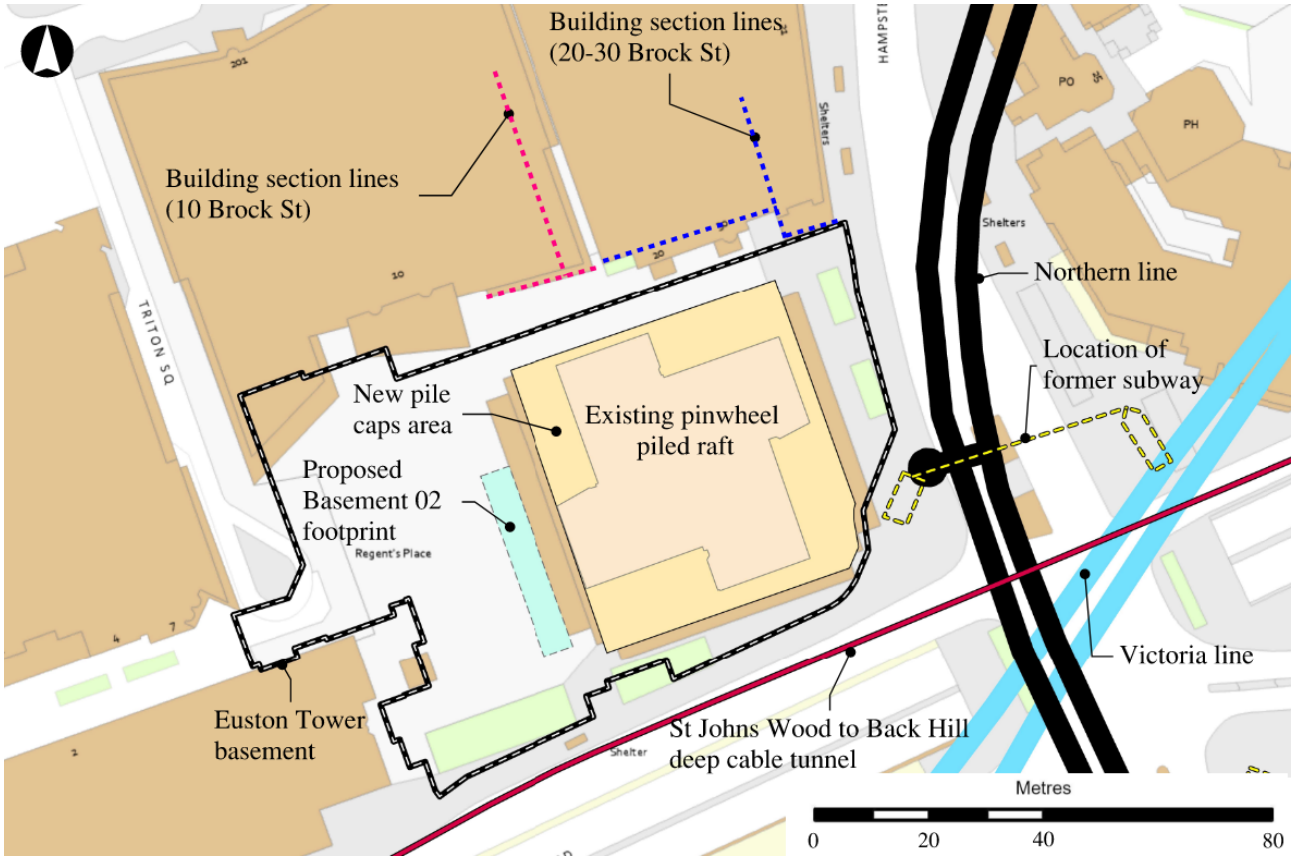
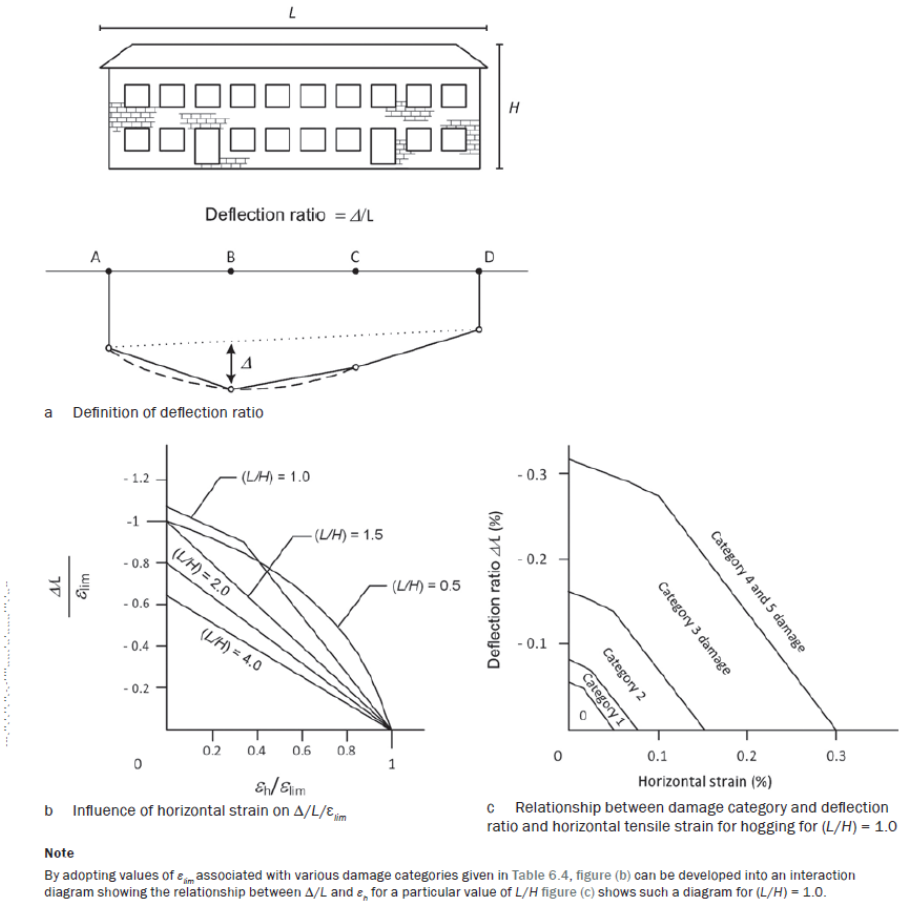


Figure 27: Neighbouring 10-30 Brock Street building section lines analysed for potential impact.



Note

By adopting values of ε_{lim} associated with various damage categories given in Table 6.4, figure (b) can be developed into an interaction diagram showing the relationship between Δ/L and ε_h for a particular value of L/H figure (c) shows such a diagram for $(L/H) = 1.0$.

Figure 28: Relationship between damage category, deflection ratio and horizontal tensile strain (after Burland, 2001) (extract from CIRIA C760)

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	

Figure 29: Classification of visible damage to walls (after Burland et al, 1977, Boscardin and Cording, 1989, and Burland, 2001) and target damage category in red (extract from CIRIA 760)

6.3.1 10 Brock Street

Key assumptions made for potential impact assessment on 10 Brock Street are outlined below:

- The structure is expected to be a 9-storey framed building with a two level basement, with calculated movements assessed at the foundation level.
- Burland assessment assumes a structural height of 40m above basement level +21.6mOD, with the neutral axis taken at the mid height and full height for sagging and hogging respectively.
- E/G ratio of 12.5 is assumed for concrete framed structure (Burland, 1995)

The most critical section for 10 Brock Street has been identified as illustrated in Figure 30. The Burland damage assessment results (see Figure 31 and Figure 32) indicated that the structure has potential damage category 0 (negligible).

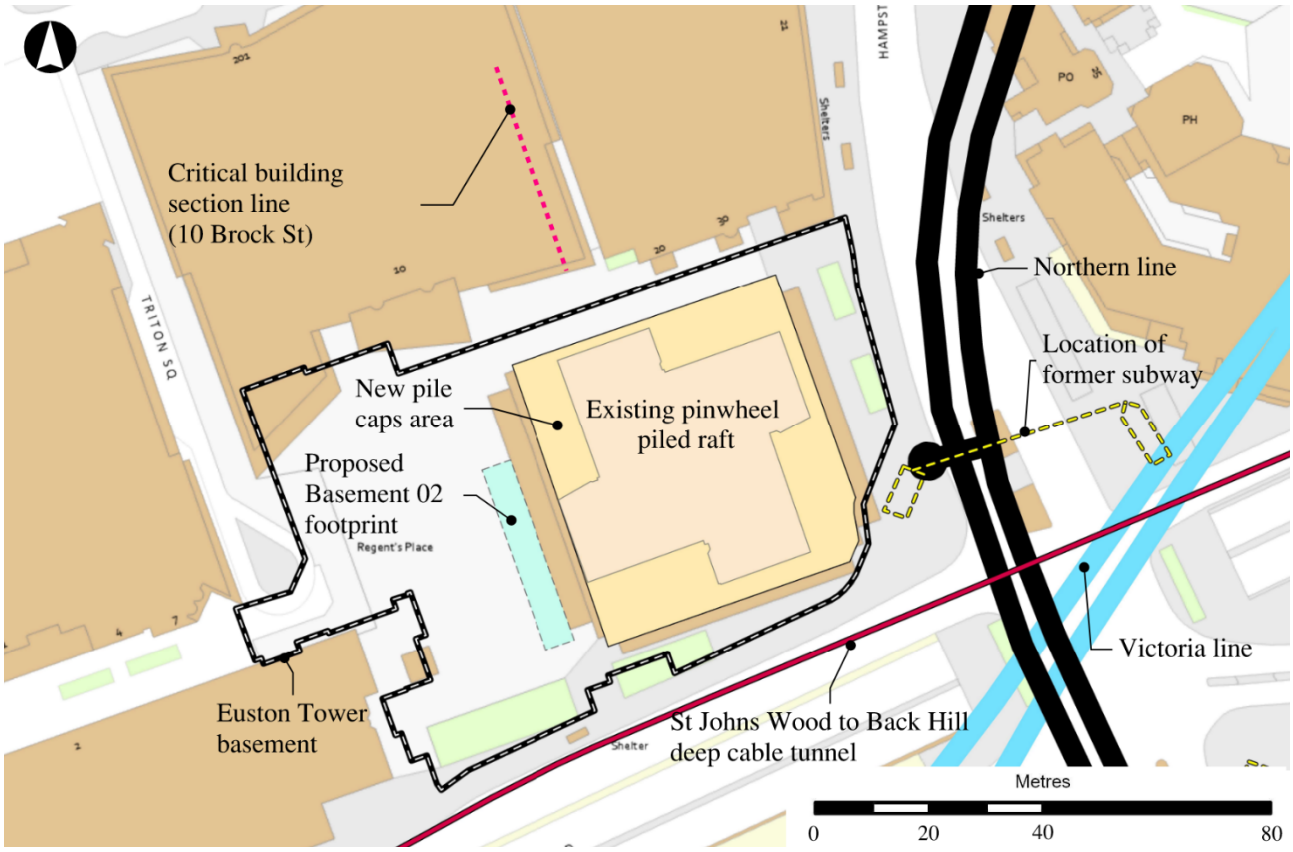


Figure 30: Plan showing critical section (in pink dashed line) for ground movements at 10 Brock St.

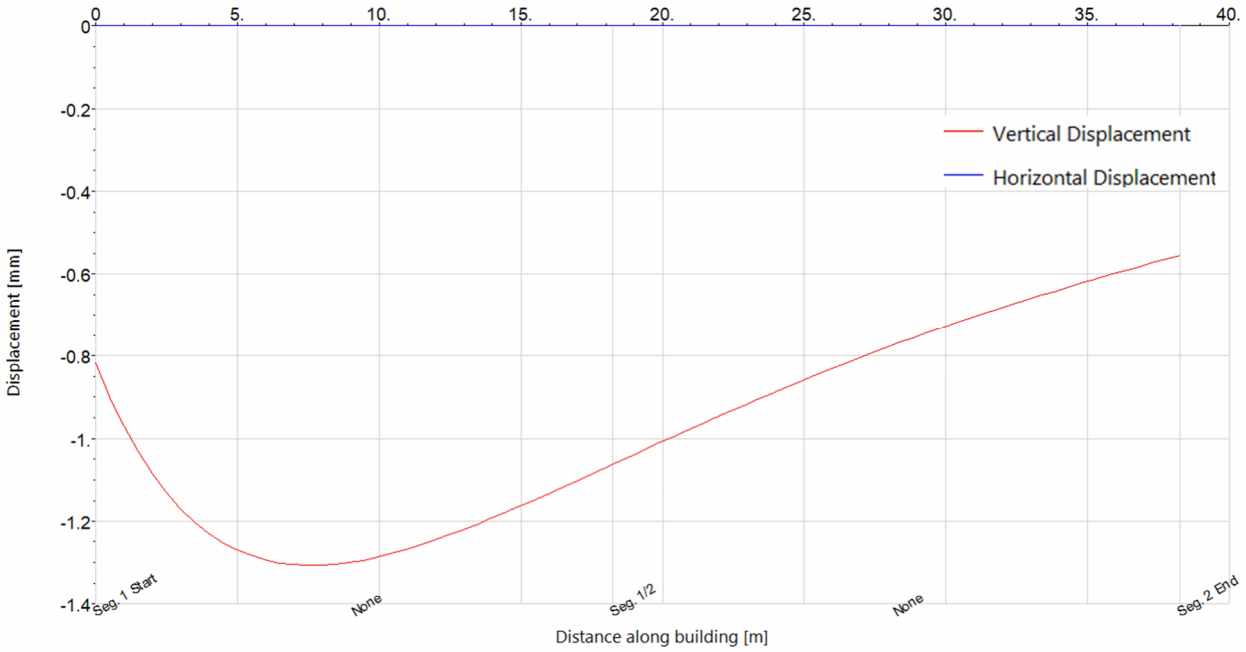


Figure 31: Short term (during construction) displacements along 10 Brock Street critical section line

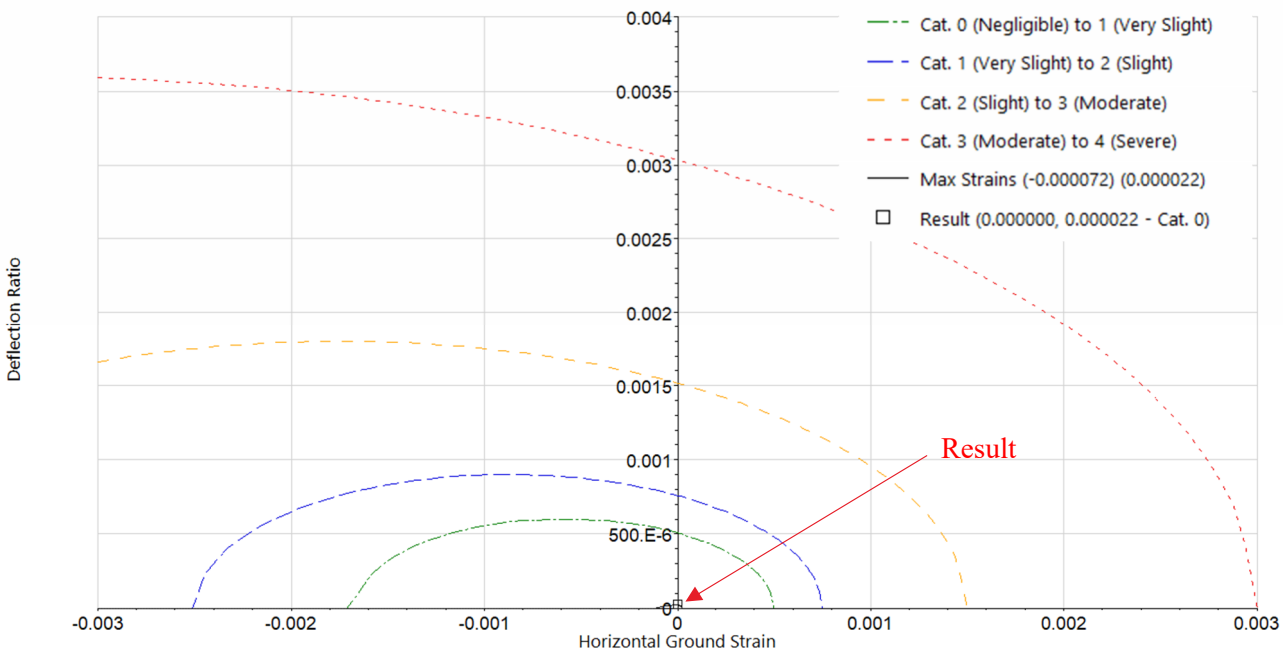


Figure 32: Short term (during construction) building damage interaction for 10 Brock Street critical section line

6.3.2 20-30 Brock Street

Key assumptions made for potential impact assessment on 20-30 Brock Street are outlined below:

- The structure expected to be an 8-storey framed building with a two-level basement, with calculated movements assessed at the foundation level.
- Burland assessment assumes a structural height of 36m above basement level +21.6mOD with the neutral axis taken at the mid height and full height for sagging and hogging respectively.
- E/G ratio of 12.5 assumed for concrete framed structure (Burland, 1995)

The most critical section for 20-30 Brock Street has been identified as illustrated in Figure 33. The Burland damage assessment results (see Figure 34 and Figure 35) indicated that the structure has potential damage category 0 (negligible).

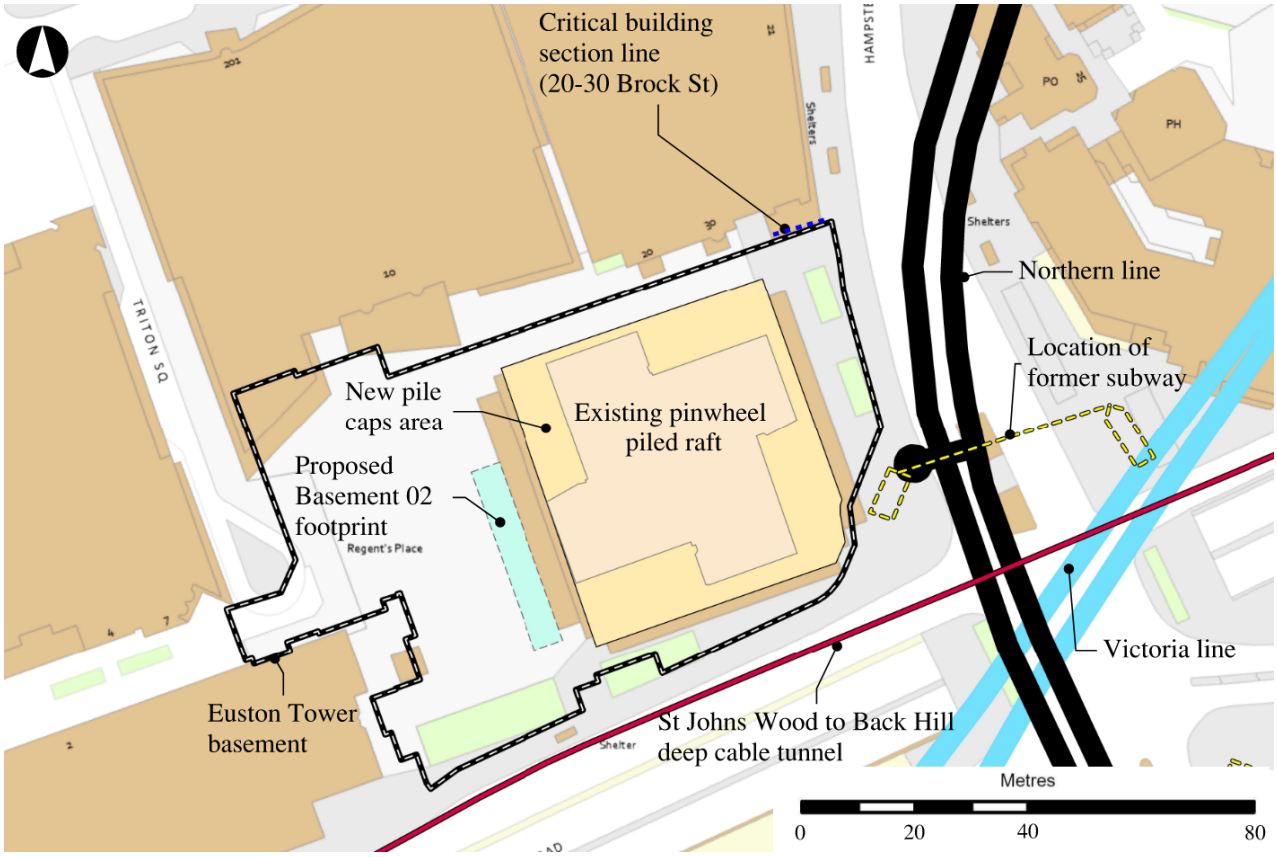


Figure 33: Plan showing critical section (in blue dashed line) for ground movements at 20-30 Brock St.

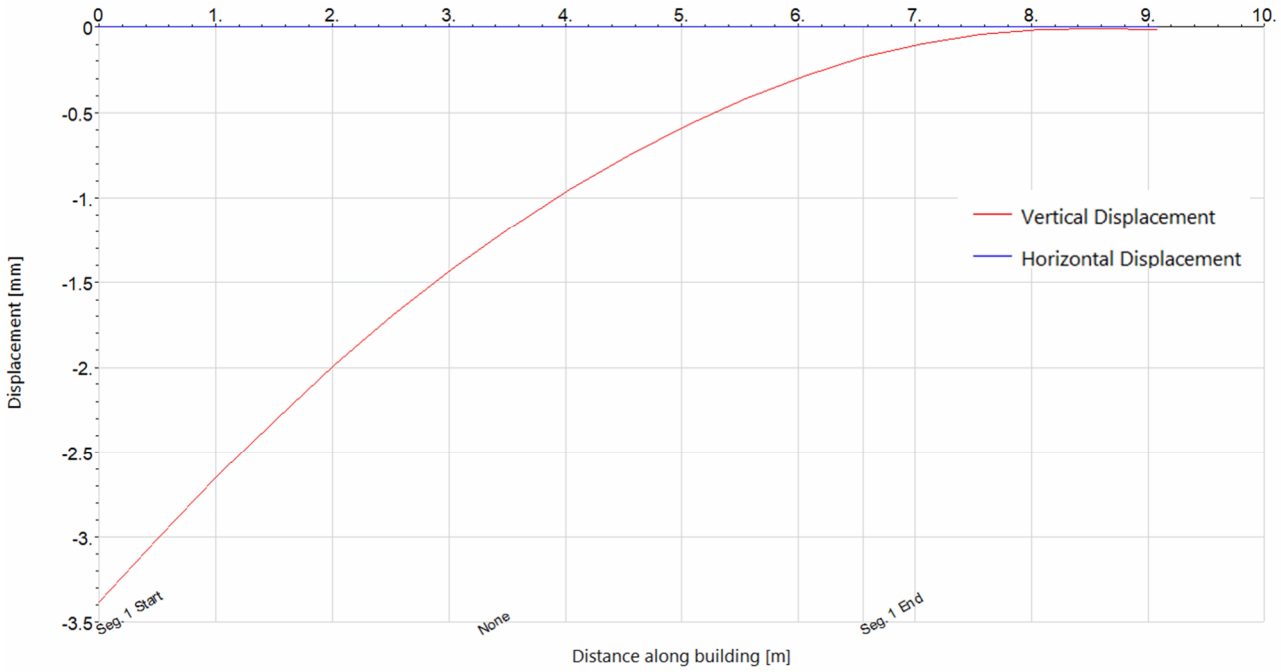


Figure 34: Long term displacements along 20-30 Brock Street critical section line

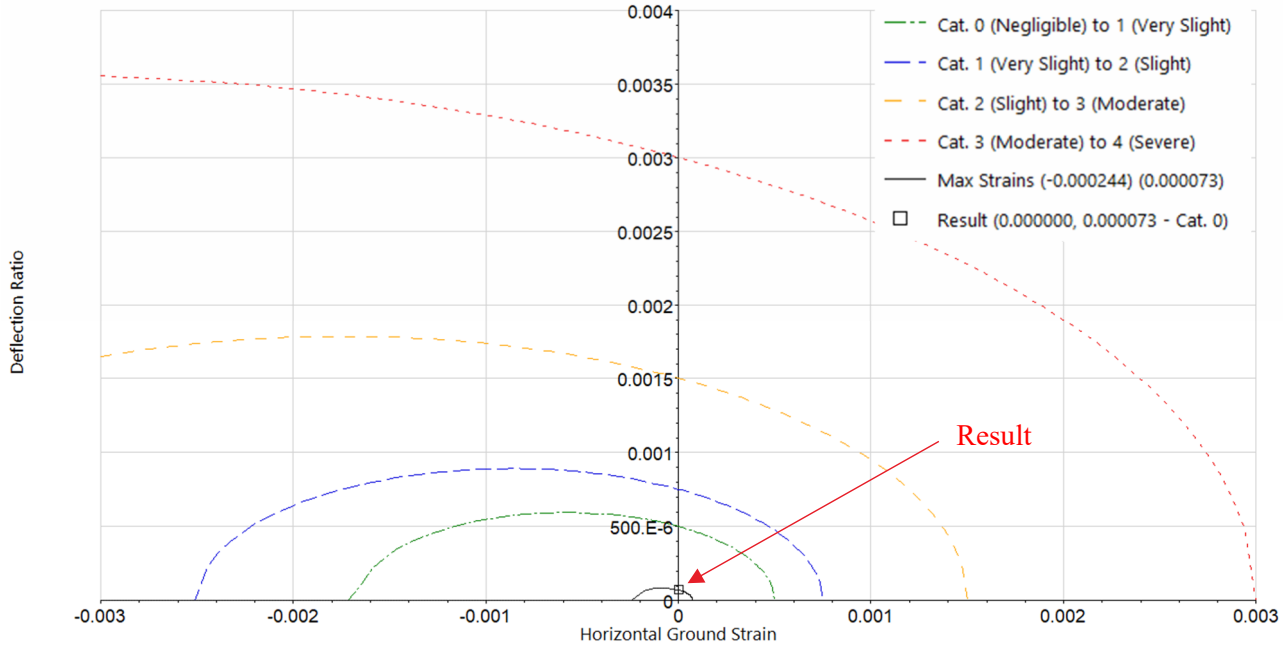


Figure 35: Long term building damage interaction for 20-30 Brock Street critical section line

6.3.3 Burland damage assessment results summary

Assessment of the potential impact of the calculated ground movements on neighbouring 10-30 Brock Street buildings has been carried out using the Burland (1995) method. Table 8 shows a summary of the preliminary impact assessment results.

The critical building sections lines for 10 and 20-30 Brock Street are found to have damage category 0 'negligible' on the Burland scale.

Table 8: Summary of neighbouring buildings preliminary damage category

Neighbouring building	Critical section	Burland damage category
10 Brock Street	Refer to figures	0 (Negligible)
20-30 Brock Street	Refer to figures	0 (Negligible)

The potential impact on Northeast Quadrant (10-30 Brock Street) is not anticipated to exceed category 1 'very slight' on the Burland scale and is compliant with Camden Planning Guidance (CPG) on Basements (Camden, 2021).

7. Basement impact assessment conclusions

7.1 Summary

The assessment presented in this BIA report is based on guidance provided in the following documents (listed in top-down hierarchy order):

- Camden Local Plan - Policy A5 'Basements' (Camden 2017).
- Camden Planning Guidance (CPG) on Basements (Camden, 2021); and
- Camden geological, hydrogeological and hydrological study. Guidance for subterranean development (Camden, 2010).

A screening assessment has been carried out on the proposed redevelopment at Euston Tower in accordance with Camden geological, hydrogeological and hydrological study. Guidance for subterranean development (Camden, 2010). The proposed local B02 basement is expected have an impact on groundwater flow and levels locally to the new basement area due to the introduction of a full local cut-off of the shallow aquifer to the London Clay aquiclude through the river terrace deposits (upper aquifer). However, due to the size and location of the local B02 basement proposal this is expected to be negligible and not present a heightened risk to adjacent structures. The proposed B02 waterproof basement also excludes the ground mass within its enclosed area from groundwater. This will tend to reduce field capacity for water retention/storage and may result in a higher local groundwater level during or following rainfall events, however due to the small size of the basement and location within the site the effect is expected to be negligible.

Based on the screening assessment presented in this report and findings from Flood Risk Assessment report (Arup, 2024, Report ref.: 281835-ARP-XX-XX-RP-CD-0001) and Flood Risk Assessment Addendum (Arup, 2024, Report ref.: 281835-ARP-XX-XX-TN-CD-0001), it is concluded that the proposed basement development is unlikely to result in groundwater or surface water issues and is therefore compliant with the Camden Planning Guidance (CPG) on Basements (Camden, 2021).

The relative depth of the proposed Basement 02 level is deeper than the existing single level basement. Preliminary ground movement assessment carried out in this report indicated that the neighbouring 1 Triton Square and 2 Triton Square do not fall within the zone of influence for ground movements associated with the proposed redevelopment, defined as greater than 1mm. The southern façade of neighbouring Northeast Quadrant (10-30 Brock Street) falls within the zone of influence and is calculated to experience long term settlements between 1mm and 8mm. However, the potential impact of the long-term settlements on 10-30 Brock Street is calculated to fall within damage category 0 'negligible' on the Burland scale. This does not exceed category 1 'very slight' on the Burland scale and is compliant with Camden Planning Guidance (CPG) on Basements (Camden, 2021).

The previous version of this BIA report has undergone audit process (see CampbellReith Basement Impact Assessment Audit, Report ref..: SSkb14006-59-230424-Euston Tower_D1, 2024). In response to comments raised, a technical note was prepared (see Arup, 2024, Basement Impact Assessment Audit [2023/5240/P] File Note, Ref: 281835-07). Table 9 shows a comparison of the basement impact assessment results update. There is a small reduction in long term settlements calculated for neighbouring 10-30 Brock Street. The Burland damage category calculated is unchanged at damage category 0 'negligible' on the Burland scale.

Table 9: Summary of Basement Impact Assessment results update

Neighbouring building	Results	Previous version of BIA and audit response	Current BIA report
10-30 Brock Street	Long term settlements	2mm to 10mm	1mm to 8mm
	Burland damage category	0 (Negligible)	0 (Negligible)

The site falls within the 2015 Crossrail 2 Safeguarding Directions and is located to the west of Northern and Victoria line tunnels, to the north of St Johns Wood to Back Hill deep cable tunnel and Hammersmith & City, Circle and Metropolitan line tunnel). Third party consultation and engagement with the respective asset owners is in progress. Ground movement assessments and construction method statements will be carried out in separate technical submissions for review by the respective third parties ahead of proposed redevelopment.

7.2 Monitoring strategy

A monitoring regime is recommended to be scoped and specified to measure the ground and asset movements during partial superstructure deconstruction, localised excavation, and construction of the new superstructure, in order to verify that they are within the assessed range. The required monitoring will be confirmed at later design stages following development of the construction methodology and agreement with third party building owners.

In addition to monitoring of buildings, monitoring of existing LUL underground assets, and other third-party assets would be scoped and specified based on ground movement assessments of these assets and development of the basement design and construction sequence.

References

Arup (2023), Euston Tower, 286 Euston Road Structural Report

Arup (2024) Euston Tower Drainage and SuDS Strategy (Report ref.: 181835-ARP-XX-XX-RP-CD-0002)

Arup (2024) Euston Tower Drainage and SuDS Strategy Addendum (Report ref.: 281835-ARP-XX-XX-TN-CD-0002)

Arup (2024), Euston Tower Flood Risk Assessment (Report ref.: 281835-ARP-XX-XX-RP-CD-0001)

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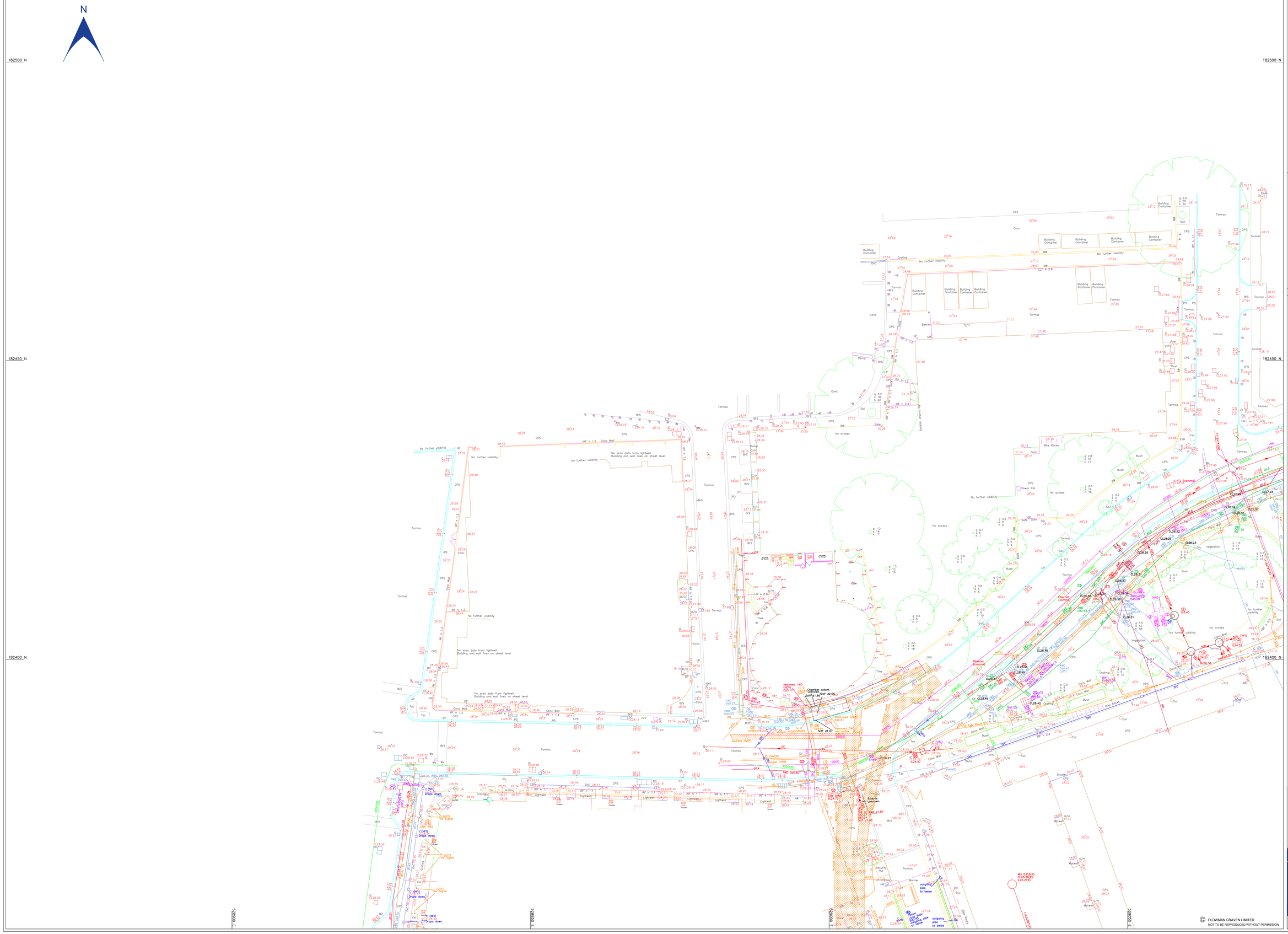
London Borough of Camden (2010), Camden geological, hydrogeological and hydrological study – Guidance for Subterranean Development

London Borough of Camden (2017), Camden Local Plan

London Borough of Camden (2021), Camden Planning Guidance – Basements

Mair, R. J., Taylor, R.N. and Burland, J. B. (1996), Prediction of ground movements and assessment of risk of building damage due to bored tunnelling.

Appendix A – Plowman Craven topographic survey



STANDARD ABBREVIATIONS

A/C	Air Conditioner	LB	Litter Bin
ATM	Automated Telling Machine	LP	Lamp Post
B	Bollard	Max	Maximum
BB	Belisha Beacon	Mb	Multibole
Bh	Borehole	MH	Manhole
Br	Brick	Min	Minimum
BrS	Brick Setts	Mkr	Marker
BRW	Brick Retaining Wall	NB	Notice Board
BS	Bus Stop	NP	Name Plate
BT	British Telecom	OBF	Open Boarded Fence
BW	Brick Wall	O/H	Overhead
BWF	Barbed Wire Fence	OSBM	Ordnance Survey Bench Mark
CBF	Close Boarded Fence	P	Post
CCTV	Closed Circuit Television	PB	Pillar Box
CIF	Corrugated Iron Fence	PGM	Permanent Ground Marker
CL	Cover Level	L	Pavement Light
CLF	Chain Link Fence	PM	Parking Meter
Col	Column	PRF	Post and Rail Fence
Conc	Concrete	PS	Paving Stones
CoW	Cable on Wall	PWF	Post and Wire Fence
CPS	Concrete Paving Slabs	RE	Rodding Eye
CTV	Cable Television IC	RG	Road Gully
d	depth	RS	Road Sign
DC	Duct Cover	RSJ	Rolled Steel Joist
DH	Duct Height	RWP	Rain Water Pipe
DP	Down Pipe	s	spread
DrC	Drainage Channel	SB	Sign Board
EIC	Electrical Inspection Cover	SBM	Site Bench Mark
EJB	Electrical Junction Box	SC	Stop Cock
EP	Electricity Pole	SF	Security Fence
ER	Earthing Rod	ShB	Shrub Bed
ESG	Electrical Switchgear	SL	Sump Level
FB	Flower Bed	SO	Smoke Outlet
FH	Fire Hydrant	SP	Sign Post
FL	Floor Level	SV	Stop Valve
Flt	Floodlight	T	Telephone
g	girth	Tac	Tactile Paving
G	Gully	TBM	Temporary Bench Mark
GC	Gas Cock	TCB	Telephone Call Box
GM	Gas Meter	TCP	Traffic Control Post
GP	Gate Post	TIC	Telephone Inspection Cover
GV	Gas Valve	TJB	Telephone Junction Box
h	height	TL	Traffic Light
HR	Handrail	TLCB	Traffic Light Control Box
IB	Illuminated Bollard	TLIC	Traffic Light Inspection Cover
IC	Inspection Cover	TP	Telephone Pole
IL	Invert Level	Typ	Typical
IRF	Iron Railing Fence	V	Vent
IRS	Illuminated Road Sign	VP	Vent Pipe
JB	Junction Box	W	Window
KO	Kerb Outlet	WM	Water Meter
L	Light	WV	Water Valve

LEGEND

──►	Stair/step arrows point up
— · —	Assumed detail

SERVICE LEGEND

FOUL DRAINAGE	──►──
SURFACE WATER DRAINAGE	──>──
WATER	────
GAS	────
ELECTRIC	────
TFL	────
VERIZON	────
COLT	────
CENTURY LINK	────
ZAYO GROUP	────
VODAFONE	────
BRITISH TELECOM	────
VIRGIN MEDIA	────
UNKNOWN SERVICE	────
UNDERGROUND CHAMBER	┆┄┄┆

SERVICE ABBREVIATIONS

(AC)	Assumed Connection	IL	Invert Level
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Dd	Depth to top of duct	Pe	Polyethylene
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(e)	Empty Duct	(s)	Service cable
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HB	Hatch Box	(UTL)	Unable to Lift without damage
HbL	Hatch Box Level	(UTT)	Unable to Trace
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42746T-01-3	42746T-01-4

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3D Topographic Survey

PRESENTATION SCALE 1:200 @ A0

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DRAWING No. 42746T-01-1

ISSUE I

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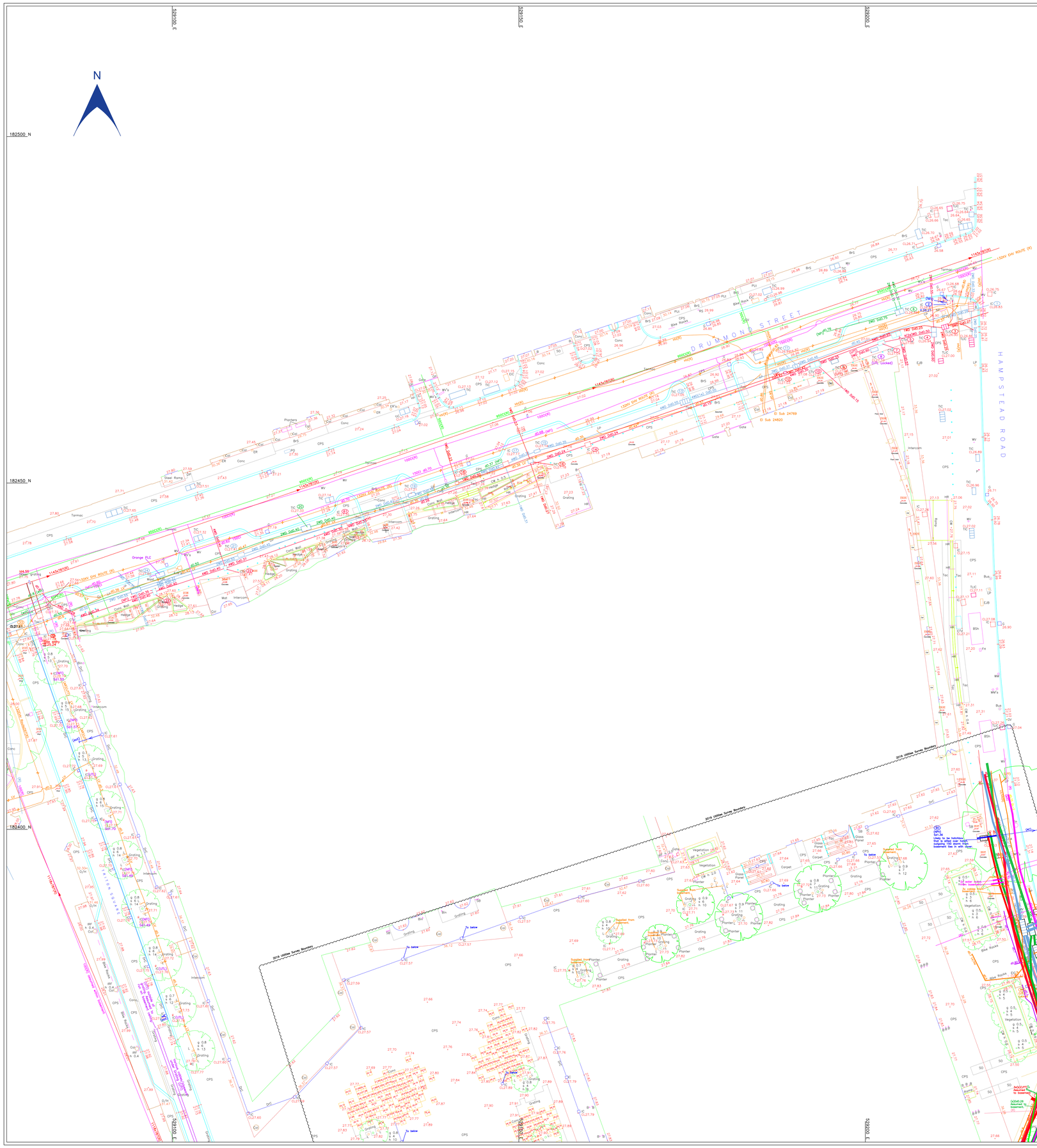

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LEGEND

——►	Stair/step arrows point up
— · —	Assumed detail

SERVICE LEGEND

FOUL DRAINAGE	——►——
SURFACE WATER DRAINAGE	——>——
WATER	——
GAS	——
ELECTRIC	——
TFL	——
VERIZON	——
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York House
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PROJECT TITLE

Regents Place
London, NW1

3D Topographic Survey

PRESENTATION SCALE 1:200 @ A0

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PC PROJECT No. 42746 CHECKED GH

DRAWING No. ISSUE

42746T-01-2 I

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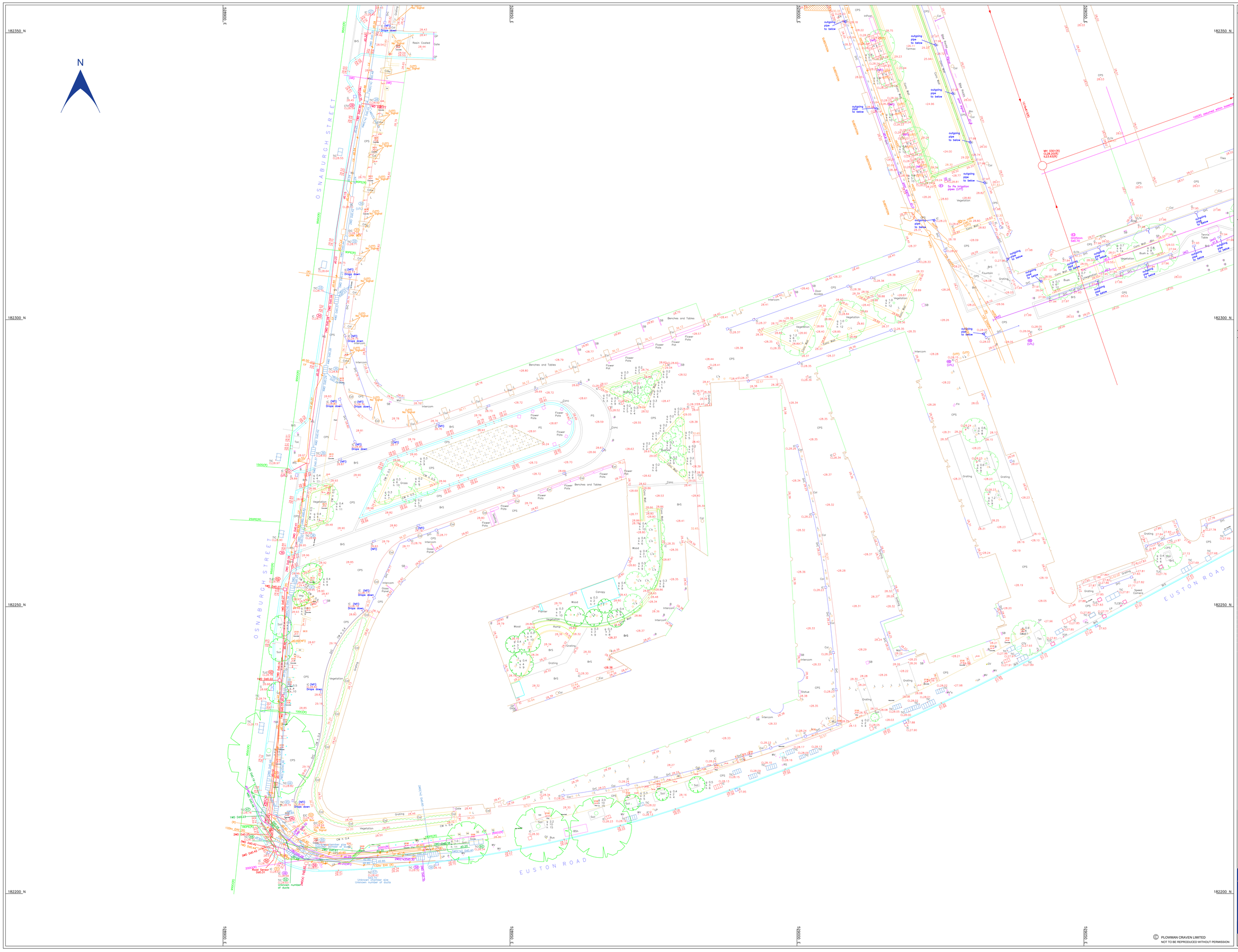

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LEGEND

──►	Stair/step arrows point up
— · —	Assumed detail

SERVICE LEGEND

FOUL DRAINAGE	──►──
SURFACE WATER DRAINAGE	──>──
WATER	────
GAS	────
ELECTRIC	────
TFL	────
VERIZON	────
COLT	────
CENTURY LINK	────
ZAYO GROUP	────
VODAFONE	────
BRITISH TELECOM	────
VIRGIN MEDIA	────
UNKNOWN SERVICE	────
UNDERGROUND CHAMBER	┌┄┄┐

SERVICE ABBREVIATIONS

(AC)	Assumed Connection	IL	Invert Level
(AR)	Assumed Route	LV	Low Voltage
CI	Cast Iron	(NFI)	No Further Information
Cd	Depth to top of cable	(NPV)	No Pipes Visible
d	Depth of service (approx)	Pd	Depth to top of pipe
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DRAWING No. 42746T-01-3

ISSUE I

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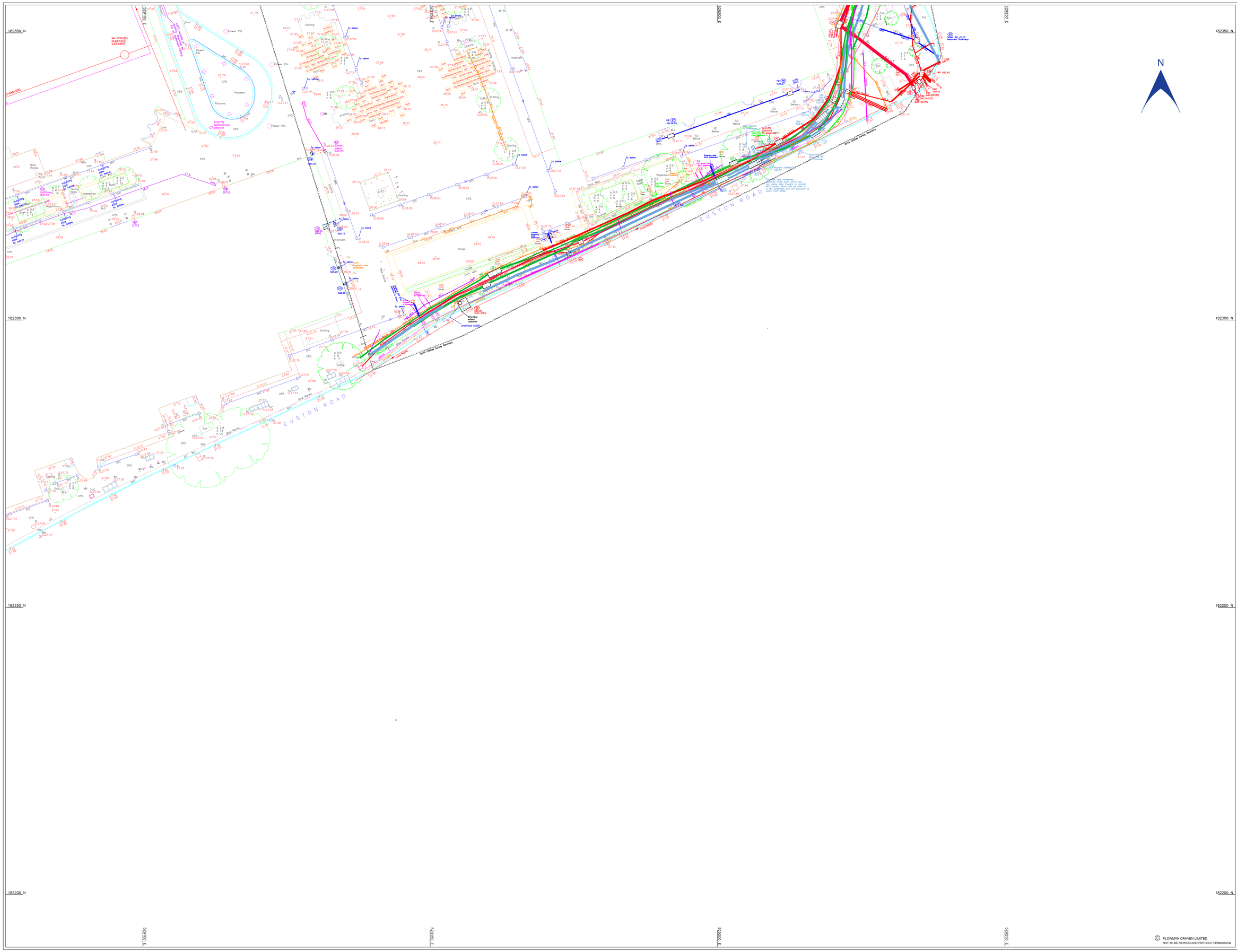

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—— · ——	Assumed detail

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PRESENTATION SCALE 1:200 @ A0

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DRAWING No. 42746T-01-4 ISSUE I

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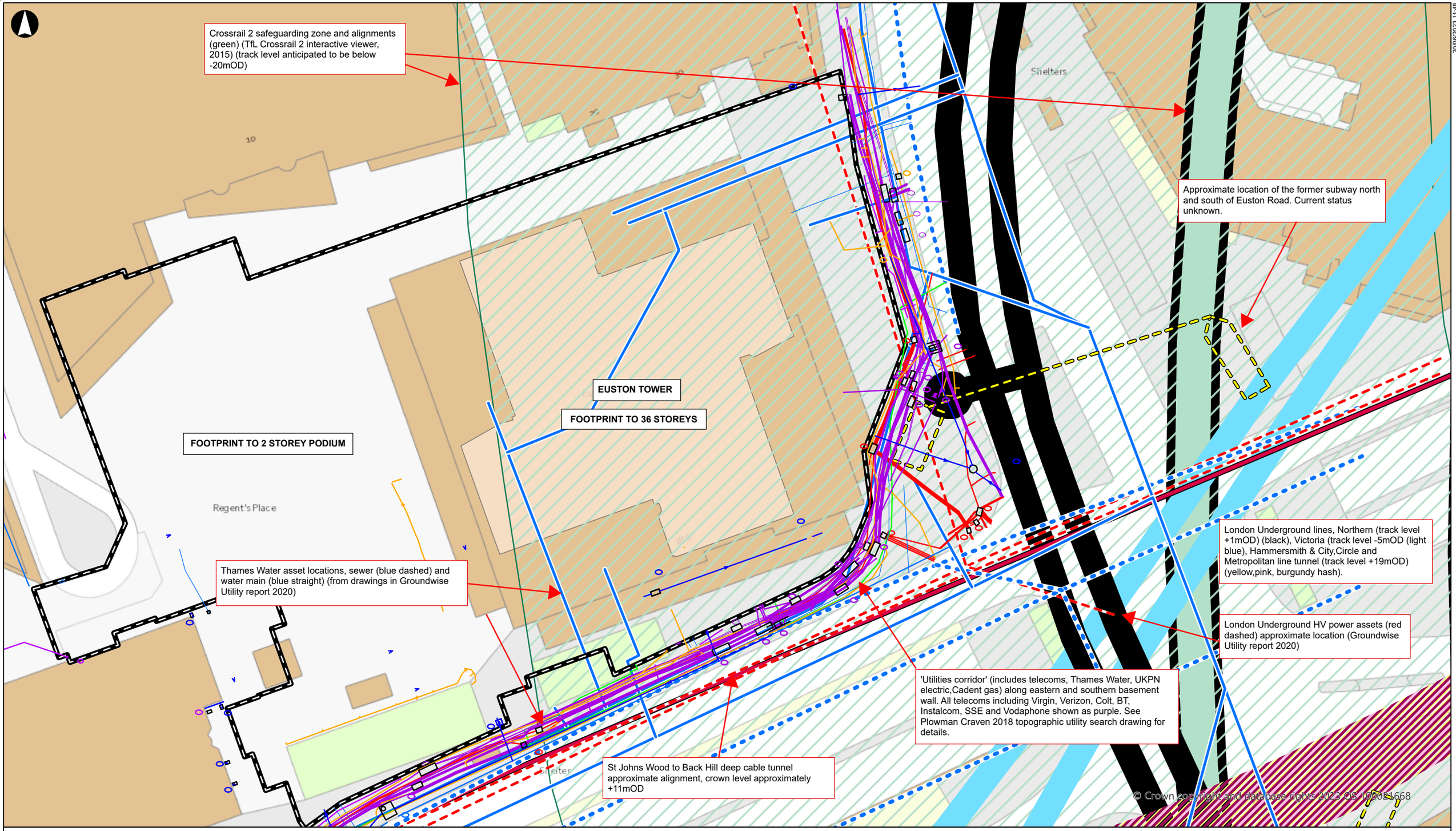
Appendix B – Site constraints plans

A3



- Power tunnel (CL ~+11.0mOD, 3m diameter)
- LU HV Track cables
- TW sewer
- LU HV Road&Track
- Victoria line (TL -5.0mOD, ~4.0m diameter)
- Northern line (TL +0.7mOD, ~4.0m diameter)
- CR2 Safeguarding (2015)
- TW Water main
- Crossrail 2 safeguarded alignment (2015)
- Service Route - Storm
- Service Route - Foul
- Service Route - Chamber
- Service Route - Water
- Service Route - Telecom
- Service Route - Electric
- Service Route - Verizon
- Service Route - Unknown
- Service Route - Vodafone
- Service Route - COLT
- Service Route - Gas
- Service Route - Virgin Media
- Service Route - TFL
- Service Route - Century Link
- Euston Tower basement
- Location of former subway
- H&C, Circle line

Metres: 0 5 10 20

Coordinate System: British National Grid

Rev	Date	By	Chkd	Appd
00	20/06/2023	ST	HT	ME

ARUP
8 Fitzroy Street
London W1T 4BJ
Tel +44 20 7755 4026
www.arup.com

Client
British Land PLC

Project Title
286 Euston Tower, London NW1 3DP

Drawing Title
Euston Tower - Site constraints plan

Scale at A3
1:500

Role
Geotechnics-Structures

Suitability
S0 - Initial Status

Arup Job No
281835-00

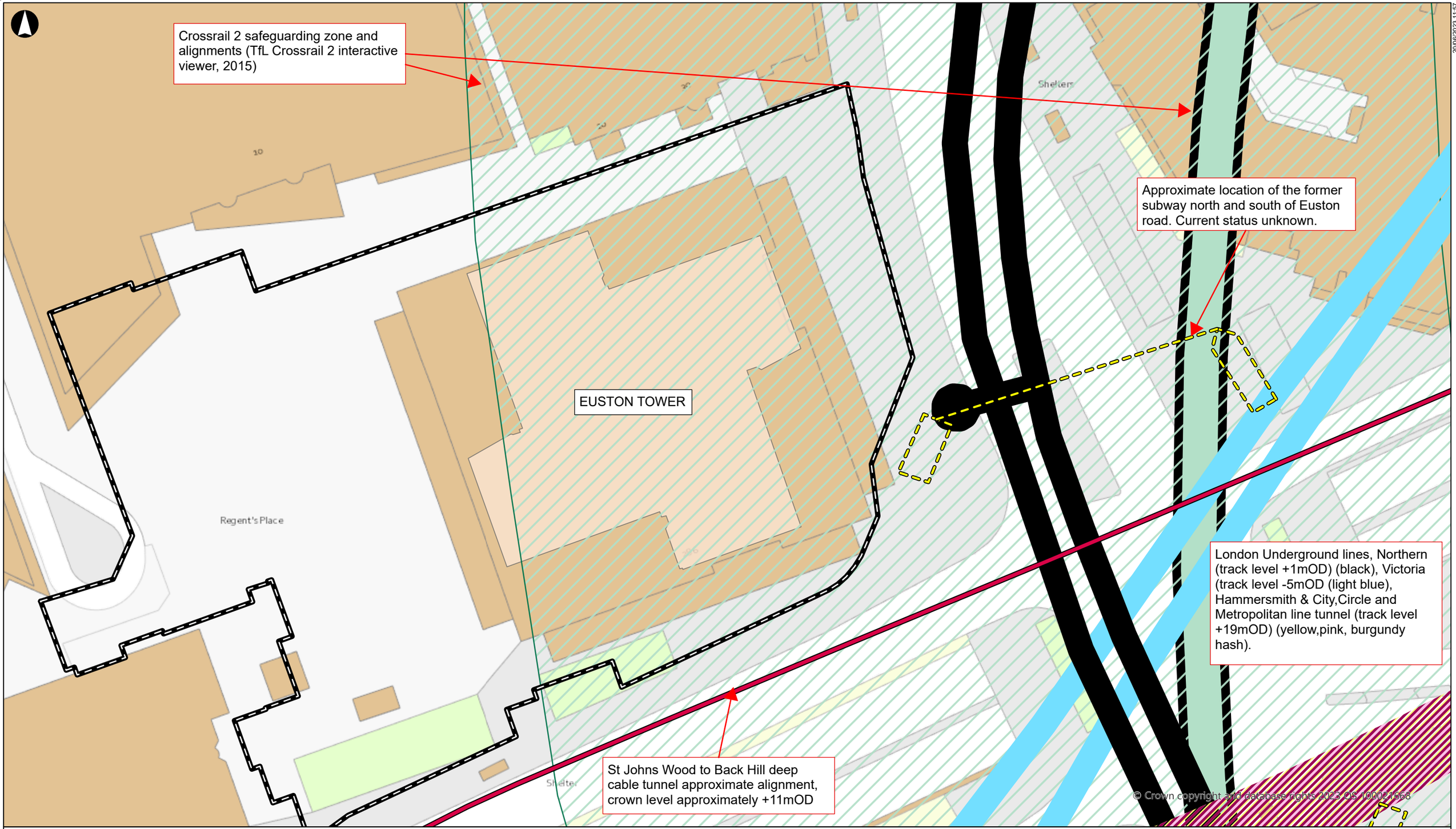
Rev
00

Name
281835-ARP-GE-SK-00001

20/06/2023 11:48

C:\Users\sam.taylor\Arup\281835-00 EUSTON TOWER NEW BUILD - Internal Data\07 Arup Specialists\05 Geotechnics\03_GIS\Euston Tower GIS\Euston Tower.aprx

A3



- Location of former subway
- Power tunnel (CL ~+11.0mOD, 3m diameter)
- H&C, Circle line
- Northern line (TL +0.7mOD, ~4.0m diameter)
- Victoria line (TL -5.0mOD, ~4.0m diameter)
- CR2 Safeguarding (2015)
- Crossrail 2 safeguarded alignment (2015)

Metres
0 5 10 20

Coordinate System: British National Grid

Rev	Date	By	Chkd	Appd
00	20/06/2023	ST	HT	ME

ARUP
8 Fitzroy Street
London W1T 4BJ
Tel +44 20 7755 4026
www.arup.com

Client
British Land PLC

Project Title
Euston Tower

Drawing Title
Euston Tower - Site constraints plan (tunnels only)

Scale at A3
1:500

Role
Geotechnics-Structures

Suitability
S0

Arup Job No
281835-00

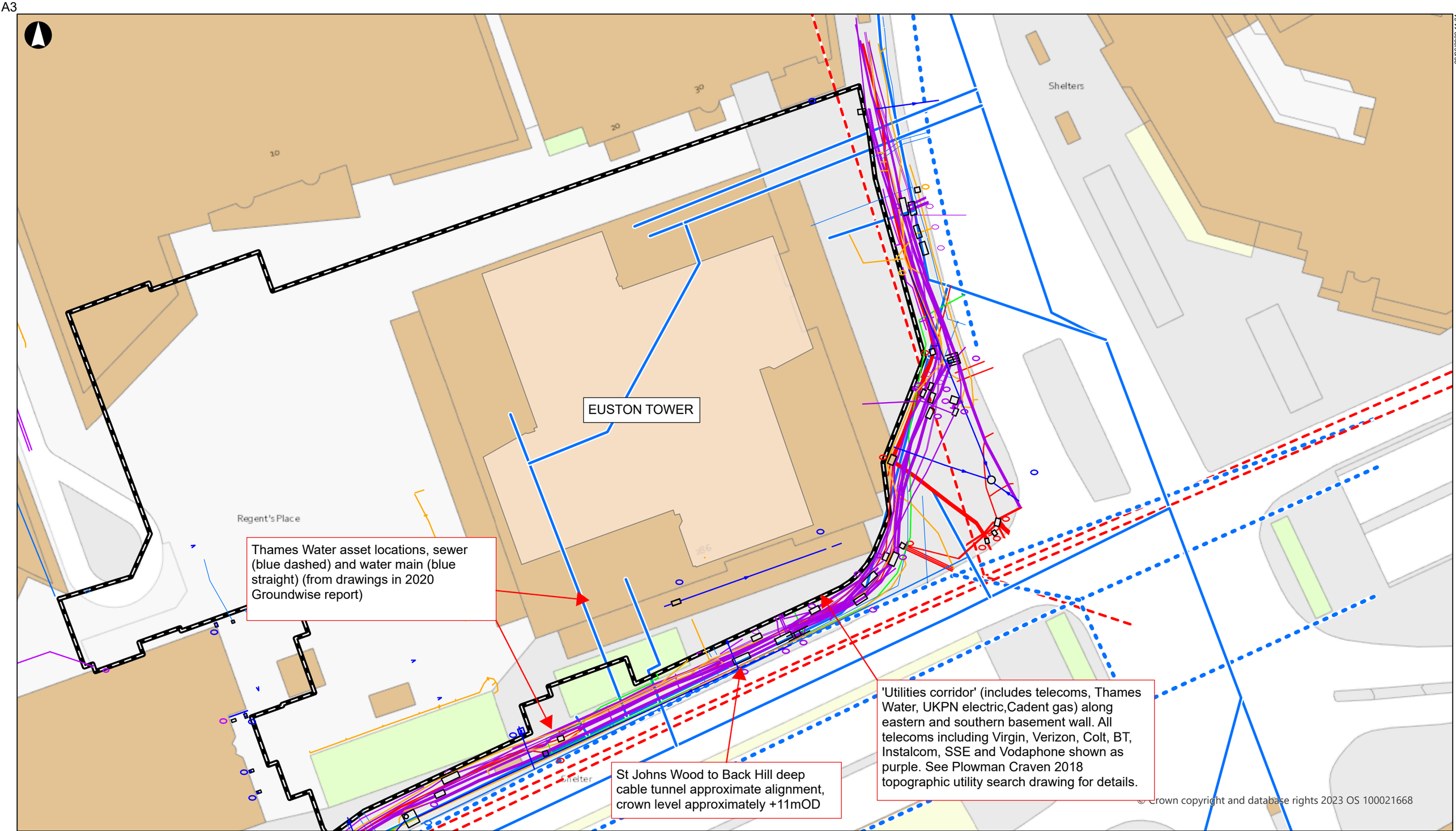
Rev
00

Name
#####

20/06/2023 11:57

C:\Users\sam.taylor\Arup\281835-00 EUSTON TOWER NEW BUILD - Internal Data\07 Arup Specialists\05 Geotechnics\03_GIS\Euston Tower GIS\Euston Tower.aprx

A3



- Service Route - Storm
- Service Route - Foul
- Service Route - Chamber
- Service Route - Water
- Service Route - Telecom
- Service Route - Electric
- Service Route - Verizon
- Service Route - Unknown
- Service Route - Vodafone
- Service Route - COLT
- Service Route - Gas
- Service Route - Virgin Media
- Service Route - TFL
- Service Route - Century Link
- TW Water main
- LU HV Track cables
- TW sewer
- LU HV Road&Track

Metres
0 5 10 20

Coordinate System: British National Grid

Rev	Date	By	Chkd	Appd
00	20/06/2023	ST	HT	ME

ARUP
8 Fitzroy Street
London W1T 4BJ
Tel +44 20 7755 4026
www.arup.com

Client
British Land PLC

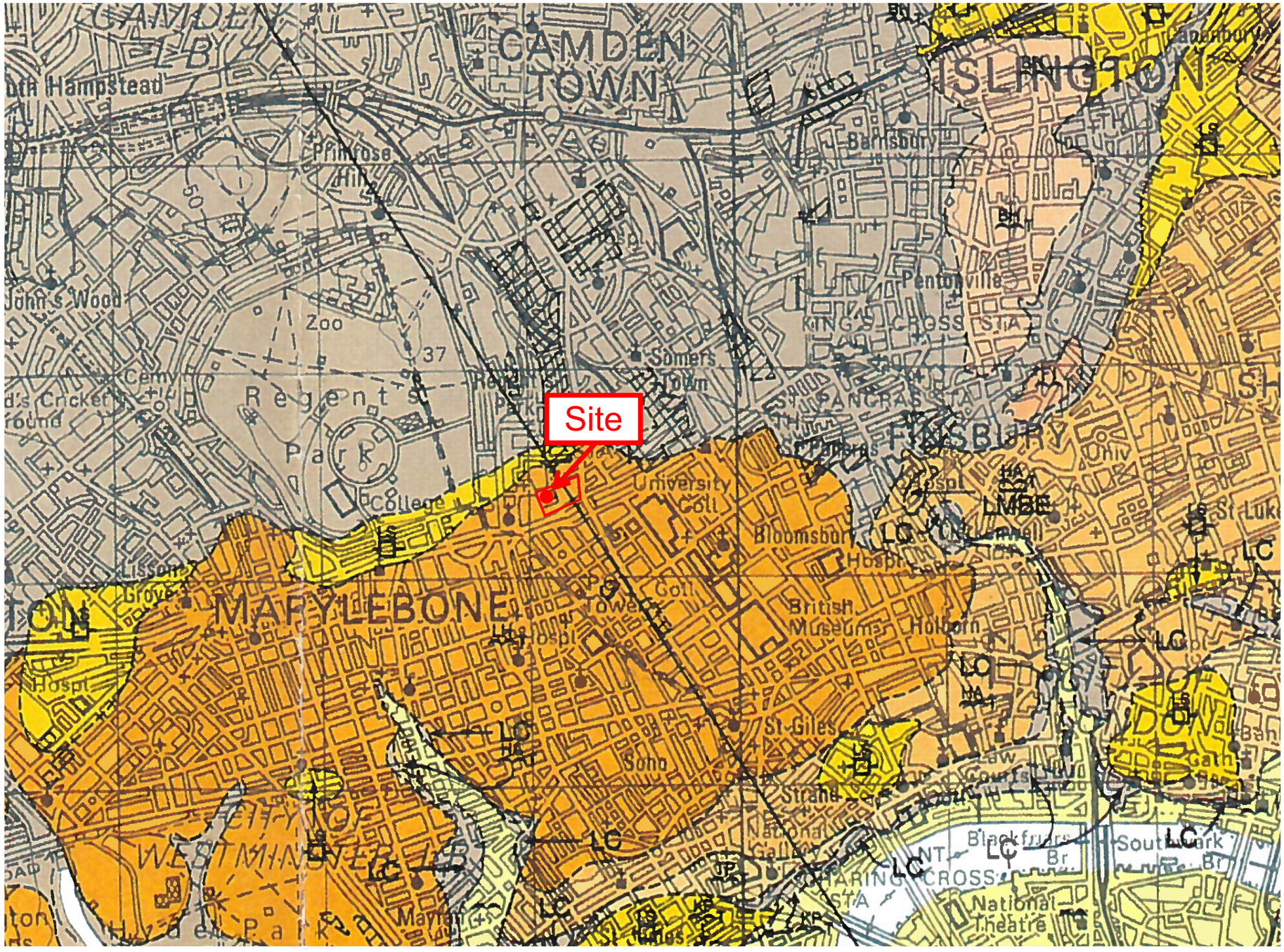
Project Title
Euston Tower

Drawing Title
Euston Tower - Site constraints plan (buried utilities only)

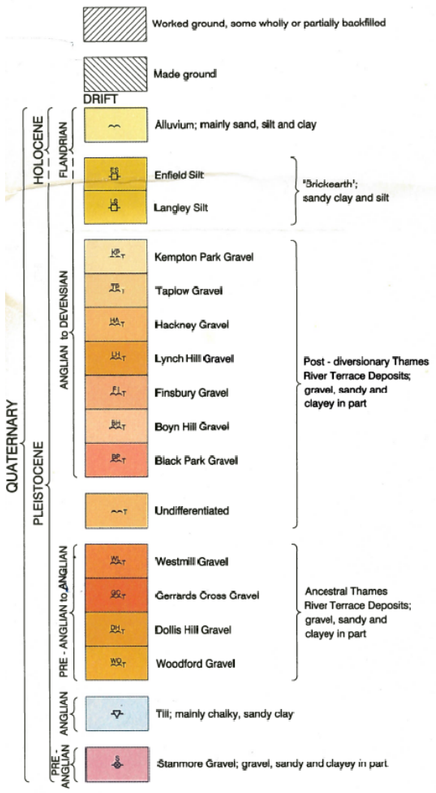
Scale at A3
1:500
Role
Geotechnics-Structures
Suitability
S0
Arup Job No
281835-00
Rev
00
Name
#####

C:\Users\sam.taylor\Arup\281835-00 EUSTON TOWER NEW BUILD - Internal Data\07 Arup Specialists\05 Geotechnics\03_GIS\Euston Tower GIS\Euston Tower.aprx

Appendix C – Regional geology



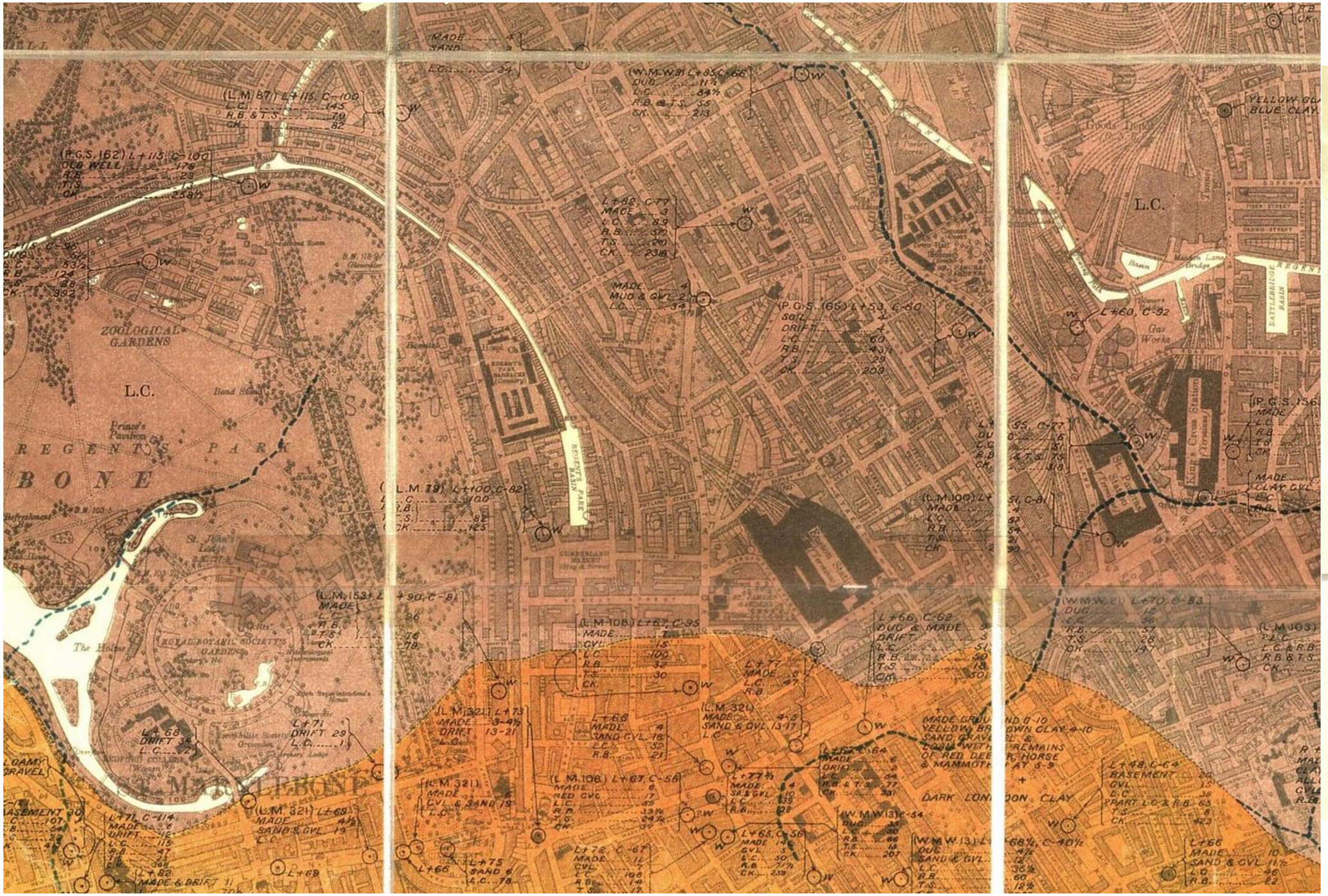
KEY TO GEOLOGICAL SYMBOLS AND COLOURS



N

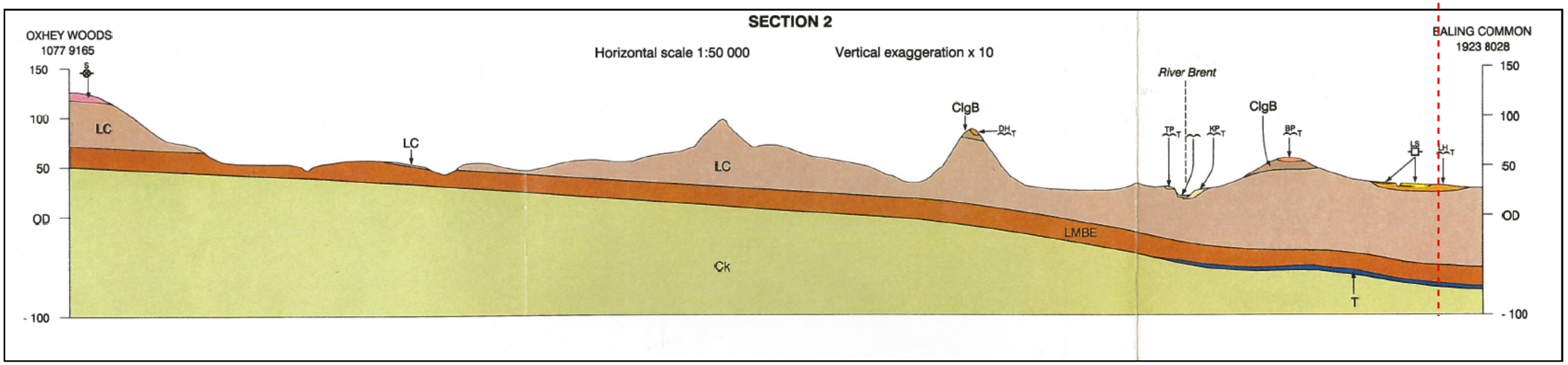
Euston Tower
1994 BGS Geological Map
Sheet 256 (1:50,000)

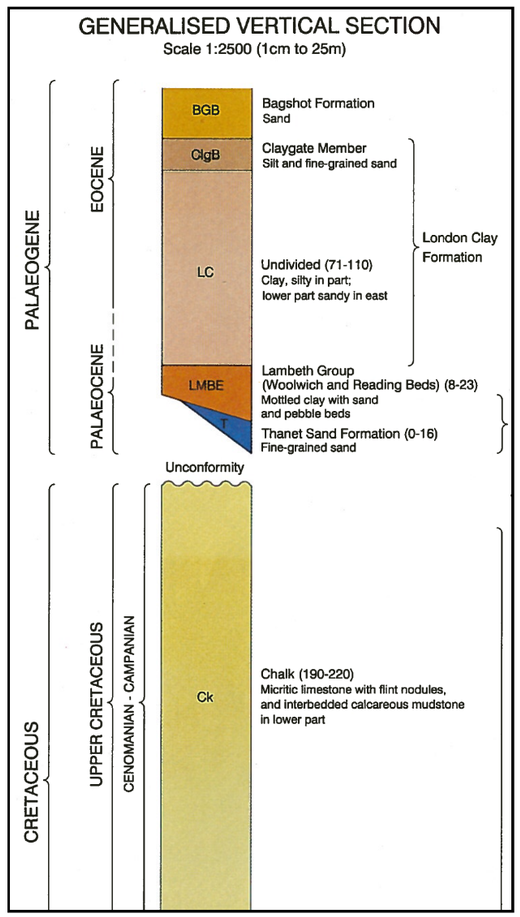
FIGURE 1



Euston Tower
BGS GEOLOGICAL MAP 1920
FIGURE 2

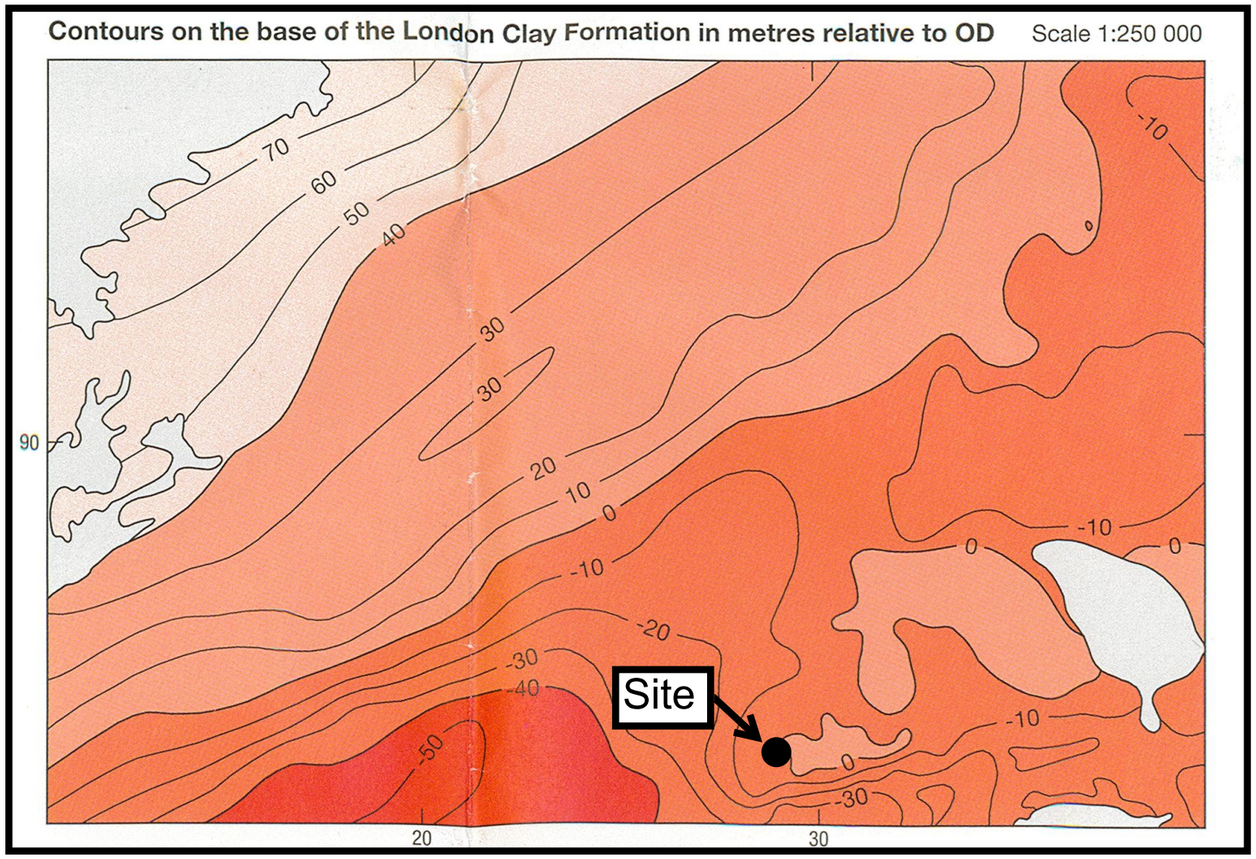
Approximate site location

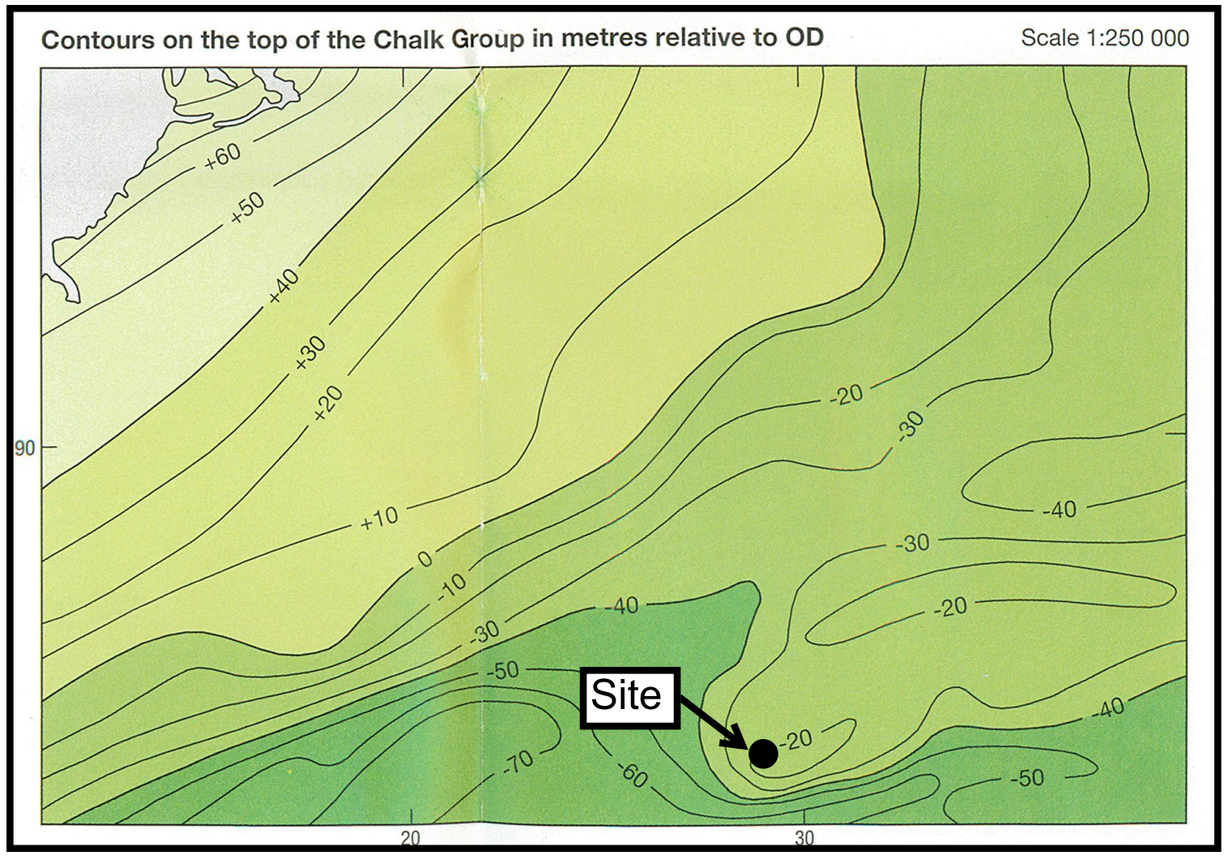




Euston Tower
1994 BGS Geological Map
Sheet 256 (1:50,000)

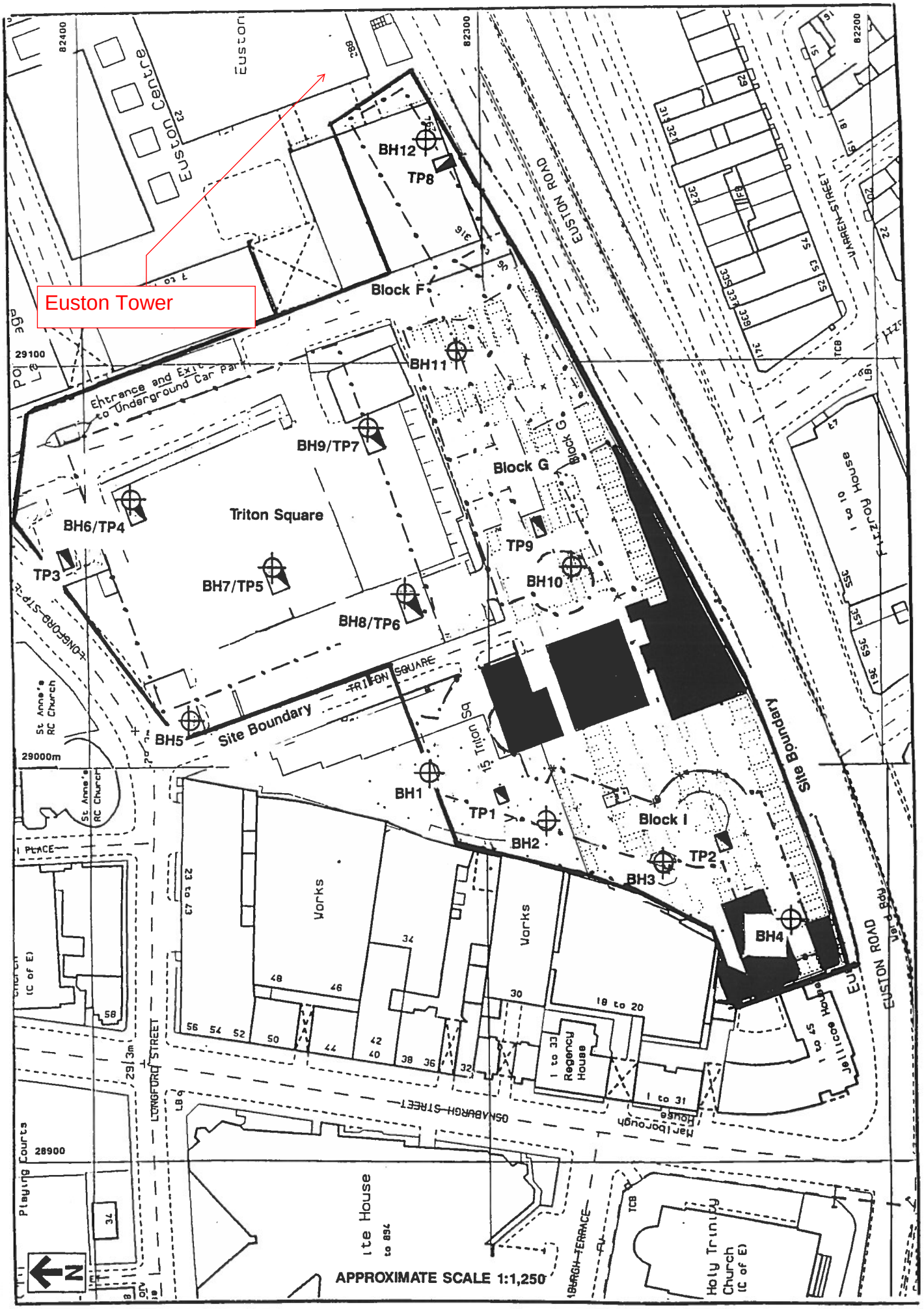
FIGURE 3





Euston Tower
BGS CONTOUR MAPS FOR LONDON CLAY AND CHALK
FIGURE 4

Appendix D – Existing ground investigation information



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SITE PLAN SHOWING BASEMENT

Borehole

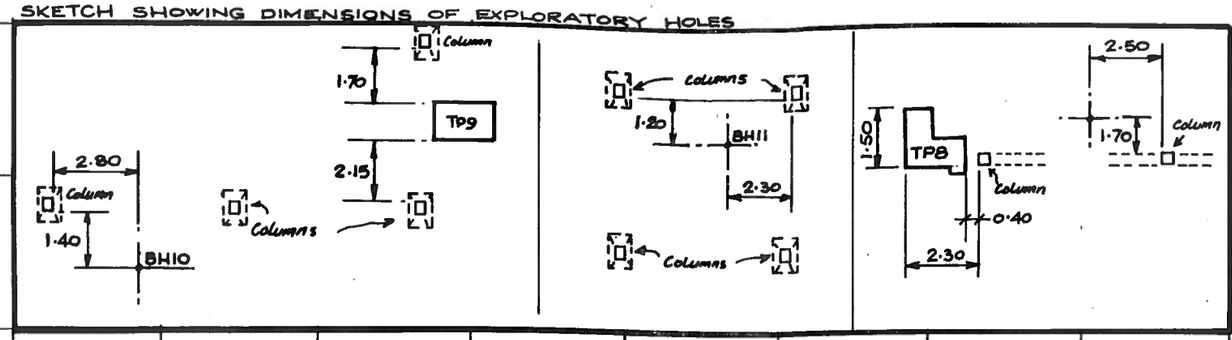
Trial Pit

Proposed Development

TRITON SQUARE / REGENTS PLACE

94484

SKETCH SHOWING DIMENSIONS OF EXPLORATORY HOLES



KEY

- BOREHOLE LOCATIONS
- TRIAL PIT LOCATIONS

Euston Tower

TP9

BH10

BH11

TP8

BH12

0 10 20 30

SCALE (m)

LTG SERVICES

EXPLORATORY HOLE LOCATION PLAN

Project Name:		Record of Borehole No:
TRITON SQUARE/REGENTS PLACE		BH 12
Project No: 9 4 4 8 4	Client: THE BRITISH LAND CORPORATION	

Co-ordinates (National):	Ground level (mAOD):	Method:		
29153.0E 82311.0N	23.87	CABLE PERCUSSION		
Date:	**Depth of Hole:**	**Hole diameter:**	**Casing diameter:**	**Sheet:**
24/01/95 to 31/01/95	40.90	200/150mm	200/150mm	1 of 6

Machine Number

Samples & Tests				Strata		Description of Strata	Geology	Legend	Water	Piezo/Backfill
Depth (m)	No.	Type	SPT CPT 'N' value	Depth (m)	Reduced Level (m)					
				0						
				(0.25) 0.25	23.62	MADE GROUND(concrete floor)				
0.25-0.70	1	B		(0.35) 0.60	23.27	MADE GROUND(yellow brown medium to coarse sand and subangular to rounded fine to coarse gravel predominantly of flint).				
0.60-0.85	2	B		(0.25) 0.85	23.02	MADE GROUND(red brown subrounded brick and mortar cobbles.				
0.85	3	D		1		Medium dense yellow brown fine to coarse SAND and subangular to rounded fine to coarse flint GRAVEL. (TERRACE GRAVEL)				
1.00-1.45	4	BC	37							
1.60	6	W								
2.00-2.45	5	BC	24	2 (2.00)						
				2.85	21.02					
2.90	7	D		3		Firm brown and yellow brown mottled poorly fissured silty CLAY with occasional communited shell, (fissures degraded by weathering). (WEATHERED LONDON CLAY)				
3.00-3.45	8	U		(0.35) 3.20	20.67					
3.45	9	D	19			Stiff to very stiff dark grey brown very to extremely closely fissured silty CLAY with occasional light blue grey or green grey silt veins and communited shell debris, fissure planes generally inclined, smooth and planar - curviplanar, commonly and communited shell debris with black mottling along fissure planes. From 3.20 - 3.45m slight bluish alteration along fissure planes. @3.45m occasional 5mm diameter orange brown clay pockets; (oxidised pyrite?). From 3.50 - 5.00m brown silt or fine sand lining to some fissure planes. (LONDON CLAY)				
3.50-3.95	10	DS		4						
4.50-4.95	11	U	(45)							
4.95	12	D	19	5						
5.00-5.45	13	DS								
6.00-6.45	14	U	(45)	6						
6.45	15	D	24			...@6.50m occasional light grey silt pockets up to 2 - 3mm in diameter.				
6.50-6.95	16	DS		7						
7.50-7.95	17	U	(45)							
				8						

Boring Progress & Water Obs.							Chiselling			Remarks:
Date	Time	Depth	Casing	Water	Rose	Sealed	From	To	Mins	Full boring progress, water observations and chiselling details are given on a separate sheet. Full SPT and U100 details are given on separate sheets. Borehole in underground car park.

For abbreviations and symbols see key sheet

GE/tech 101 Produced by J.M.Davidson on gINT, 1992

LTG

Scale: 1:50 All dimensions in metres	Processed in accordance with BS5930, BS5750 and AGS standards	Processed by: DC	Logged by: SR

Project Name:		Record of Borehole No:
TRITON SQUARE/REGENTS PLACE		BH 12
Project No: 9 4 4 8 4	Client: THE BRITISH LAND CORPORATION	

Co-ordinates (National):	Ground level (mAOD):	Method:		
29153.0E 82311.0N	23.87	CABLE PERCUSSION		
Date:	**Depth of Hole:**	**Hole diameter:**	**Casing diameter:**	**Sheet:**
24/01/95 to 31/01/95	40.90	200/150mm	200/150mm	2 of 6

Machine Number

Samples & Tests				Strata		Description of Strata	Geology	Legend	Water	Piezo Backfill
Depth (m)	No.	Type	SPT CPT 'N' value	Depth (m)	Reduced Level (m)					
7.95	18	D	25			Stiff to very stiff dark grey brown very to extremely closely fissured silty CLAY with occasional light blue grey or green grey silt veins and communited shell debris, fissure planes generally inclined, smooth and planar - curviplanar, commonly and communited shell debris with black mottling along fissure planes.				
8.00-8.45	19	DS		(10.35)						
9.00-9.45	20	U	(65)							
9.45	21	D	29							
9.50-9.95	22	DS								
10.50-10.95	23	U	(65)							
10.95	24	D	28							
11.00-11.45	25	DS								
12.00-12.45	26	U	(55)							
12.45	27	D	28							
12.50-12.95	28	DS								
13.50-13.65	29	U	(100)	13.55	10.32					
13.65-14.10	30	B				Grey fresh CLAYSTONE, strong.				
14.00-14.30	31	B		(0.45) 14.00	9.87					
14.50-14.95	32	U	(70)			Very stiff dark grey brown locally grey brown extremely closely fissured silty CLAY with occasional communited shell debris, fissure planes generally inclined smooth planar and mottled black.				
14.95	33	D	30							
15.00-15.45	34	DS								

Boring Progress & Water Obs.							Chiselling			Remarks:
Date	Time	Depth	Casing	Water	Rose	Sealed	From	To	Mins	Full boring progress, water observations and chiselling details are given on a separate sheet. Full SPT and U100 details are given on separate sheets. Borehole in underground car park.

For abbreviations and symbols see key sheet

GE/tech 101

Produced by J.M.Davidson on gINT, 1992

LTG

Scale: 1:50 All dimensions in metres	Processed in accordance with BS5930, BS5750 and AGS standards	Processed by: DC	Logged by: SR

Project Name:		Record of Borehole No:
TRITON SQUARE/REGENTS PLACE		BH 12
Project No: 9 4 4 8 4	Client: THE BRITISH LAND CORPORATION	

Co-ordinates (National):	Ground level (mAOD):	Method:		
29153.0E 82311.0N	23.87	CABLE PERCUSSION		
Date:	**Depth of Hole:**	**Hole diameter:**	**Casing diameter:**	**Sheet:**
24/01/95 to 31/01/95	40.90	200/150mm	200/150mm	3 of 6

Machine Number

Samples & Tests				Strata		Description of Strata	Geology	Legend	Water	Piezo. Backfill
Depth (m)	No.	Type	SPT CPT 'N' value	Depth (m)	Reduced Level (m)					
16.00-16.45	35	U	(70)			Very stiff dark grey brown locally grey brown extremely closely fissured silty CLAY with occasional communited shell debris, fissure planes generally inclined smooth planar and mottled black.				
16.45 16.50-16.95	36 37	D DS	29	(4.80)		...@16.45m silty to very silty with occasional light brown silt/fine sand partings.				
17.50-17.95	38	U	(65)							
17.95 18.00-18.45	39 40	D DS	32							
				18.80	5.07					
18.80-19.00	41	B		19.00	4.87	Grey fresh CLAYSTONE, strong.				
19.00-19.45	42	U	(80)			Very stiff dark grey brown silty to very silty CLAY with occasional communited shell debris, grey green silt veins and pyritised wood fragments.				
19.45 19.50-19.95	43 44	D DS	33							
						...@20.00m becoming silty and extremely closely fissured; fissure planes generally inclined smooth planar and mottled black.				
20.50-20.95	45	U	(60)							
20.95 21.00-21.45	46 47	D DS	31							
22.00-22.45	48	U	(60)							
22.45 22.50-22.95	49 50	D DS	34	(7.50)		...@22.50m with occasional fine brown sand/silt partings; fissure planes show polishing and striated.				
23.50-23.95	51	U	(70)			...@23.50m small 3mm diameter pockets of silt/fine sand partings; fissure planes show polishing in part.				

Boring Progress & Water Obs.							Chiselling		
Date	Time	Depth	Casing	Water	Rose	Sealed	From	To	Mins

Remarks:
Full boring progress, water observations and chiselling details are given on a separate sheet. Full SPT and U100 details are given on separate sheets. Borehole in underground car park.

For abbreviations and symbols see key sheet

GE/tech 101

LTG

Scale: 1:50	Processed in accordance with	Processed by:	Logged by:
All dimensions in metres	BS5930, BS5750 and AGS standards	DC	SR

Project Name:		Record of Borehole No:
TRITON SQUARE/REGENTS PLACE		BH 12
Project No: 9 4 4 8 4	Client: THE BRITISH LAND CORPORATION	

Co-ordinates (National):	Ground level (mAOD):	Method:		
29153.0E 82311.0N	23.87	CABLE PERCUSSION		
Date:	**Depth of Hole:**	**Hole diameter:**	**Casing diameter:**	**Sheet:**
24/01/95 to 31/01/95	40.90	200/150mm	200/150mm	4 of 6

Machine Number

Samples & Tests				Strata		Description of Strata	Geology	Legend	Water	Piezo. Backfill
Depth (m)	No.	Type	SPT CPT 'N' value	Depth (m)	Reduced Level (m)					
23.95	52	D	35							
24.00-24.45	53	DS				Very stiff dark grey brown silty to very silty CLAY with occasional communited shell debris, grey green silt veins and pyritised wood fragments.				
24.70-24.80	54	B				...@24.70m grey fresh CLAYSTONE, strong.				
25.00-25.45	55	U	(70)							
25.45	56	D	37							
25.50-25.95	57	DS				...@25.50m becoming very silty/sandy.				
26.50-26.95	58/59	D/U	(80)	26.50	-2.63					
				(0.40) 26.90	-3.03	Very stiff grey mottled red and brown silty to very silty CLAY; fissure planes generally inclined, polished and curviplanar.				
26.95	60	D	75	27.10	-3.23	(WOOLWICH AND READING BEDS)				
27.00-27.35	61	DS				Firm, probably stiff in-situ, light brown and light blue mottled silty sandy CLAY with occasional small 5mm diameter pockets of fine to medium grey sand.				
				(0.90)						
				28.00	-4.13	Very stiff brown and blue grey banded and mottled silty CLAY with occasional pockets (up to 5mm) of fine to medium grey sand.				
28.00-28.45	62	U	(100)							
28.45	63	D	86			Very stiff hard blue grey yellow and purple mottled extremely closely fissured silty CLAY locally with a little sand. Fissure planes generally inclined smooth and planar.				
28.50-28.83	64	DS								
				(1.70)						
29.50-29.95	65	U	(120)							
				29.70	-5.83					
29.85	66	D	55			Very stiff to hard red or red brown mottled brown spotted blue very to extremely closely fissured silty CLAY; fissure planes generally inclined smooth polished or striated and planar - curviplanar; locally lined with blue grey clay and undulatory				
29.90-30.35	67	DS								
31.00-31.35	68	U	(120)							
31.35	69	D	61							
31.40-31.80	70	DS								
				(3.70)						

Boring Progress & Water Obs.							Chiselling		
Date	Time	Depth	Casing	Water	Rose	Sealed	From	To	Mins

Remarks:
Full boring progress, water observations and chiselling details are given on a separate sheet. Full SPT and U100 details are given on separate sheets. Borehole in underground car park.

For abbreviations and symbols see key sheet

GE/tech 101 Produced by J.M.Davidson on gINT, 1992

LTG

Scale: 1:50	Processed in accordance with	Processed by:	Logged by:
All dimensions in metres	BS5930, BS5750 and AGS standards	DC	SR

Project Name: TRITON SQUARE/REGENTS PLACE							Record of Borehole No: BH 12
Project No: 9 4 4 8 4	Client: THE BRITISH LAND CORPORATION						
Co-ordinates (National): 29153.0E 82311.0N	Ground level (mAOD): 23.87	Method: CABLE PERCUSSION					
Date: 24/01/95 to 31/01/95	Depth of Hole: 40.90	Hole diameter: 200/150mm	Casing diameter: 200/150mm	Sheet: 5 of 6			Machine Number

Samples & Tests				Strata		Description of Strata	Geology	Legend	Water	Piezo Backfill
Depth (m)	No.	Type	SPT CPT 'N' value	Depth (m)	Reduced Level (m)					
32.50-32.95	71	U	(120)			Very stiff to hard red or red brown mottled brown spotted blue extremely to very closely fissured silty CLAY; fissure planes generally inclined planar and silt/fine sand lined.				
32.95	72	D								
33.30	73	D		33.40	-9.53					
33.50-33.95	74	DS	61			Hard blue grey, yellow, brown and orange brown mottled very to extremely closely fissured silty sandy locally very sandy CLAY with occasional rounded medium flint gravel; fissure planes generally inclined planar and silt/fine sand lined.				
34.50-34.85	75	U	(120)							
34.85	76	D	64							
34.90-35.21	77	DS		(2.90)						
36.00-36.25	78	U	(120)							
36.25	79	D	103	36.30	-12.43	...@36.25m with small pockets and lenses of fine to medium brown sand.				
36.30-36.59	80	DS				Very dense black/dark grey subrounded to rounded fine to coarse clayey sandy GRAVEL with white incrust on some gravel surfaces; probably becoming gravelly with depth.				
37.00-37.25	81	BC	143	(1.10)						
37.50-37.70	82	DS	300	37.40	-13.53	Very dense grey silty fine to medium SAND with occasional gravel sized lumps of soft silt/clay. (THANET SAND)				
38.50-38.78	83	DS	200							
39.50-39.77	84	DS	206	(3.50)		...from 39.50 - 40.00m occasional thin (3mm) bands of soft? brown silty CLAY.				

Boring Progress & Water Obs.							Chiselling			Remarks:
Date	Time	Depth	Casing	Water	Rose	Sealed	From	To	Mins	Full boring progress, water observations and chiselling details are given on a separate sheet. Full SPT and U100 details are given on separate sheets. Borehole in underground car park.

For abbreviations and symbols see key sheet

GE/tech 101 Produced by J.M.Davidson on gINT, 1992

LTG

Scale: 1:50 All dimensions in metres	Processed in accordance with BS5930, BS5750 and AGS standards	Processed by: DC	Logged by: SR

Project Name:		Record of Borehole No:
TRITON SQUARE/REGENTS PLACE		BH 12
Project No: 9 4 4 8 4	Client: THE BRITISH LAND CORPORATION	

Co-ordinates (National):	Ground level (mAOD):	Method:		
29153.0E 82311.0N	23.87	CABLE PERCUSSION		
Date:	**Depth of Hole:**	**Hole diameter:**	**Casing diameter:**	**Sheet:**
24/01/95 to 31/01/95	40.90	200/150mm	200/150mm	6 of 6

Machine Number

Samples & Tests				Strata		Description of Strata	Geology	Legend	Water	Piezo Backfill
Depth (m)	No.	Type	SPT CPT 'N' value	Depth (m)	Reduced Level (m)					
				40						
40.50-40.75	85	DS	240			Very dense grey silty fine to medium SAND.				
				40.90	-17.03					
						EXPLORATORY HOLE COMPLETED AT 40.90m.				

Boring Progress & Water Obs.							Chiselling		
Date	Time	Depth	Casing	Water	Rose	Sealed	From	To	Mins

Remarks:
Full boring progress, water observations and chiselling details are given on a separate sheet. Full SPT and U100 details are given on separate sheets. Borehole in underground car park.

For abbreviations and symbols see key sheet

GE/tech 101

LTG

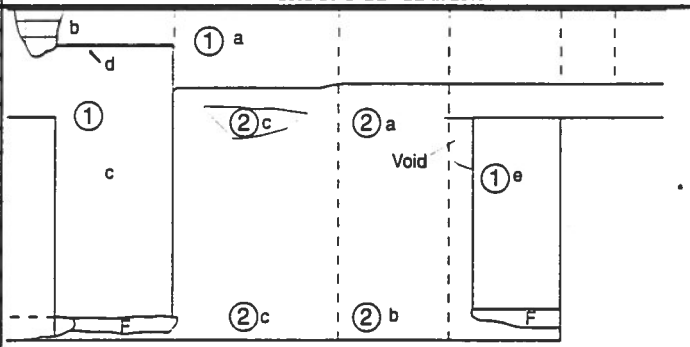
Scale: 1:50 All dimensions in metres	Processed in accordance with BS5930, BS5750 and AGS standards	Processed by: DC	Logged by: SR

OVE ARUP AND PARTNERS
REGENT'S PLACE
RECORD OF TRIAL PIT - TP 8 **Page 1 of 2**

APPENDIX	
JOB NO.	49198/77
MADE BY	JMB
DATE MADE	25/1/95

DAILY PROG-RESS	DEPTH TO WATER	SAMPLE/ IN SITU TEST DEPTH FROM	DEPTH TO	TYPE		LEG END	DEPTH	RED LEVEL
	(m)	(m)	(m)				(m)	(mOD)
23/1/95								
		0.40		3	J			
		0.40		4	J		0.45	23.42
24/1/95	1.25*	1.25		5	W		1.25	22.62
		1.30		1	B		1.35	22.52
		1.35		2	B			

DESCRIPTION OF STRATA



STRATA

1 a. Concrete floor slab with 6mm diameter mesh with 150mm spacing.
b&c. Structural concrete with spiral drawn 16mm diameter reinforcement @ 300mm centres & 10-12mm shear reinforcement @ 150mm centres
d. 150mm wide black rubber water bar
e. Concrete footing under column
f. Blinding

2 a. Medium dense orange brown medium to coarse SAND and fine to medium angular to rounded GRAVEL with occasional building rubble (concrete & wood)
b. Black sheet pile section surrounded in concrete
c. Below 0.6m (2) a becoming SAND and GRAVEL (as (2) a) with soft to firm grey CLAY

NOTES

* Water level after overnight rise.

** Void noticed underneath slab - see section 1-,1 2m long and up to 0.45m wide. Black pipe visible 1.5m into void.

METHOD OF EXCAVATION

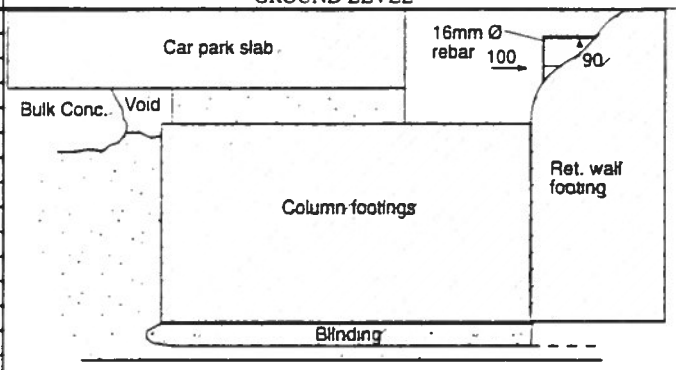
Hand Dug

TP 8

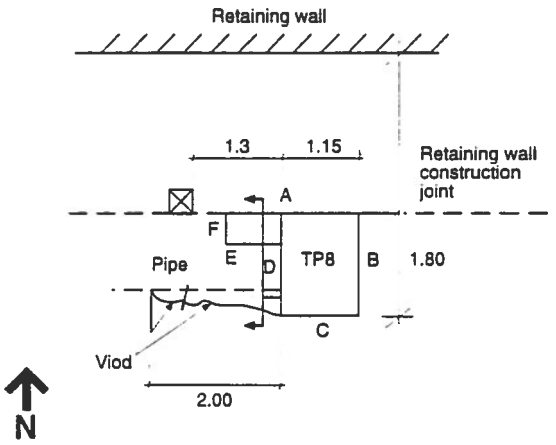
OVE ARUP AND PARTNERS
REGENT'S PLACE
RECORD OF TRIAL PIT - TP 8

APPENDIX	
JOB NO.	49198/77
MADE BY	JMB
DATE MADE	25/1/95

DAILY PROG-RESS	DEPTH TO WATER	SAMPLE/ IN SITU TEST DEPTH FROM	DEPTH TO	TYPE	LEG-END	DEPT	RED LEVEL	DESCRIPTION OF STRATA
	(m)	(m)	(m)			(m)	(mOD)	GROUND LEVEL
						0.30		
						0.45		
						1.25		
						1.35		



Section 1-1



PLAN VIEW

All dimensions in m

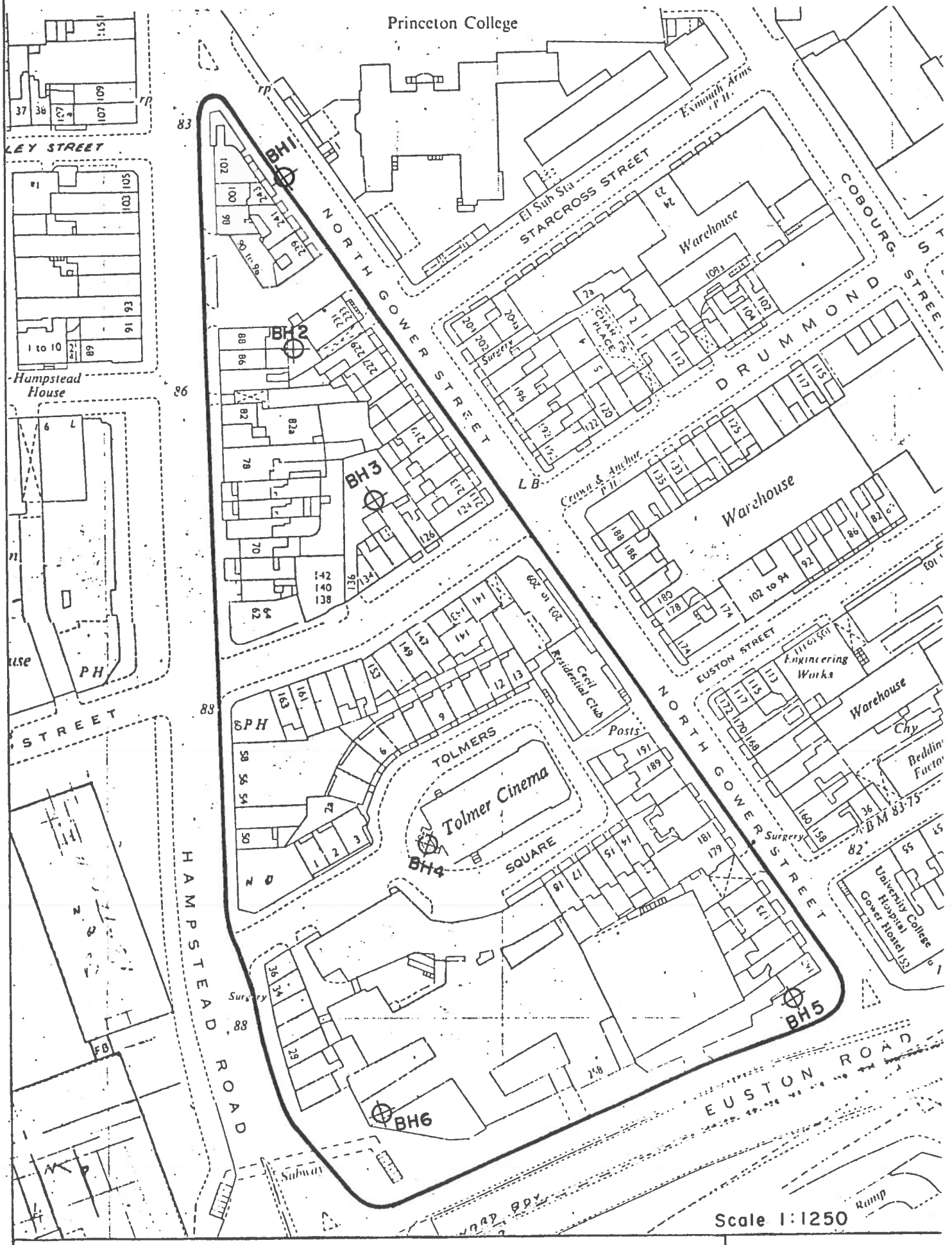
NOTES

METHOD OF EXCAVATION

Hand Dug

TP 8

TOLMERS SQUARE — BOREHOLE LOCATION PLAN



NUTTALL GEOTECHNICAL SERVICES LTD.

DRG. 1

Job 374

Site investigation at Tolmers Square. **Job** 374

LOG OF BOREHOLE No. 1

Type of equipment Shell and Auger

Diameter of hole 200mm (8") to 6.90m
150mm (6") to 20.00m

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	GROUND LEVEL: 25.48m O.D.
	7.12/76			G.L.	2.40	1	D				Ashphalt, concrete and ballast material (Road surface foundations).
1 m											
2 m											
3 m						1			2.90	22.58	(Fill)
			3.00	3.15	3.45	2	CP(18)B				Medium dense brown sandy fine to coarse GRAVEL with occasional cobbles.
4 m				3.90		3	D		3.80	21.68	(Taplow Gravel)
			3.50	3.90	4.35	4	U4				Firm to stiff brown highly fissured, slightly silty CLAY with occasional grey fissure surfaces.
				4.35		5	D				
				4.50	4.80	6	SP(21)D				(London Clay)
5 m											
6 m				6.00		7	D				
				6.00	6.45	8	U4				---with traces of organic material
				6.45		9	D				
7 m				6.60	6.90	10	SP(25)D				
				7.50		11	D				
				7.50	7.95	12	U4				
8 m				7.95		13	D				
			7.50	8.10	8.40	14	SP(19)D				
	8.40	DRY	7.50								
	8.12/76	DRY									
9 m				9.00		15	D				
				9.00	9.45	16	U4				
				9.45		17	D				
10 m				9.60	9.90	18	SP(24)D				
11 m											
				11.40		19	D				
				11.40	11.85	20	U4				
12 m				11.85		21	D				
				12.00	12.30	22	SP(33)D				
13 m				13.00		23	D				

continued on next sheet

Key

▨	sampling depth, soils
U4	4 in. dia. undisturbed sample (102 mm)
U3	3 in. dia. undisturbed sample (73 mm)
D	disturbed jar sample
B	disturbed bulk sample
W	water sample
SP ( )	standard penetration test
CP ( )	cone penetration test
(25)	number of blows e.g. 25
*	no recovery
▩ 80	core drilling, 80% recovery
RQD	rock quality designation

Notes

(a) Starting pit dug to 1.00m.

BOREHOLE 1

Site Investigation at Tolmers Square Job 374

LOG OF BOREHOLE No. 1
(Continuation Sheet)

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	continued from previous sheet
			7.50	13.00	13.45	24	U4				(Stiff mottled brown and grey fissured silty CLAY with traces of organic staining)
				13.45		25	D				
14m				13.60	13.90	26	SP(34)D				(London Clay)
15m											
16m				16.00		27	D				
				16.00	16.45	28	U4				---with some silt bands
				16.45		29	D				
17m				16.60	16.90	30	SP(37)D				
18m											
19m											
				19.10		31	D				
				19.10	19.55	32	U4				
				19.55		33	D				
20m	20.00	DRY	7.50	19.70	20.00	34	SP(41)D		20.00	5.48	
											Borehole completed.
21m											
22m											
23m											
24m											
25m											
26m											
27m											
28m											
29m											
30m											

Revised April 71

For Key to symbols and Notes, see first sheet for this borehole.

BOREHOLE 1

NUTTALL GEOTECHNICAL SERVICES LTD.

Job 374

R.2

Site Investigation at Tolmers Square **Job** 374

Type of equipment Shell and Auger

Diameter of hole 200mm (8")

LOG OF BOREHOLE No. 2

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	GROUND LEVEL: 25.79m O.D.
1 m	27.11.76			G.L.	1.85	1	D				Soft to firm dark brown sandy silty CLAY with some gravel of brick, concrete and flint material and occasional ash fragments. (Fill)
2 m				2.20		2	D		2.50	23.29	Soft mottled brown slightly sandy silty CLAY with some iron staining.
3 m				2.80	3.25	3	U4		3.00	22.79	
				3.25		4	D				Medium dense brown fine to coarse SAND with some fine and medium, angular to sub-rounded gravel.
4 m				3.45	3.75	5	CP(14)B				
5 m				4.05	4.35	6	CP(29)B				(Taplow Gravel)
				5.60		7	D		5.60	20.19	
6 m				5.60	6.05	8	U4				Stiff mottled grey-brown laminated (2mm) fissured slightly silty CLAY with occasional brown fissure surfaces and hard clay layers. (London Clay)
				6.05		9	D				
7 m	6.50	DRY	5.60	6.20	6.50	10	SP(27)D		6.50	19.29	Borehole completed.
8 m											
9 m											
10 m											
11 m											
12 m											
13 m											

Key

▨	sampling depth, soils
U4	4 in. dia. undisturbed sample (102 mm)
U3	3 in. dia. undisturbed sample (73 mm)
D	disturbed jar sample
B	disturbed bulk sample
W	water sample
SP ( )	standard penetration test
CP ( )	cone penetration test
(25)	number of blows e.g. 25
•	no recovery
▨ 80	core drilling, 80% recovery
RQD	rock quality designation

Notes

(a) Starting pit dug to 0.25m.

(b) Standpipe installed with tip at 5.50m.

BOREHOLE 2

374

Site Investigation at Tolmers Square **Job** 374

Type of equipment Shell and Auger

Diameter of hole 200mm (8")

LOG OF BOREHOLE No. 3

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	GROUND LEVEL: 25.75m O.D.
	23.11.76			0.50		1	D				Fine to coarse GRAVEL of brick rubble, ash and wood material.
1 m											(Fill)
				1.60		2	D		1.45	24.30	
2 m	2.00	DRY	1.50								Soft brown sandy silty CLAY with some gravel of brick and ash material.
	24.11.76	DRY	1.50	2.35	2.65	3	SP(1)D				(Fill)
3 m									2.75	23.00	
				2.95	3.25	4	CP(33)B				Dense to very dense brown medium to coarse SAND and fine to medium angular to rounded GRAVEL.
				3.65	3.95	5	CP(50)B				
4 m											
				4.35	4.65	6	CP(30)B				
5 m											
				4.95	5.25	7	CP(50)B				
											(Taplow Gravel)
				5.60		8	D		5.60	20.15	
6 m				5.80	6.25	9	U4				Stiff brown and grey laminated fissured CLAY.
				6.55	6.85	10	SP(22)D				(London Clay)
7 m	7.00	DRY	5.80								
	25.11.76	DRY	5.80	7.30	7.75	11	U4				
8 m											
				8.20	8.50	12	SP(34)D				
9 m											
				8.80	9.25	13	U4				---with some mudstone fragments
10 m				9.75	10.05	14	SP(28)D				
				10.30	10.75	15	U4				---with some organic staining
11 m											
				11.15	11.45	16	SP(24)D				
12 m				11.80	12.25	17	U4				---becoming slightly silty with occasional silt pockets
	12.70	DRY	5.80	12.40	12.70	18	SP(28)D		12.70	13.05	
13 m											Borehole completed

Key

▨	sampling depth, soils
U4	4 in. dia. undisturbed sample (102 mm)
U3	3 in. dia. undisturbed sample (73 mm)
D	disturbed jar sample
B	disturbed bulk sample
W	water sample
SP ( )	standard penetration test
CP ( )	cone penetration test
(25)	number of blows e.g. 25
•	no recovery
▨ 80	core drilling, 80% recovery
RQD	rock quality designation

Notes

(a) Starting pit dug to 0.80m.

(b) Piezometer installed with tip at 12.00m.

BOREHOLE 3

Job 344

Site Investigation at Tolmers Square **Job** 374

LOG OF BOREHOLE No. 4

Type of equipment Shell and Auger

Diameter of hole 200mm (8")

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	GROUND LEVEL: 28.50m O.D.
1 m	10.12.76			G.L.	2.00	1	B				Grey slightly silty fine and medium SAND with much fine to coarse, sub-angular to rounded gravel. (Fill)
2 m				2.00		2	D		2.00	26.50	
3 m											Firm to stiff mottled grey and brown slightly sandy, silty CLAY with some fine and medium gravel of flint and brick material and occasional bone material. (Fill)
				3.50		3	D		3.50	25.00	
4 m			3.00	3.50	3.95	4	U4				Firm dark grey silty CLAY.
				3.95		5	D		4.50	24.00	
5 m			4.20	4.65	4.95	6	CP(54)B				Medium dense brown medium to coarse SAND with much fine and medium, sub-angular to sub-rounded gravel. (Taplow Gravel)
6 m											
7 m			5.80	6.15	6.23	7	CP(80)‡B				
			6.40	6.65	6.95	8	CP(28)B				
8 m											
				8.20		9	D		8.10	20.40	
			8.00	8.20	8.65	10	U4				Stiff mottled brown and grey fissured CLAY with evidence of iron staining on fissure surfaces. (London Clay)
9 m	9.10	DRY		8.65		11	D				
			8.00	8.80	9.10	12	SP(31)D		9.10	19.40	
10 m											Borehole Completed
11 m											
12 m											
13 m											

Key

▨	sampling depth, soils
U4	4 in. dia. undisturbed sample (102 mm)
U3	3 in. dia. undisturbed sample (73 mm)
D	disturbed jar sample
B	disturbed bulk sample
W	water sample
SP ( )	standard penetration test
CP ( )	cone penetration test
(25)	number of blows e.g. 25
•	no recovery
▨ 80	core drilling, 80% recovery
RQD	rock quality designation
‡	No. of blows for 0.30m penetration calculated from actual number of blows.

Notes

(a) Starting pit dug to 0.50m.

(b) Standpipe installed with tip at 8.00m.

Site Investigation at Tolmers Square **Job** 374

LOG OF BOREHOLE No. 5

Type of equipment Shell and Auger

Diameter of hole 200mm (8") to 7.00m
150mm (6") to 22.00m

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	GROUND LEVEL: 26.08m O.D.
	13.12'76			G.L.	3.00	1	B				Fine to coarse GRAVEL of brick, concrete and paving material with some sand and wood fragments.
1 m											
2 m											
3 m	3.00	DRY	3.00								(Fill)
	4.12'76	DRY				/					
									3.30	22.78	
4 m											
			3.70	3.95	4.25	2	CP(19)B				Medium dense grey, medium and coarse SAND with some fine to coarse gravel.
				4.60		3	W				
5 m											(Taplow Gravel)
									5.10	20.98	
				5.50		4	D				Firm to stiff brown highly fissured slightly silty CLAY with occasional grey fissure surfaces.
				5.50	5.95	5	U4				
6 m				5.95		6	D				
				6.10	6.40	7	SP(23)D				
7 m											(London Clay)
				7.50		8					
			6.00	7.50	7.95	9	U4				
8 m				7.95		10	D				
				8.10	8.40	11	SP(22)D				
9 m											
			9.00	9.65		12	D				
10 m				9.65	10.10	13	U4				
				10.10		14	D				
				10.25	10.55	15	SP(26)D				
11 m				11.00		16	D				
				11.00	11.45	17	U4				---with traces of organic material
				11.45		18	D				
12 m	12.00	DRY	9.00	11.60	11.90	19	SP(27)D				
	15.12'76	DRY									
13 m				12.80		20	D				

continued on next sheet

Key

▨	sampling depth, soils
U4	4 in. dia. undisturbed sample (102 mm)
U3	3 in. dia. undisturbed sample (73 mm)
D	disturbed jar sample
B	disturbed bulk sample
W	water sample
SP ( )	standard penetration test
CP ( )	cone penetration test
(25)	number of blows e.g. 25
•	no recovery
▨ 80	core drilling, 80% recovery
RQD	rock quality designation

Notes

(a) Starting pit dug to 0.75m

(b) Reduced to 150mm (6") casing at 7.00m

Site Investigation at Tolmers Square Job 374

LOG OF BOREHOLE No. 5

(Continuation Sheet)

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	continued from previous sheet
			9.00	12.80	13.25	21	U4				
				13.25		22	D				(Stiff brown fissured CLAY)
				13.40	13.70	23	SP(29)D				
14m											(London Clay)
15m											
				15.50		24	D				
				15.50	15.95	25	U4				
16m				15.95		26	D				
				16.10	16.40	27	SP(34)D				
17m											
18m											
				18.50		28	D				
				18.50	18.95	29	U4				
19m				18.95		30	D				
				19.10	19.40	31	SP(38)D				
20m											
21m											
				21.55		32	D				
22m				21.55	22.00	33	U4		22.00	4.08	---with occasional grey mottling and traces of organic staining
	22.00	DRY	9.00	22.00			D				Borehole completed
23m											
24m											
25m											
26m											
27m											
28m											
29m											
30m											

For Key to symbols and Notes, see first sheet for this borehole.

BOREHOLE 5

NUTTALL GEOTECHNICAL SERVICES LTD.

Job 374

Revised April 71

R.2

Site Investigation at Tolmers Square **Job** 374

LOG OF BOREHOLE No. 6

Type of equipment Shell & Auger

Diameter of hole 200mm (8") to 13.40m
150mm (6") to 23.70m

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	GROUND LEVEL: 26.62m O.D.
	29.11.76			G.L.	2.00	1	B				Fine to coarse, angular to sub-rounded GRAVEL of flint and brick material, with much fine to coarse sand.
1 m											
2 m									2.00	24.62	(Fill)
				2.15	2.45	2	SP(8)D				Soft to firm mottled brown silty CLAY with some ash material.
3 m									3.00	23.62	(Fill)
			3.00	3.15	3.30	3	CP(102)B				Dense brown silty sandy GRAVEL.
4 m											
											(Taplow Gravel)
5 m	4.95	DRY	4.60	4.65	4.95	4	CP(15)B		4.60	22.02	Soft to firm brown silty CLAY with traces of sand and medium gravel.
	L1.2.76	DRY	4.60	5.00		5	D				
				5.00	5.45	6	U4		5.40	21.22	
				5.45		7	D				Firm to stiff grey-brown laminated, fissured CLAY with some organic staining.
6 m				5.60	5.90	8	SP(15)D				
				6.50		9	D				
				6.50	6.95	10	U4				---becoming stiff
7 m				6.95		11	D				
				7.10	7.40	12	SP(24)D				
8 m											(London Clay)
				8.00		13	D				
				8.00	8.45	14	U4				
				8.45		15	D				
9 m				8.60	8.90	16	SP(31)D				
				9.50		17	D				
				9.50	9.95	18	U4				
10 m				9.95		19	D				
				10.10	10.40	20	SP(37)D				---5-10mm band of mudstone
11 m											
				11.00	11.45	21	U4*,D				---band of grey, moderately strong mudstone
12 m				11.60	11.90	22	SP(41)D				
				12.50		23	D				
				12.50	12.95	24	U4				
13 m	13.00	DRY	5.00	12.95		25	D				

continued on next sheet

Key

▨	sampling depth, soils
U4	4 in. dia. undisturbed sample (102 mm)
U3	3 in. dia. undisturbed sample (73 mm)
D	disturbed jar sample
B	disturbed bulk sample
W	water sample
SP ( )	standard penetration test
CP ( )	cone penetration test
(25)	number of blows e.g. 25
*	no recovery
▮ 80	core drilling, 80% recovery
RQD	rock quality designation
+ +	No. of blows for 0.30m penetration calculated from actual number of blows.

Notes

(a) Piezometer installed with tip at 23.00m.
(b) Reduced to 150mm (6") casing at 13.40m.

BOREHOLE 6

RI. NUTTALL GEOTECHNICAL SERVICES LTD. **Job 374**

Site Investigation at Tolmers Square Job 374

LOG OF BOREHOLE No. 6

(Continuation Sheet)

DEPTH SCALE	DAILY PROGRESS	DEPTH TO WATER	DEPTH OF CASING	SAMPLING DATA: DEPTH FROM	DEPTH TO	No.	TYPE	LEGEND	CHANGE OF STRATA: DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		m	m	m	m				m	m	continued from previous sheet
	2.1276	DRY	5.00	13.15	13.45	26	SP(31)D				(Stiff grey weakly laminated fissured micaceous CLAY)
14m											
											(London Clay)
				14.50		27	D				
			14.00	14.50	14.95	28	U4				
15m				14.95		29	D				
				15.10	15.40	30	SP(32)D				
16m											
17m				17.00		31	D				
				17.00	17.45	32	U4				---with some partially pyritised wood fragments
				17.45		33	D				
18m				17.60	17.90	34	SP(36)D				
19m											
20m											
				20.50		35	D				
				20.50	20.95	36	U4				
21m				20.95		37	D				
				21.10	21.40	38	SP(35)				
22m									21.90	4.72	
				22.05		39	D				Hard, light grey, mottled red, laminated and fissured silty CLAY (Woolwich and Reading Beds)
				22.05	22.50	40	U4				
23m				22.50		41	D				
				23.20		42	D				Red-brown from 22.50m.
				23.25	23.70	43	U4				Light grey-green from 23.60m.
24m	23.70	DRY	14.00	23.70		44	D		23.70	2.92	
											Borehole Completed
25m											
26m											
27m											
28m											
29m											
30m											

For Key to symbols and Notes see first sheet for this borehole

BOREHOLE 6

NUTTALL GEOTECHNICAL SERVICES LTD.

Job 374

Revised April 71

R.2

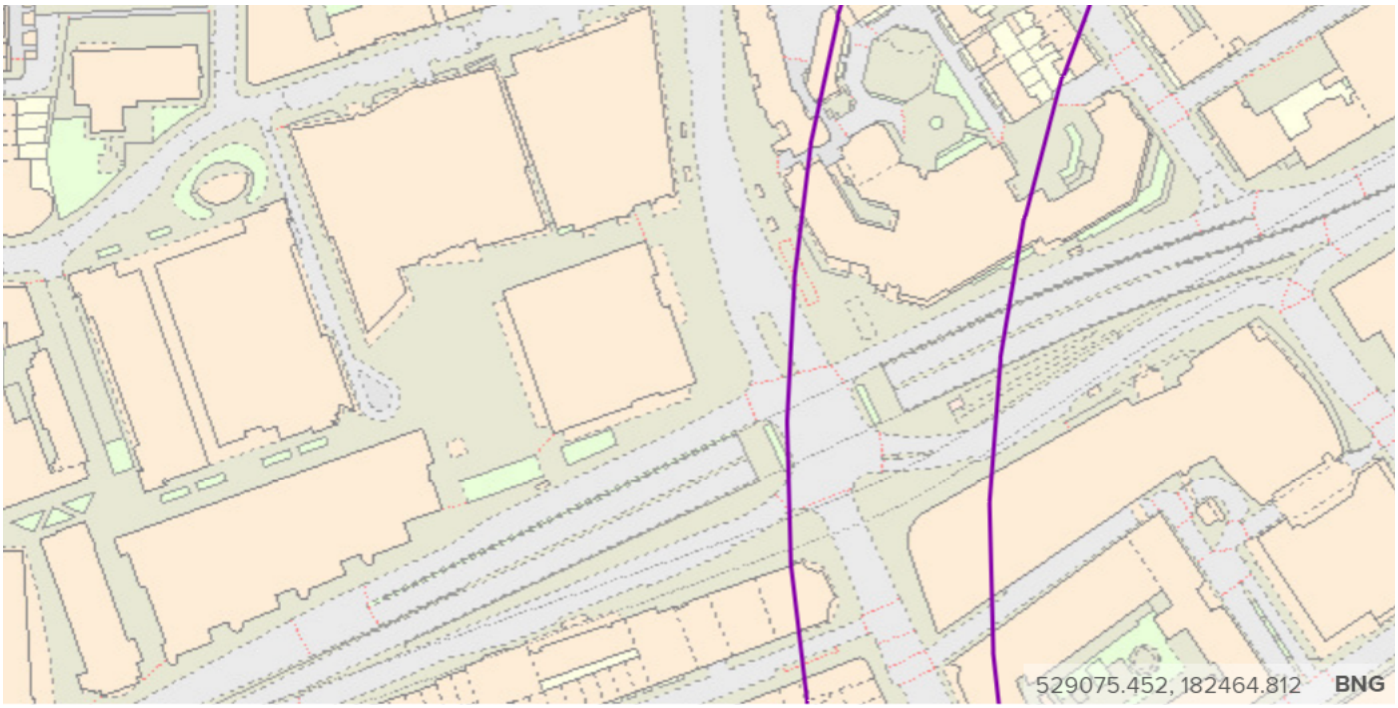
Appendix E – Crossrail 2 safeguarding correspondence

From: Crossrail2 <Crossrail2@tfl.gov.uk>
Sent: Monday, October 9, 2023 3:07 PM
To: Henry Tayler <Henry.Tayler@arup.com>; Crossrail2 <Crossrail2@tfl.gov.uk>
Cc: G.Williams@Gardiner.com; j.pennell@gardiner.com; Marc Easton <Marc.Easton@arup.com>
Subject: RE: Euston Tower, 286 Euston Road, London. Crossrail 2 Safeguarding

Henry,

Euston Tower, 286 Euston Road, does fall within the 2015 Crossrail 2 Safeguarding Directions. This means that any consultation on planning applications submitted to the Local Planning Authority in respect of this site which propose or imply works more than 3 metres below ground level, an increase in height or floor area must include TfL to prevent planning permission being granted for development that might be prejudicial to the subsequent delivery of Crossrail 2.

Since the 2015 Directions were confirmed the current alignment of Crossrail 2 has been the subject of ongoing review and the latest proposal, shown below, are for the Mk.20.1 alignment which has moved the running tunnels slightly east of the above site. The purple lines show the centrelines of each of the two running tunnels.



Given the distance between the Crossrail 2 running tunnels and the site, in the event an application for planning permission were to be submitted I would still expect TfL to be notified of the proposals. Your email speaks about modifications to the existing building and, depending on the nature of the works and whether any below ground works are proposed, TfL may recommend to the local planning authority its Crossrail 2 conditions relating to ground movement and noise and vibration be attached to a grant of planning permission. If we do recommend conditions

the Crossrail 2 information for Developers guidance document provides further advice on how these may be discharged in conjunction with the local planning authority.

I am happy to meet but don't necessarily see there being an immediate need unless you would like to share the proposals in more detail.

Regards,

Michael Johnson BSc. Hons BTP MRTPI
Safeguarding Manager Crossrail 2
Investment Delivery Planning
Transport for London

M: 0751 505 2717 E: michaeljohnson@tfl.gov.uk

TfL RESTRICTED

From: Henry Tayler <Henry.Tayler@arup.com>
Sent: 07 October 2023 10:00
To: Crossrail2 <Crossrail2@tfl.gov.uk>; Safeguardcrossrail2 <Safeguardcrossrail2@tfl.gov.uk>
Cc: G.Williams@Gardiner.com; j.pennell@gardiner.com; Marc Easton <Marc.Easton@arup.com>
Subject: Euston Tower, 286 Euston Road, London. Crossrail 2 Safeguarding

For attention of the safeguarding manager, Crossrail 2-TfL.

This correspondence is to request details of TfL Crossrail 2 safeguarding in proximity to the above site and to make initial contact with the safeguarding manager in relation to proposed feasibility studies for modifications to the existing building and development of the site.

Brief summary:
On behalf of our client, British Land, Arup are carrying out structural/geotechnical studies for the 286 Euston Road, "Euston Tower" site, Euston Road, within the London Borough of Camden.
The site is located at the corner of Euston Road and Hampstead Road and the existing 1960s constructed Euston Tower building and associated 2 storey podium structure are located within the Regents Place /former Euston Centre development. The existing 36 storey 1960s constructed Euston Tower building has a single level basement and is founded on deep piled foundations.

Existing TfL engagement.
The project team have held initial screening sessions with TfL related to the public realm and highways aspects of the proposal since April 2023.
The lead contact for engagement within TfL related to this scheme is Nahuel Mainard-Sardon.
The project team are in contact with TfL/LUL Infrastructure Protection in relation to tube assets adjacent to the site, the lead contact within TfL is Lydia Wong.

Crossrail 2 safeguarding:
An extract from the Crossrail 2 safeguarding directions is provided below, showing the location of the existing Euston Tower building in blue.
The Euston Tower and associated basement surrounding the tower is shown as located within the limited of land subject to consultation (safeguarding limits).

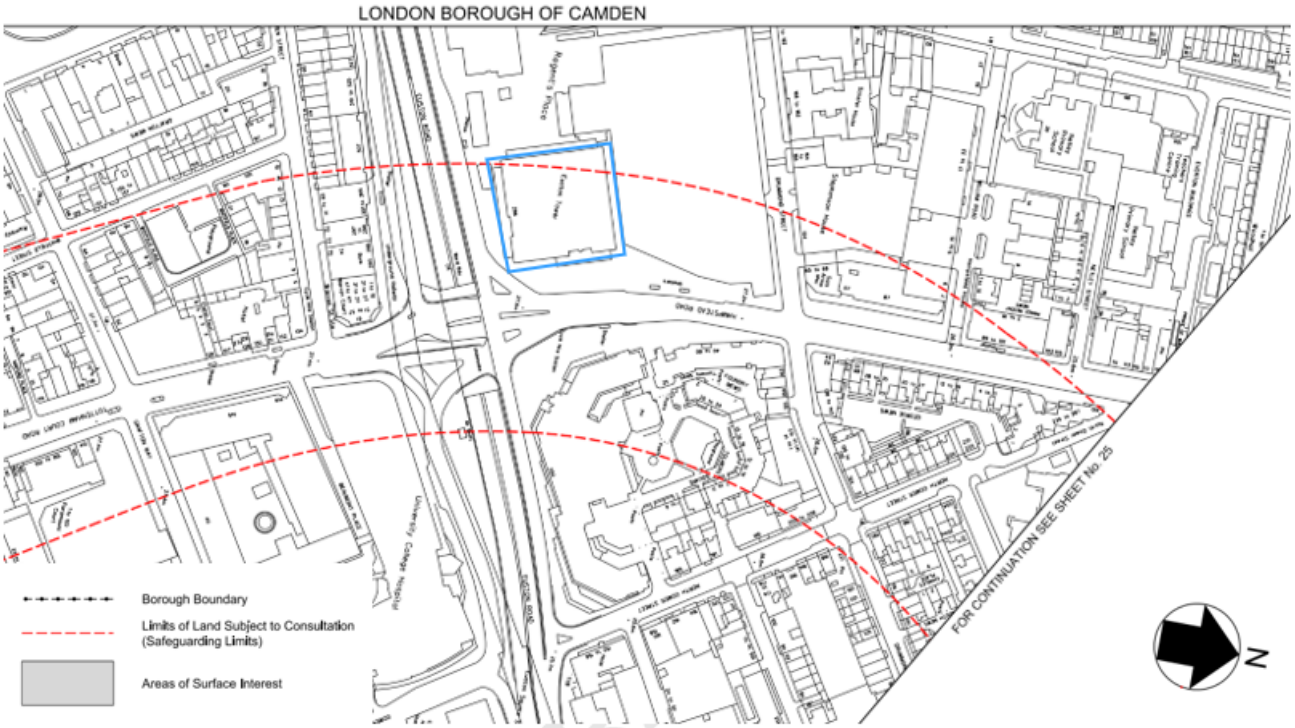


Figure 14 - Crossrail 2 safeguarding directions Sheet No24. March 2015. [MMD-307346-C-DR-SG-XX-1124]

An extract from the Crossrail2 interactive webmap is below, also showing the location of the existing Euston Tower building in blue.
https://cr2.maps.arcgis.com/apps/webappviewer/index.html?id=21a7f72dfd0c443db5733bd81a707a67
The Euston Tower site falls within the Crossrail 2 safeguarding limits, however we note that the proposed tunnel alignment, shown in brown, falls outside the safeguarding limits to the east.

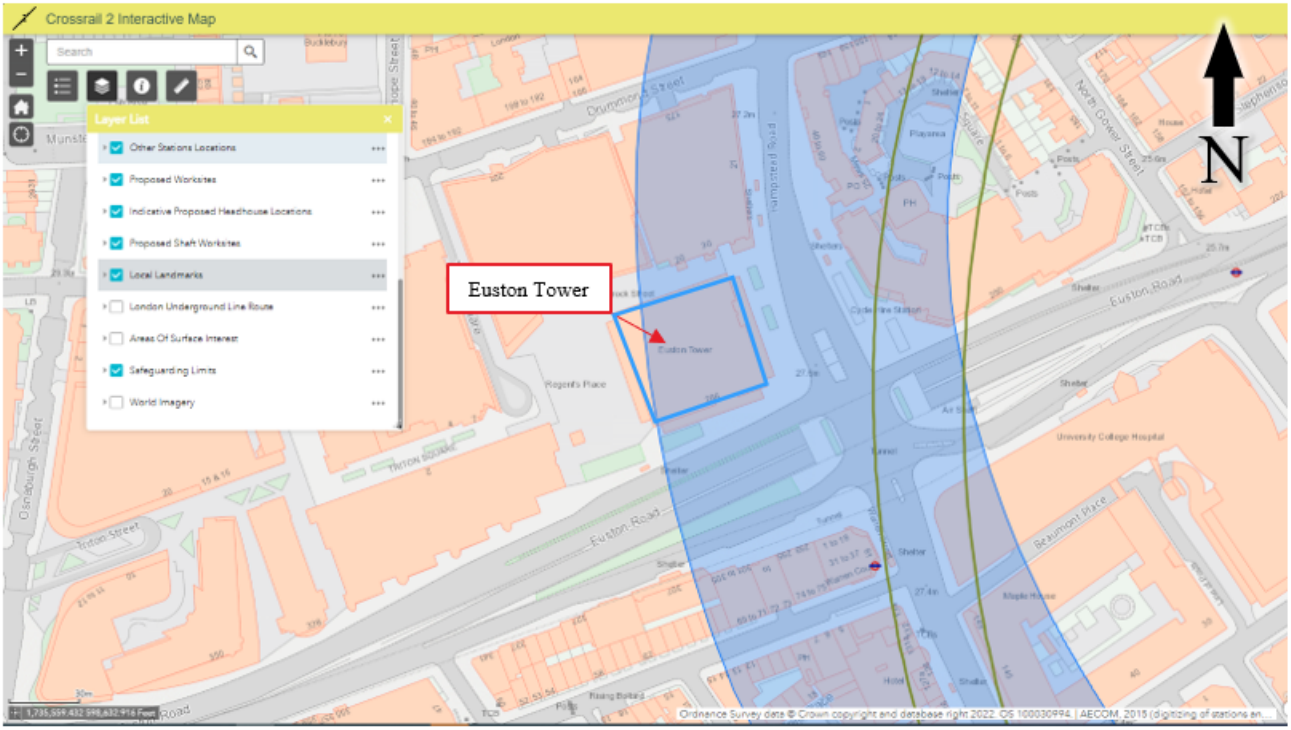


Figure 15 - Crossrail 2 safeguarding map extract – accessed 13/1/2023.

The team are aware of the guidance information available on https://crossrail2.co.uk/discover/safeguarding/ and the associated "Information for Developers" guidance - CRL2-CRL2-GEN-ROUTWID-NOT-LP-00003. The team request details of the latest safeguarding arrangements, tunnel alignment and exclusion zones to inform engineering assessment at the site and ahead of a Planning Application.

We would like to arrange an initial meeting to discuss the current feasibility proposals and establish the requirements for further studies or submissions.

Please let us know if we can provide any further information to assist in this enquiry. Our contact details are given below.

Kind regards,

Henry

Henry Tayler
Associate | Geotechnics - Transport London
MEng CEng MICE MAPM

Arup
8 Fitzroy Street London W1T 4BJ United Kingdom
d: +44 20 7755 4420
m: +44 7788217894
arup.com

Appendix F – TfL Infrastructure Protection correspondence

From: Location Enquiries
Sent: Wednesday, January 17, 2024, 10:56 AM
To: David Fowler; Planning
Subject: RE: Consultee letter for Planning Application: 2023/5240/P

FAO David Fowler,

Application No: 2023/5240/P
Site address: Euston Tower 286 Euston Road London NW1 3DP
Proposal: Redevelopment of Euston Tower comprising retention of parts of the existing building (including central core, basement and foundations) and erection of a new building incorporating these retained elements, to provide a 32-storey mixed-use building providing offices and research and development floorspace (Class E(g)) and office, retail, café and restaurant space (Class E) and learning and community space (Class F) at ground, first and second floors, and associated external terraces; public realm enhancements, including new landscaping and provision of new publicly accessible steps and ramp; short and long stay cycle storage; servicing; refuse storage; plant and other ancillary and associated work

Thank you for your consultation.

Though we have no objection in principle to the above planning application, there are a number of potential constraints on the redevelopment of a site situated close to railway infrastructure. Therefore, it will need to be demonstrated to the satisfaction of TfL Infrastructure Protection engineers that:

- our right of support is not compromised;
- the development will not have any detrimental effect on our structures either in the short or long term;
- the design must be such that the loading imposed on our structures is not increased or removed;
- we offer no right of support to the development or land.

Therefore, we request that the grant of planning permission be subject to the following separate numbered conditions to be discharged in a phased manner as and when they are completed.

1. Before the pre-commencement/demolition stage begins, no works shall be carried out until the following, in consultation with TfL Infrastructure

Protection, have been submitted to and approved in writing by the local planning authority.

a) provide an overview of the overall development including both design on temporary and permanent works;
b) provide demolition details;
c) accommodate the location of the existing London Underground structures and roads;
d) accommodate ground movement arising from the development construction thereof;
e) mitigate the effects of noise and vibration arising from the adjoining railway operations and roads;
f) provide details on the use of tall plant/scaffolding for the demolition phase;
g) No claims to be made against TfL or London Underground by the Local Authority, purchasers, tenants, occupants or lessees of the development for any noise or vibration resulting from London Underground running, operating and maintaining the adjacent railway.

2. Before the sub-structure construction stage begins, no works shall be carried out until the following, in consultation with TfL Infrastructure Protection, have been submitted to and approved in writing by the local planning authority.

a) provide detailed design for foundations, basement and ground floor structures, or for any other structures below ground level, including piling (temporary and permanent);
b) site specific Risk Assessments and Method Statements (RAMS) for any activities (basement excavation, groundworks, piling) which TfL may deem to be a risk to LU. Individual RAMS should be issued a minimum of 6 weeks prior to the individual activity commencing.

3. Before the super-structure construction stage begins, no works shall be carried out until the following, in consultation with TfL Infrastructure Protection, have been submitted to and approved in writing by the local planning authority.

a) provide detailed design for all superstructure works (temporary and permanent);
b) site specific Risk Assessments and Method Statements (RAMS) for any activities (craneage, scaffolding, use of tall plant) which TfL may deem to be a risk to LU. Individual RAMS should be issued a minimum of 6 weeks prior to the individual activity commencing.

The development shall thereafter be carried out in all respects in accordance with the approved design and method statements, and all structures and works comprised within the development hereby permitted which are required by the approved design statements in order to procure the matters mentioned in paragraphs of this condition shall be completed, in their entirety, before any part of the building hereby permitted is occupied.

Reason: To ensure that the development does not impact on existing London Underground transport infrastructure, in accordance with London Plan 2021, draft London Plan policy T3 and 'Land for Industry and Transport' Supplementary Planning Guidance 2012

This response is made as Railway Infrastructure Manager under the "Town and Country Planning (Development Management Procedure) Order 2015". It therefore relates only to railway engineering and safety matters. Other parts of TfL may have other comments in line with their own statutory responsibilities.

Kind regards,

Tom Li
Safeguarding Engineer (LU+DLR) | Infrastructure Protection
5 Endeavour Square | 7th Floor Zone B | Westfield Avenue | E20 1JN

Appendix G – Proposed B2 retaining wall calculations

ARUP

Euston Tower

BIA (P05): Frew analysis

David Foo

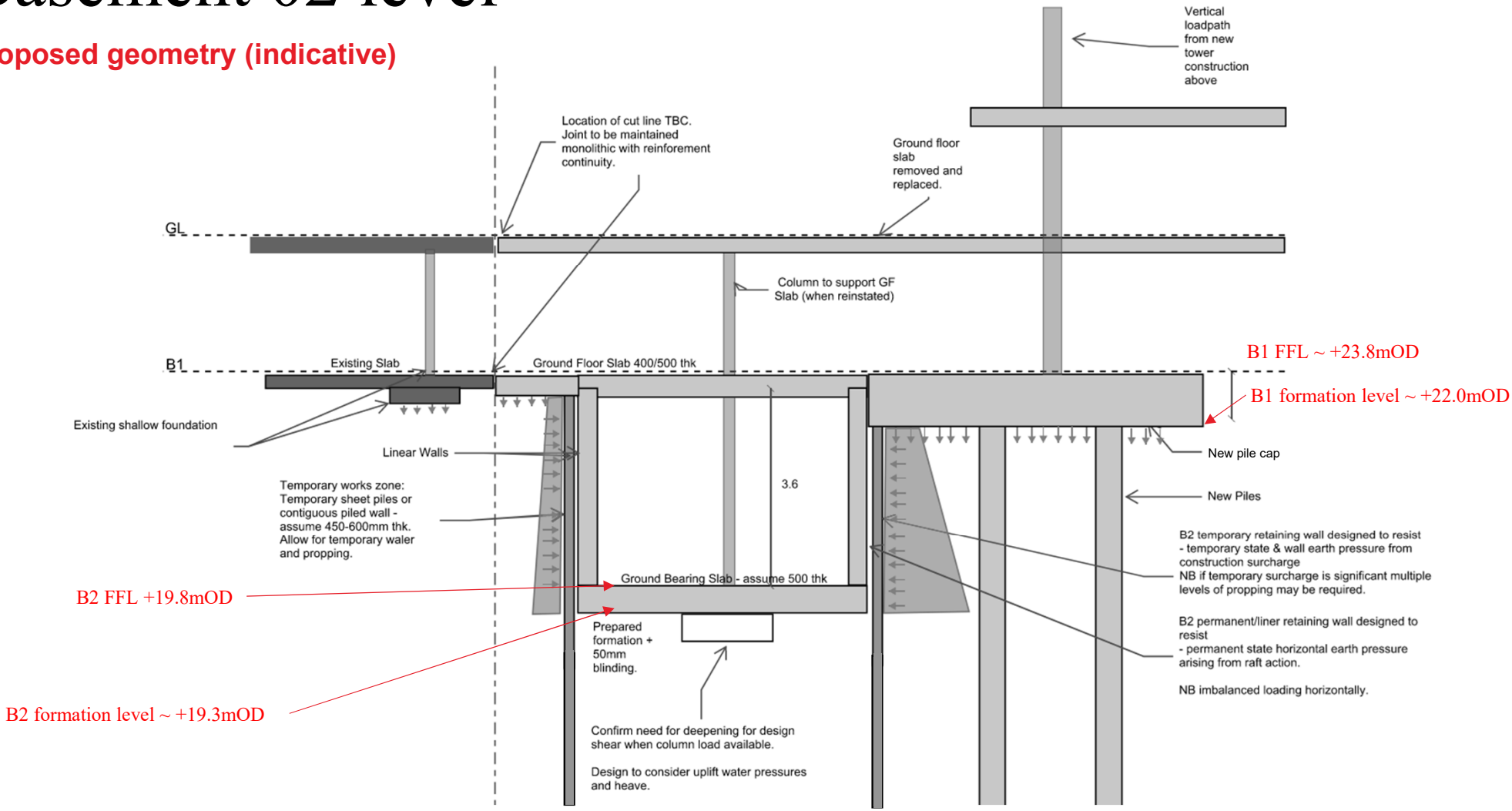
25 November 2024

ARUP

240202 STR stage 2 report book.pdf

Basement 02 level

Proposed geometry (indicative)



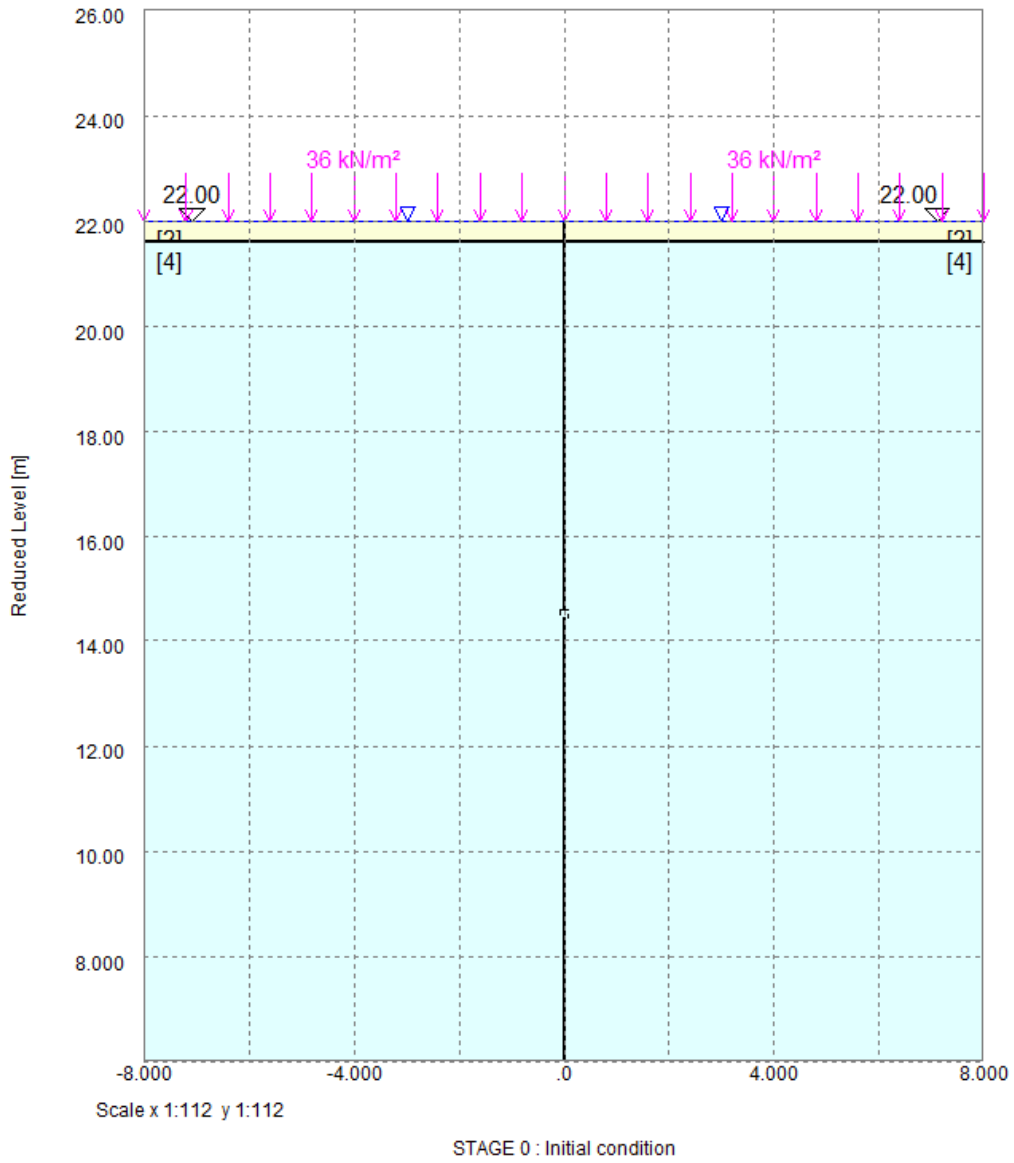
Basement 02 level

Future B1 slab pressure (TBC)

Loads	Value
B1 permanent surcharge	**45 kPa**
B1 variable surcharge	**10 kPa**

Frew

Frew model



ARUP

Frew

Stages

Stages	Description
0	Initial condition
1	Install wall
2	Cast B1 slab
3	Partial excavation to +20.5mOD
4	Install temporary prop at +22.4mOD
5	Excavation to FL +19.3mOD (for ULS check – unplanned excavation 0.5m included)
6	Cast B02 slab_wet concrete
7	Cast B02 slab
8	Cast B1 roof slab
9	Remove temporary prop
10	Long term soil condition
11	Concrete relaxation

ARUP

Frew

Ground model

- Groundwater level taken at +22mOD. Assume provision of temporary groundwater control.

Stratum	Top of stratum level (mOD)	Unit weight (kN/m3)	Undrained shear strength, Cu (kPa)	Effective angle of shearing resistance (°)	Undrained Young's modulus, Eu (kPa)	Drained Young's modulus, E' (kPa)	Ko	Delta/ phi	Cw/ Cu	Kr (Und)	Kr (Dr)
London Clay (weathered)	+22.0	20	60	24 (assumed)	60,000 (E_u=1000C_u)	45,000 (E'=750C_u)	1.00	-	0.5	1.00	0.25
London Clay Formation	+21.6	20	80 + 5z	24 (assumed)	80,000+5,000z (E_u=1000C_u)	60,000+3,750z (E'=750C_u)	1.00	-	0.5	1.00	0.25

ARUP

Frew

Wall stiffness

- Piled wall bending stiffness (EI) calculated as follows:
  - Short term EI =$0.7E_0I$, where $E_0 = 34\text{GPa}$ (for C32/40 concrete assumed)
  - Long term EI =$0.5E_0I$, (modelled through 30% relaxation of stiffness on short term)

Pile diameter (m)	Pile spacing (m)	I (m^4/m run)	EI/m short term (kNm^2 / m run)	EI/m long term (kNm^2 / m run)
0.6 (assumed)	1.20	0.0053 (0.00636 for single pile)	126,140	90,100

- Liner wall contribution ignored and not modelled in Frew.

ARUP

Frew

Prop stiffness

- Temporary prop (TP1) stiffness assumed to be 40,000 kN/m/m
- Permanent slab stiffness approximated as follows:
  - B1 slab – assumed 0.4m thick
  - B2 base slab – assumed 0.5m thick
  - Rotational restraint due to propping slabs ignored

Slab type	Thickness (m)	E_0 (GPa)	Free length, L (m)	EA/L (kN/m/m)	0.5 EA/L (kN/m/m) Long-term
B1 slab	0.40	34 (for C32/40 concrete)	3.75 (assume 7.5m wide symmetrical excavation)	3,626,667	1,813,334
B2 base slab	0.50	34 (for C32/40 concrete)	3.75 (assume 7.5m wide symmetrical excavation)	4,533,333	2,266,667

ARUP

Frew

Prop and wall levels

Scenario considered	Formation level (mOD)	Excavation depth to formation (m)	Temporary prop (TP) levels (mOD)	Permanent slab centre levels (mOD)	Contiguous wall diameter (m) & spacing (m)	Contiguous pile toe level (mOD)
Proposed Basement 02 level	+19.30	22.0-19.3 = 2.7	TP1 at +22.4	B1 slab at +23.6 B2 slab at +19.55	600mm dia. at 1.2m c/c	+14mOD (8m long contig pile)

ARUP

Frew

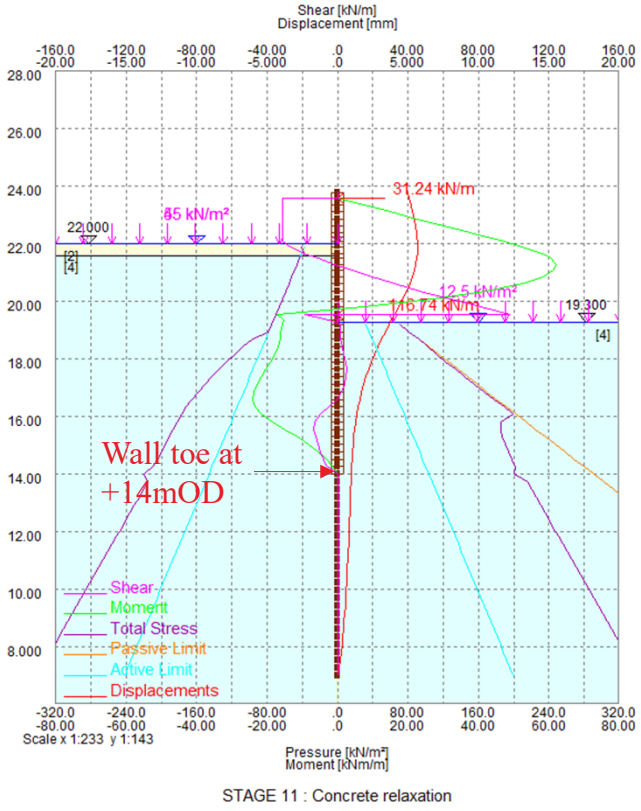
Surcharge

- A variable surcharge of 10 kPa adopted during construction on the active side of the wall.
- Future B1 raft permanent and variable surcharges behind the wall are taken to be 45 kPa and 10 kPa respectively.

ARUP

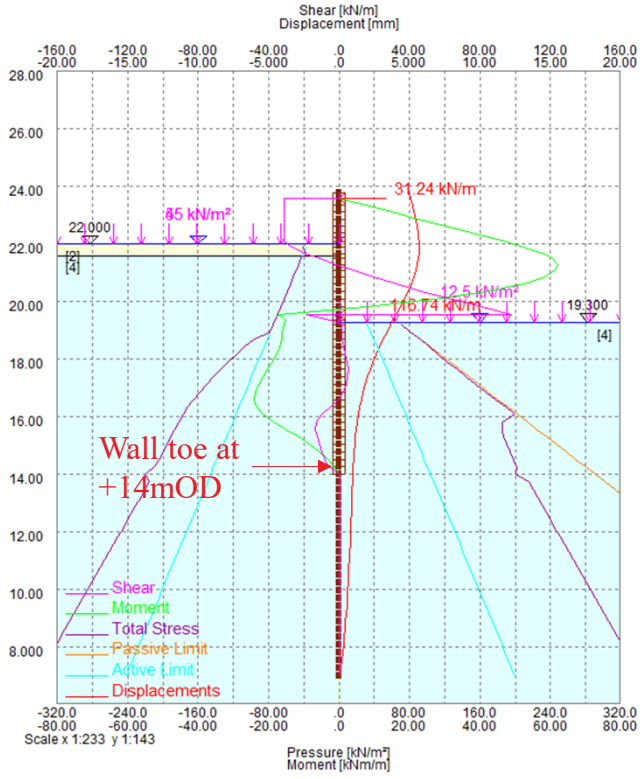
Frew

SLS Results



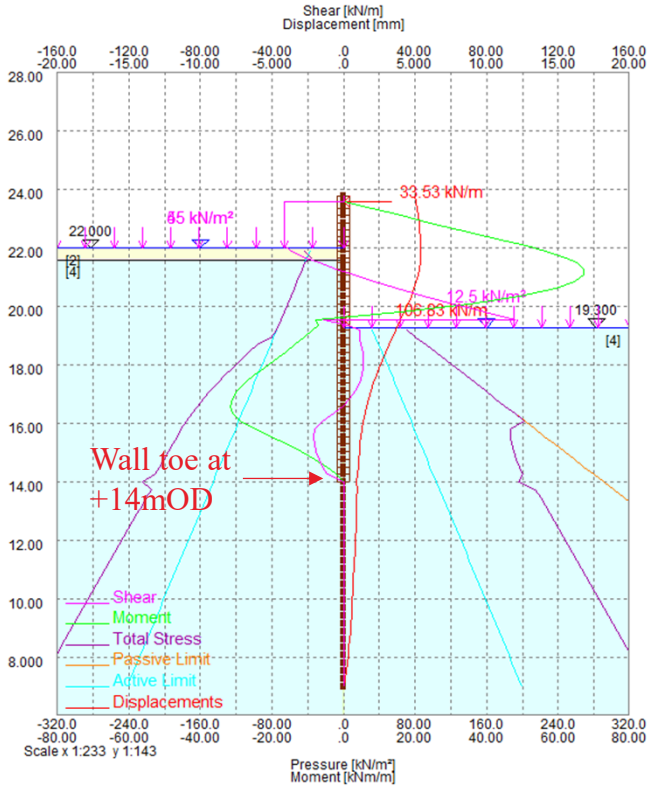
STAGE 11 : Concrete relaxation

SLS Max Disp: 5.7mm at +21.9mOD



STAGE 11 : Concrete relaxation

SLS Max SF: 98 kN/m at +19.6mOD

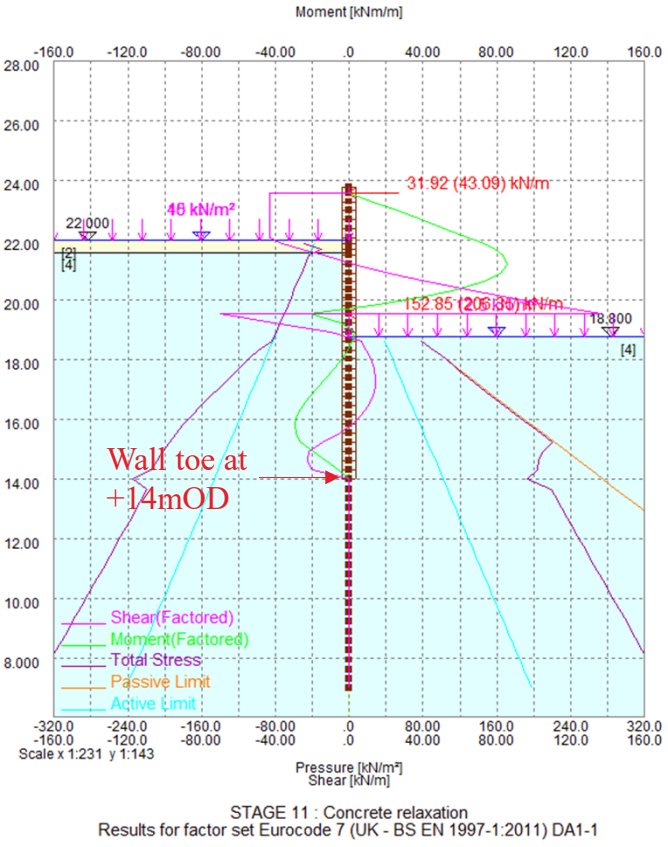


STAGE 10 : Long term soil conditions

SLS Max BM: 67 kNm/m at +21.3mOD

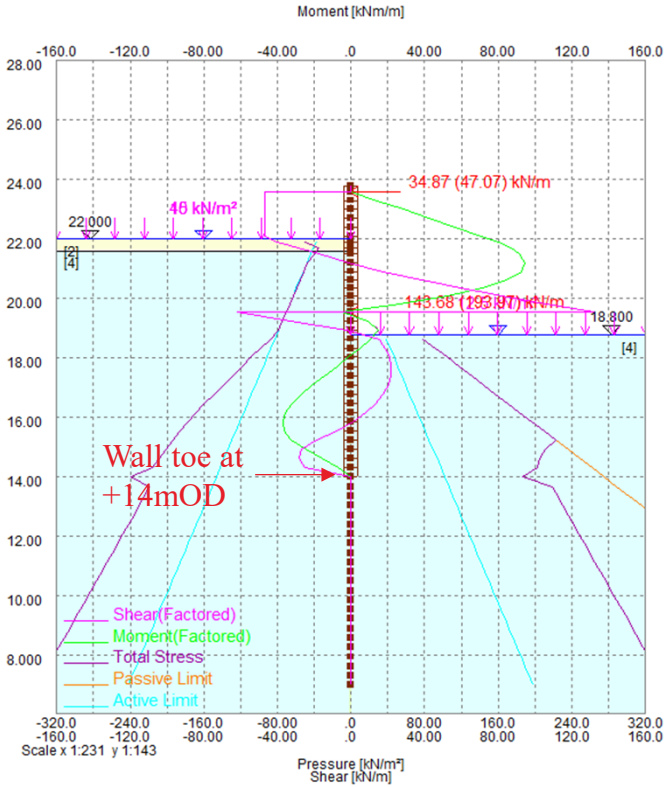
Frew

DA1C1 Results



STAGE 11 : Concrete relaxation
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

DA1C1 Max SF: 136 kN/m (164kN/pile) at +19.6mOD

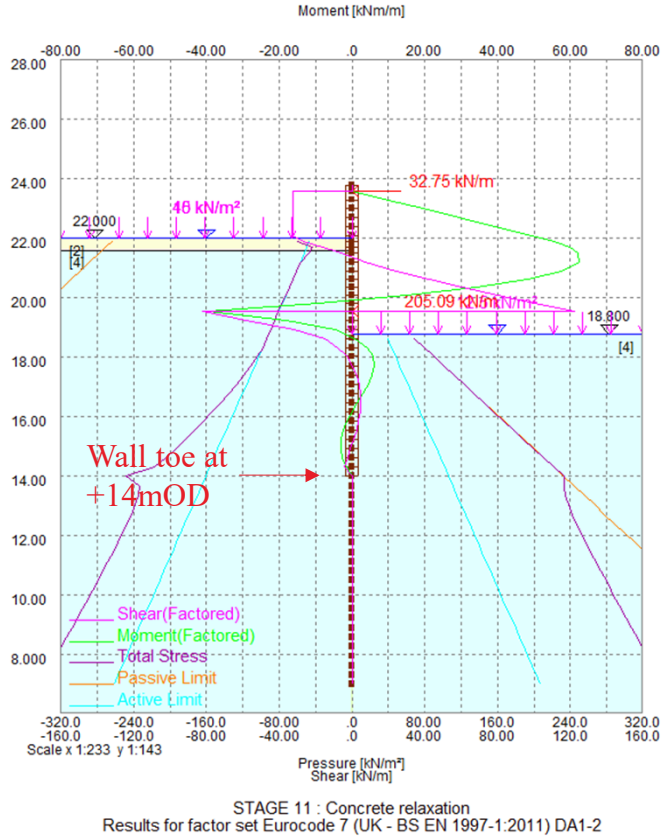


STAGE 10 : Long term soil conditions
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

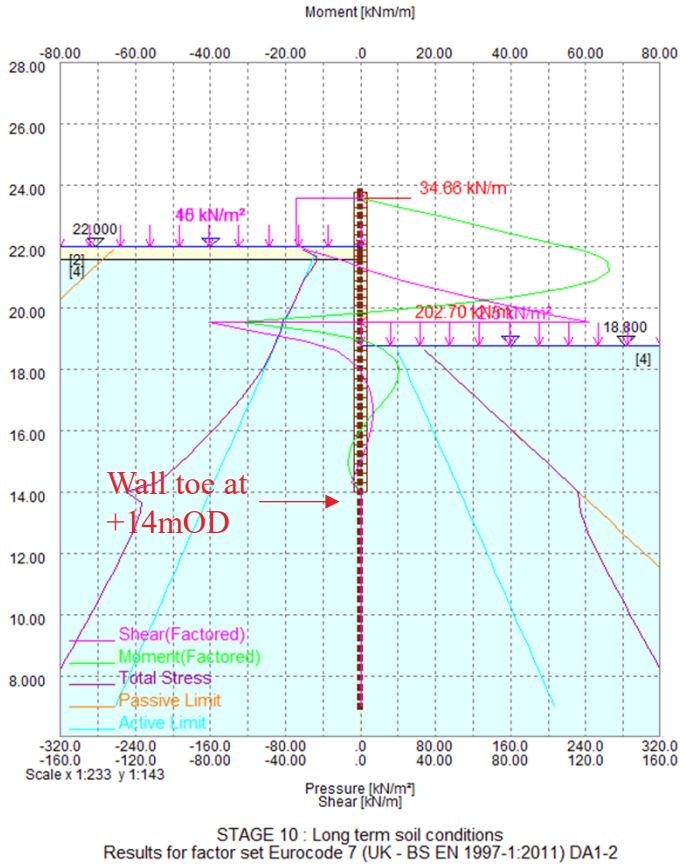
DA1C1 Max BM: 95 kNm/m (114kNm/pile) at +21.2mOD

Frew

DA1C2 Results



DA1C2 Max SF: 123 kN/m (148kN/pile) at +19.6mOD



DA1C2 Max BM: 66 kNm/m (80kNm/pile) at +21.2mOD

INITIAL DATA

Soil properties

No.	Description	Unit Wt	K0	Ka	Kp	Kac	Kpc	Kr	Earth pressure coefficients.
		[kN/m³]							
1	LC (weathered)-Undrained	20.00000	1.00000	1.00000	1.00000	2.44949	2.44949	1.00000	*Calculated*
2	LC (weathered)-Drained	20.00000	1.00000	0.36762	3.22452	1.21264	3.59139	0.25000	*Calculated*
3	LC-Undrained	20.00000	1.00000	1.00000	1.00000	2.44949	2.44949	1.00000	*Calculated*
4	LC-Drained	20.00000	1.00000	0.36762	3.22452	1.21264	3.59139	0.25000	*Calculated*

No.	c0	y0	Gradient of c	E0	Gradient of E	Drained/
	[kN/m²]	[m]	[kN/m²/m]	[kN/m²]	[kN/m²/m]	**Undrained**
1	60.00000	22.00000	0.00000	60000	0.0	Undrained
2	0.00000	22.00000	0.00000	45000	0.0	Drained
3	80.00000	21.60000	5.00000	80000	5000.0	Undrained
4	0.00000	21.60000	0.00000	60000	3750.0	Drained

Parameters used to calculate Earth pressure coefficients

No.	Phi [°]	Delta/Phi Ratio	Beta [°]	Cw/C Ratio
1	0.00000	0.00000	0.00000	0.50000
2	24.00000	0.67000	0.00000	0.00000
3	0.00000	0.00000	0.00000	0.50000
4	24.00000	0.67000	0.00000	0.00000

Partial factor sets

Factor Set	Tan phi	Cohesion	Undrained cohesion	Young's modulus	Live (restoring)	Live (disturbing)	Dead (restoring)	Dead (disturbing)
DA1-1	1.00000	1.00000	1.00000	1.00000	0.00000	1.11110	1.00000	1.00000
DA1-2	1.25000	1.25000	1.40000	1.00000	0.00000	1.30000	1.00000	1.00000

Soil Strength Partial Factors

Name of Partial Factors:	tan Phi'	c'	Cu	E
DA1-1	1.00000	1.00000	1.00000	1.00000

Note: Only the parameters in bold have been affected by Partial Factors, No geometry or other factors have been changed.

Design Soil properties after applying Partial Factors

No.	Unit Wt	K0	Ka	Kp	Kac	Kpc	Kr	Earth pressure coefficients.
	[kN/m3]							
1	20.00000	1.00000	**1.00000**	**1.00000**	**2.44949**	**2.44949**	1.00000	Calculated
2	20.00000	1.00000	**0.36762**	**3.22452**	**1.21264**	**3.59139**	0.25000	Calculated
3	20.00000	1.00000	**1.00000**	**1.00000**	**2.44949**	**2.44949**	1.00000	Calculated
4	20.00000	1.00000	**0.36762**	**3.22452**	**1.21264**	**3.59139**	0.25000	Calculated

No.	c0	y0	Gradient of c	E0	Gradient of E	Drained/
	[kN/m2]	[m]	[kN/m2/m]	[kN/m2]	[kN/m2/m]	**Undrained**
1	**60.00000**	22.00000	**0.00000**	**60000**	**0.00000**	Undrained
2	**0.00000**	22.00000	**0.00000**	**45000**	**0.00000**	Drained
3	**80.00000**	21.60000	**5.00000**	**80000**	**5000.00000**	Undrained
4	**0.00000**	21.60000	**0.00000**	**60000**	**3750.00000**	Drained

Parameters used to calculate design Earth pressure coefficients

No.	Phi [°]	Delta/Phi Ratio	Beta [°]	Cw/C Ratio
1	**0.00000**	0.00000	0.00000	0.50000
2	**24.00000**	0.67000	0.00000	0.00000
3	**0.00000**	0.00000	0.00000	0.50000
4	**24.00000**	0.67000	0.00000	0.00000

Surcharge properties

No.	Stage In	Stage Out	Side	Level [m]	Pressure [kN/m²]	Factor Type	Partial Factor	Offset [m]	Width [m]	Ks
1	0	2	Right	22.00000	36.00000	Tan	0.00000			

No.	Stage In	Stage Out	Side	Level [m]	Pressure [kN/m²]	Factor Type	Partial Factor	Offset [m]	Width [m]	Ks
2	0	2	Left	22.00000	36.00000	phi Tan	1.00000			
3	2	-	Left	22.00000	45.00000	phi Tan	0.00000			
4	1	10	Left	22.00000	10.00000	phi Tan	1.00000			
5	6	-	Right	18.80000	12.50000	phi Tan	1.00000			
6	10	-	Left	22.00000	45.00000	phi Tan	1.00000			
7	10	-	Left	22.00000	10.00000	phi Tan	1.00000			

Note: Only the parameters in bold have been affected by Partial Factors.

Surcharge Design properties

No.	Stage In	Stage Out	Side	Level [m]	Pressure [kN/m²]	Offset [m]	Width [m]	Ks
1	0	2	Right	22.00000	**36.00000**			
2	0	2	Left	22.00000	36.00000			
3	2	-	Left	22.00000	**45.00000**			
4	1	10	Left	22.00000	11.11100			
5	6	-	Right	18.80000	12.50000			
6	10	-	Left	22.00000	45.00000			
7	10	-	Left	22.00000	11.11100			

Strut properties

No.	Stage In	Stage Out	Node	Level [m]	Prestress [kN/m]	Stiffness [kN/m/m]	Angle [°]	Lever arm [m]
1	4	9	6	22.40000	0.0	40000.	0.00000	0.00000
2	8	11	2	23.60000	0.0	3.6267E+6	0.00000	0.00000
3	7	11	17	19.55000	0.0	4.5333E+6	0.00000	0.00000
4	11	-	2	23.60000	0.0	1.8133E+6	0.00000	0.00000
5	11	-	17	19.55000	0.0	2.2667E+6	0.00000	0.00000

STAGE 0 : INITIAL CONDITION

Ground level [m] LEFT: 22.00 RIGHT: 22.00 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Analysis details

SAFE model with redistribution
and with friction at wall/soil interface

	Left	Right
E profile Generated		
Boundary distances [m] :	50.00000	3.75000

Convergence control parameters

Maximum number of iterations : 900
Tolerance for displacement convergence [mm] : 0.01000
Tolerance for pressure convergence [kN/m²] : 0.10000
Damping coefficient : 1.00000
Maximum incremental displacement [m] : 1.00000

RESULTS FOR STAGE 0 : Initial condition (DA1-1)

Warning: Frew has features to simplify application of partial factors in line with various code standards. However, there are alternative ways of complying with these standards, including manual adjustment of certain values. The features in the program do not automatically make a design code compliant and the user must continue to check the output carefully to ensure the assumptions and adjustments to characteristic values are as they require.
Note that pore pressures and strut pre-stress are not factored. If a strut pre-stress is used to model a structural force, and other effects of actions are being factored, the user

	Left	Right

may wish to factor the input value of strut pre-stress.

Surcharge, strut or wall load changes
Surcharge no. 1 applied at this stage
Surcharge no. 2 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	0.0	0.0	0.0
Dig level (L)	8	21.90000	0.0	0.0	0.0

STAGE 1 : INSTALL WALL

Ground level [m] LEFT: 22.00 RIGHT: 22.00 Soil zones changed and wall EI changed

Analysis details
SAFE model with redistribution
and with friction at wall/soil interface

	Left	Right
E profile Generated		
Boundary distances [m] :	50.00000	3.75000

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 1 : Install wall (DA1-1)

Surcharge, strut or wall load changes
Surcharge no. 4 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	0.33096	0.0	0.0
Dig level (L)	8	21.90000	0.31265	0.0	-0.11362
Max Shear	13	20.63571	0.30036	0.072708	-0.16659
Max BM	19	18.95000	0.28251	0.22254	0.0065219
Wall toe	35	14.00000	0.21385	421.18E-12	-60.382E-12

STAGE 2 : CAST B1 RAFT

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 2 : Cast B1 raft (DA1-1)

Surcharge, strut or wall load changes
Surcharge no. 1 removed at this stage
Surcharge no. 2 removed at this stage
Surcharge no. 3 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	1.6713	0.0	0.0
Dig level (L)	8	21.90000	1.5789	0.0	-0.57376
Max Shear	13	20.63571	1.5168	0.36718	-0.84126
Max BM	19	18.95000	1.4267	1.1239	0.032936
Wall toe	35	14.00000	1.0800	2.1273E-9	-304.92E-12

STAGE 3 : PARTIAL EXCAVATION TO +20.5MOD

Ground level [m] LEFT: 22.00 RIGHT: 20.50 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	20.50000	0.00000	10.00000

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 3 : Partial excavation to +20.5mOD (DA1-1)

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.2340	0.0	0.0
Dig level (L)	8	21.90000	4.0589	0.0	0.067003
Max Shear	13	20.63571	3.2819	-12.973	37.437
Dig level (R)	14	20.36429	3.1236	-25.738	33.292
Max BM	16	19.82143	2.8414	-32.835	1.8701
Wall toe	35	14.00000	1.6876	5.7776E-9	-709.64E-12

STAGE 4 : INSTALL TEMPORARY PROP AT +22.4MOD

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 4 : Install temporary prop at +22.4mOD (DA1-1)

Surcharge, strut or wall load changes

Strut no. 1 inserted at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.2340	0.0	0.0
Above strut 1	6	22.40000	4.3682	0.0	0.0
Below strut 1				0.0	-0.0013445
Dig level (L)	8	21.90000	4.0590	672.26E-6	0.066139

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Max Shear	13	20.63571	3.2819	-12.974	37.436
Dig level (R)	14	20.36429	3.1236	-25.739	33.292
Max BM	16	19.82143	2.8414	-32.835	1.8694
Wall toe	35	14.00000	1.6876	5.7778E-9	-709.67E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	0.00100	0.00100	0.00000	0.00100

Factored Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	0.00134	0.00134	0.00000	0.00134

STAGE 5 : EXCAVATION TO FL +18.8MOD(ALLOW 0.5M UNPLANNED EXC)

Ground level [m] LEFT: 22.00 RIGHT: 18.80 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	18.80000	0.00000	10.00000

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 5 : Excavation to FL +18.8mOD(allow 0.5m unplanned exc) (DA1-1)

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	4.9706	0.0	0.0
Above strut 1	6	22.40000	5.2373	0.0	0.0
Below strut 1				0.0	-46.936
Dig level (L)	8	21.90000	5.3269	23.468	-42.432
Max BM	15	20.09286	5.1946	64.972	4.0665
Max Shear	19	18.95000	4.5411	22.692	80.881
Dig level (R)	20	18.65000	4.3222	-5.8641	74.256
Wall toe	35	14.00000	2.4149	6.9113E-9	-728.16E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	34.76722	34.76721	0.00000	34.76722

Factored Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	46.93574	46.93574	0.00000	46.93574

STAGE 6 : CAST B02 SLAB_WET CONCRETE

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]

Minimum equivalent fluid pressure parameters

Material	Left a	Left yo	Left b	Right a	Right yo	Right b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 6 : Cast B02 slab_wet concrete (DA1-1)

Surcharge, strut or wall load changes

Surcharge no. 5 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.0197	0.0	0.0
Above strut 1	6	22.40000	5.1999	0.0	0.0
Below strut 1				0.0	-44.916
Dig level (L)	8	21.90000	5.2588	22.458	-40.868
Max BM	15	20.09286	5.0302	63.775	4.0449
Max Shear	19	18.95000	4.3289	20.554	82.936
Dig level (R)	20	18.65000	4.0997	-8.7414	75.949
Wall toe	35	14.00000	2.1850	6.9330E-9	-768.26E-12

Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6	33.27076	33.27076	0.00000	34.76722

Factored Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6	44.91553	44.91553	0.00000	46.93574

STAGE 7 : CAST B02 SLAB

Minimum equivalent fluid pressure parameters

Material	Left a	Left yo	Left b	Right a	Right yo	Right b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 7 : Cast B02 slab (DA1-1)

Surcharge, strut or wall load changes

Strut no. 3 inserted at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.0197	0.0	0.0
Above strut 1	6	22.40000	5.1999	0.0	0.0
Below strut 1				0.0	-44.916
Dig level (L)	8	21.90000	5.2588	22.458	-40.868
Max BM	15	20.09286	5.0302	63.775	4.0449
Above strut 3	17	19.55000	4.7461	54.242	34.536

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Below strut 3				54.242	34.536
Max Shear	19	18.95000	4.3289	20.554	82.936
Dig level (R)	20	18.65000	4.0997	-8.7414	75.949
Wall toe	35	14.00000	2.1850	6.9476E-9	-770.89E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	33.27077	33.27077	0.00000	34.76722
3	17	-0.00000	-0.00000	0.00000	0.00000

Factored Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	44.91554	44.91553	0.00000	46.93574
3	17	-0.00000	-0.00000	0.00000	0.00000

STAGE 8 : CAST B1 ROOF SLAB

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 8 : Cast B1 roof slab (DA1-1)

Surcharge, strut or wall load changes

Strut no. 2 inserted at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.0197	0.0	0.0
Above strut 2	2	23.60000	5.0454	0.0	0.0
Below strut 2				0.0	3.6885E-6
Above strut 1	6	22.40000	5.1999	-4.4262E-6	3.6885E-6
Below strut 1				-4.4262E-6	-44.916
Dig level (L)	8	21.90000	5.2588	22.458	-40.868
Max BM	15	20.09286	5.0302	63.775	4.0449
Above strut 3	17	19.55000	4.7461	54.242	34.536
Below strut 3				54.242	34.536
Max Shear	19	18.95000	4.3289	20.554	82.936
Dig level (R)	20	18.65000	4.0997	-8.7414	75.949
Wall toe	35	14.00000	2.1850	6.9544E-9	-770.84E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	33.27077	33.27077	0.00000	34.76722
2	2	-0.00000	-0.00000	0.00000	0.00000
3	17	-0.00001	-0.00001	0.00000	0.00001

Factored Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	44.91554	44.91554	0.00000	46.93574
2	2	-0.00000	-0.00000	0.00000	0.00000
3	17	-0.00001	-0.00001	0.00000	0.00001

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]

STAGE 9 : REMOVE TEMPORARY PROP

Minimum equivalent fluid pressure parameters

Material	Left a	Left yo	Left b	Right a	Right yo	Right b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 9 : Remove temporary prop (DA1-1)

Surcharge, strut or wall load changes

Strut no. 1 removed at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	4.9918	0.0	0.0
Above strut 2	2	23.60000	5.0506	0.0	0.0
Below strut 2				0.0	-25.225
Dig level (L)	8	21.90000	5.4293	42.883	-21.799
Max BM	14	20.36429	5.1965	60.861	4.8087
Above strut 3	17	19.55000	4.7497	42.185	47.122
Below strut 3				42.185	25.650
Max Shear	19	18.95000	4.3110	13.336	75.764
Dig level (R)	20	18.65000	4.0774	-13.940	69.776
Wall toe	35	14.00000	2.1835	7.0442E-9	-781.30E-12

Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6				34.76722
2	2	18.68546	18.68546	0.00000	18.68546
3	17	15.90525	15.90525	0.00000	15.90525

Factored Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6				46.93574
2	2	25.22537	25.22537	0.00000	25.22537
3	17	21.47209	21.47209	0.00000	21.47209

STAGE 10 : LONG TERM SOIL CONDITIONS

Ground level [m] LEFT: 22.00 RIGHT: 18.80 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	18.80000	0.00000	10.00000
2	18.80000	32.00000	10.00000

Minimum equivalent fluid pressure parameters

Material	Left a	Left yo	Left b	Right a	Right yo	Right b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 10 : Long term soil conditions (DA1-1)

Surcharge, strut or wall load changes

Surcharge no. 4 removed at this stage
Surcharge no. 6 applied at this stage
Surcharge no. 7 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	4.9441	0.0	0.0
Above strut 2	2	23.60000	5.0551	0.0	0.0
Below strut 2				0.0	-47.072
Dig level (L)	8	21.90000	5.7720	80.022	-40.229
Max BM	11	21.21190	5.7584	94.678	-1.7192
Above strut 3	17	19.55000	4.7778	-5.4517	131.87
Below strut 3				-5.4517	-62.104
Dig level (R)	20	18.65000	4.0302	10.440	15.526
Wall toe	35	14.00000	1.0083	7.3494E-9	-818.11E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6				34.76722
2	2	34.86790	34.86790	0.00000	34.86790
3	17	143.68361	143.68361	0.00000	143.68361

Factored Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6				46.93574
2	2	47.07166	47.07166	0.00000	47.07166
3	17	193.97288	193.97287	0.00000	193.97288

STAGE 11 : CONCRETE RELAXATION

Analysis details

SAFE model with redistribution
and with friction at wall/soil interface

	Left	Right
E profile Generated		
Boundary distances [m] :	50.00000	3.75000
Wall relaxation	30%	

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 11 : Concrete relaxation (DA1-1)

Surcharge, strut or wall load changes

Strut no. 2 removed at this stage
Strut no. 3 removed at this stage
Strut no. 4 inserted at this stage
Strut no. 5 inserted at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	4.9238	0.0	0.0
Above strut 4	2	23.60000	5.0727	0.0	0.0
Below strut 4				0.0	-43.086
Dig level (L)	8	21.90000	6.0423	73.247	-36.449
Max BM	11	21.21190	6.0380	85.538	2.2833
Above strut 5	17	19.55000	4.8453	-21.463	136.17
Below strut 5				-21.463	-70.187
Dig level (R)	20	18.65000	4.0220	1.6495	6.8823
Wall toe	35	14.00000	1.0273	5.8451E-9	-629.18E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6				34.76722
2	2				34.86790
3	17				143.68361
4	2	31.91571	31.91571	0.00000	31.91571
5	17	152.85497	152.85497	0.00000	152.85497

Factored Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6				46.93574
2	2				47.07166
3	17				193.97288
4	2	43.08621	43.08621	0.00000	43.08621
5	17	206.35422	206.35421	0.00000	206.35422

Results Envelope

Node	Level [m]	Displacements [mm] Min	Displacements [mm] Max	Moments [kNm/m] Min	Moments [kNm/m] Max	Shears [kN/m] Min	Shears [kN/m] Max
1	23.80000	0.33096	5.23405	0.00000	0.00000	0.00000	0.00000
2	23.60000	0.32903	5.11036	0.00000	0.00000	-47.07166	0.00000
3	23.30000	0.32614	5.29439	-0.00000	14.12155	-47.07166	0.00000
4	23.00000	0.32325	5.50635	-0.00000	28.24302	-47.07166	0.00000
5	22.70000	0.32036	5.69880	-0.00000	42.36448	-47.07166	0.00000
6	22.40000	0.31746	5.86197	-0.00000	56.48603	-47.07166	0.00000
7	22.10000	0.31457	5.98610	0.00000	70.60749	-47.07166	0.00000
8	21.90000	0.31265	6.04234	0.00000	80.02186	-42.43228	0.06700
9	21.70000	0.31072	6.07416	-0.02680	86.69909	-37.17123	0.33570
10	21.50000	0.30878	6.07949	-0.13361	91.49930	-34.37940	2.15426
11	21.21190	0.30598	6.03802	-1.21994	94.67815	-29.73481	8.36296
12	20.92381	0.30318	5.93762	-4.95227	92.48987	-23.82827	21.70594
13	20.63571	0.30036	5.78067	-12.97449	84.49516	-16.24044	42.35462
14	20.36429	0.29767	5.58674	-25.73882	71.24806	-7.06904	63.82793
15	20.09286	0.29493	5.35717	-31.04709	64.97214	-0.66530	86.35219
16	19.82143	0.29212	5.10453	-32.83547	62.25364	-0.50160	110.23876
17	19.55000	0.28923	4.93462	-32.06190	55.59690	-70.18707	136.16716
18	19.25000	0.28593	4.74885	-29.46287	42.66446	-41.38722	56.14731
19	18.95000	0.28251	4.54114	-25.86114	22.69167	-12.59004	82.93621
20	18.65000	0.27897	4.32220	-21.90884	10.44000	-13.06045	75.94909
21	18.34000	0.27520	4.09817	-29.01536	5.06898	-12.44201	41.52024
22	18.03000	0.27131	3.88606	-36.59785	0.95984	-11.19381	20.99333
23	17.72000	0.26731	3.69110	-38.75023	0.88193	-9.62791	21.91842
24	17.41000	0.26322	3.51534	-37.44440	0.80495	-7.99392	21.61945
25	17.10000	0.25903	3.35876	-34.12359	0.73214	-12.50987	20.13747
26	16.79000	0.25477	3.21999	-30.00148	0.66440	-14.78034	17.45228
27	16.48000	0.25043	3.09698	-32.17138	0.60280	-15.24489	13.48254
28	16.17000	0.24602	2.98737	-35.63196	0.54551	-14.59168	8.08741
29	15.86000	0.24155	2.88873	-37.18557	0.48950	-13.43789	1.81371
30	15.55000	0.23702	2.79878	-36.29252	0.43059	-11.99190	0.20183
31	15.24000	0.23245	2.71541	-32.33174	0.36436	-18.85870	0.23172
32	14.93000	0.22784	2.63679	-24.60014	0.28693	-27.04496	0.27038
33	14.62000	0.22319	2.56134	-15.56387	0.19673	-28.45131	0.30500
34	14.31000	0.21853	2.48774	-6.96033	0.09782	-25.10302	0.31730
35	***14.00000***	***0.21385***	***2.41494***	***0.00000***	***0.00000***	***-0.00000***	***0.00000***
36	13.68182	0.20861	2.35833	0.00000	0.00000	-0.00000	0.00000
37	13.36364	0.20337	2.29507	0.00000	0.00000	-0.00000	0.00000
38	13.04545	0.19806	2.22895	0.00000	0.00000	-0.00000	0.00000
39	12.72727	0.19262	2.16146	0.00000	0.00000	-0.00000	0.00000
40	12.40909	0.18704	2.09281	0.00000	0.00000	-0.00000	0.00000

Node	Level [m]	Displacements [mm] Min	Displacements [mm] Max	Moments [kNm/m] Min	Moments [kNm/m] Max	Shears [kN/m] Min	Shears [kN/m] Max
41	12.09091	0.18129	2.02290	0.00000	0.00000	-0.00000	0.00000
42	11.77273	0.17536	1.95149	0.00000	0.00000	-0.00000	0.00000
43	11.45455	0.16921	1.87828	0.00000	0.00000	-0.00000	0.00000
44	11.13636	0.16281	1.80289	0.00000	0.00000	-0.00000	0.00000
45	10.81818	0.15611	1.72486	0.00000	0.00000	-0.00000	0.00000
46	10.50000	0.14909	1.64366	0.00000	0.00000	-0.00000	0.00000
47	10.18182	0.14166	1.55865	0.00000	0.00000	-0.00000	0.00000
48	9.86364	0.13378	1.46904	0.00000	0.00000	-0.00000	0.00000
49	9.54545	0.12534	1.37385	0.00000	0.00000	-0.00000	0.00000
50	9.22727	0.11623	1.27183	0.00000	0.00000	-0.00000	0.00000
51	8.90909	0.10630	1.16128	0.00000	0.00000	-0.00000	0.00000
52	8.59091	0.09534	1.03999	0.00000	0.00000	-0.00000	0.00000
53	8.27273	0.08305	0.90463	0.00000	0.00000	-0.00000	0.00000
54	7.95455	0.06895	0.75005	0.00000	0.00000	-0.00000	0.00000
55	7.63636	0.05216	0.56685	0.00000	0.00000	-0.00000	0.00000
56	7.31818	0.03054	0.33176	0.00000	0.00000	-0.00000	0.00000
57	7.00000	0.00000	0.00000	0.00000	0.00000	-0.00000	0.00000

INITIAL DATA

Soil properties

No.	Description	Unit Wt	K0	Ka	Kp	Kac	Kpc	Kr	Earth pressure coefficients.
		[kN/m³]							
1	LC (weathered)-Undrained	20.00000	1.00000	1.00000	1.00000	2.44949	2.44949	1.00000	*Calculated*
2	LC (weathered)-Drained	20.00000	1.00000	0.36762	3.22452	1.21264	3.59139	0.25000	*Calculated*
3	LC-Undrained	20.00000	1.00000	1.00000	1.00000	2.44949	2.44949	1.00000	*Calculated*
4	LC-Drained	20.00000	1.00000	0.36762	3.22452	1.21264	3.59139	0.25000	*Calculated*

No.	c0	y0	Gradient of c	E0	Gradient of E	Drained/
	[kN/m²]	[m]	[kN/m²/m]	[kN/m²]	[kN/m²/m]	**Undrained**
1	60.00000	22.00000	0.00000	60000	0.0	Undrained
2	0.00000	22.00000	0.00000	45000	0.0	Drained
3	80.00000	21.60000	5.00000	80000	5000.0	Undrained
4	0.00000	21.60000	0.00000	60000	3750.0	Drained

Parameters used to calculate Earth pressure coefficients

No.	Phi [°]	Delta/Phi Ratio	Beta [°]	Cw/C Ratio
1	0.00000	0.00000	0.00000	0.50000
2	24.00000	0.67000	0.00000	0.00000
3	0.00000	0.00000	0.00000	0.50000
4	24.00000	0.67000	0.00000	0.00000

Partial factor sets

Factor Set	Tan phi	Cohesion	Undrained cohesion	Young's modulus	Live (restoring)	Live (disturbing)	Dead (restoring)	Dead (disturbing)
DA1-1	1.00000	1.00000	1.00000	1.00000	0.00000	1.11110	1.00000	1.00000
DA1-2	1.25000	1.25000	1.40000	1.00000	0.00000	1.30000	1.00000	1.00000

Soil Strength Partial Factors

Name of Partial Factors:	tan Phi'	c'	Cu	E
DA1-2	1.25000	1.25000	1.40000	1.00000

Note: Only the parameters in bold have been affected by Partial Factors, No geometry or other factors have been changed.

Design Soil properties after applying Partial Factors

No.	Unit Wt	K0	Ka	Kp	Kac	Kpc	Kr	Earth pressure coefficients.
	[kN/m3]							
1	20.00000	1.00000	**1.00000**	**1.00000**	**2.44949**	**2.44949**	1.00000	Calculated
2	20.00000	1.00000	**0.44128**	**2.53036**	**1.32858**	**3.18142**	0.25000	Calculated
3	20.00000	1.00000	**1.00000**	**1.00000**	**2.44949**	**2.44949**	1.00000	Calculated
4	20.00000	1.00000	**0.44128**	**2.53036**	**1.32858**	**3.18142**	0.25000	Calculated

No.	c0	y0	Gradient of c	E0	Gradient of E	Drained/
	[kN/m2]	[m]	[kN/m2/m]	[kN/m2]	[kN/m2/m]	**Undrained**
1	**42.85714**	22.00000	**0.00000**	**60000**	**0.00000**	Undrained
2	**0.00000**	22.00000	**0.00000**	**45000**	**0.00000**	Drained
3	**57.14286**	21.60000	**3.57143**	**80000**	**5000.00000**	Undrained
4	**0.00000**	21.60000	**0.00000**	**60000**	**3750.00000**	Drained

Parameters used to calculate design Earth pressure coefficients

No.	Phi [°]	Delta/Phi Ratio	Beta [°]	Cw/C Ratio
1	**0.00000**	0.00000	0.00000	0.50000
2	**19.60503**	0.67000	0.00000	0.00000
3	**0.00000**	0.00000	0.00000	0.50000
4	**19.60503**	0.67000	0.00000	0.00000

Surcharge properties

No.	Stage In	Stage Out	Side	Level [m]	Pressure [kN/m²]	Factor Type	Partial Factor	Offset [m]	Width [m]	Ks
1	0	2	Right	22.00000	36.00000	Tan	0.00000			

No.	Stage In	Stage Out	Side	Level [m]	Pressure [kN/m²]	Factor Type	Partial Factor	Offset [m]	Width [m]	Ks
2	0	2	Left	22.00000	36.00000	phi Tan	1.00000			
3	2	-	Left	22.00000	45.00000	phi Tan	0.00000			
4	1	10	Left	22.00000	10.00000	phi Tan	1.00000			
5	6	-	Right	18.80000	12.50000	phi Tan	1.00000			
6	10	-	Left	22.00000	45.00000	phi Tan	1.00000			
7	10	-	Left	22.00000	10.00000	phi Tan	1.00000			

Note: Only the parameters in bold have been affected by Partial Factors.

Surcharge Design properties

No.	Stage In	Stage Out	Side	Level [m]	Pressure [kN/m²]	Offset [m]	Width [m]	Ks
1	0	2	Right	22.00000	**36.00000**			
2	0	2	Left	22.00000	36.00000			
3	2	-	Left	22.00000	**45.00000**			
4	1	10	Left	22.00000	13.00000			
5	6	-	Right	18.80000	12.50000			
6	10	-	Left	22.00000	45.00000			
7	10	-	Left	22.00000	13.00000			

Strut properties

No.	Stage In	Stage Out	Node	Level [m]	Prestress [kN/m]	Stiffness [kN/m/m]	Angle [°]	Lever arm [m]
1	4	9	6	22.40000	0.0	40000.	0.00000	0.00000
2	8	11	2	23.60000	0.0	3.6267E+6	0.00000	0.00000
3	7	11	17	19.55000	0.0	4.5333E+6	0.00000	0.00000
4	11	-	2	23.60000	0.0	1.8133E+6	0.00000	0.00000
5	11	-	17	19.55000	0.0	2.2667E+6	0.00000	0.00000

STAGE 0 : INITIAL CONDITION

Ground level [m] LEFT: 22.00 RIGHT: 22.00 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Analysis details

SAFE model with redistribution
and with friction at wall/soil interface

	Left	Right
E profile Generated		
Boundary distances [m] :	50.00000	3.75000

Convergence control parameters

Maximum number of iterations : 900
Tolerance for displacement convergence [mm] : 0.01000
Tolerance for pressure convergence [kN/m²] : 0.10000
Damping coefficient : 1.00000
Maximum incremental displacement [m] : 1.00000

RESULTS FOR STAGE 0 : Initial condition (DA1-2)

Surcharge, strut or wall load changes

Surcharge no. 1 applied at this stage
Surcharge no. 2 applied at this stage

Summary Results

Node	Level	Displacement	Moment	Shear

		[m]	[mm]	[kNm/m]	[kN/m]
Top wall node	1	23.80000	0.0	0.0	0.0
Dig level (L)	8	21.90000	0.0	0.0	0.0

STAGE 1 : INSTALL WALL

Ground level [m] LEFT: 22.00 RIGHT: 22.00 Soil zones changed and wall EI changed

Analysis details

SAFE model with redistribution
and with friction at wall/soil interface

	Left	Right
E profile Generated		
Boundary distances [m] :	50.00000	3.75000

Minimum equivalent fluid pressure parameters

Material	Left			Right		
	a	yo	b	a	yo	b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 1 : Install wall (DA1-2)

Surcharge, strut or wall load changes

Surcharge no. 4 applied at this stage

Summary Results

Node		Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	0.38722	0.0	0.0
Dig level (L)	8	21.90000	0.36580	0.0	-0.098468
Max Shear	13	20.63571	0.35142	0.063014	-0.14438
Max BM	19	18.95000	0.33054	0.19287	0.0056524
Wall toe	35	14.00000	0.25021	365.20E-12	-52.365E-12

STAGE 2 : CAST B1 RAFT

Minimum equivalent fluid pressure parameters

Material	Left			Right		
	a	yo	b	a	yo	b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 2 : Cast B1 raft (DA1-2)

Surcharge, strut or wall load changes

Surcharge no. 1 removed at this stage
Surcharge no. 2 removed at this stage
Surcharge no. 3 applied at this stage

Summary Results

Node		Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	1.7276	0.0	0.0
Dig level (L)	8	21.90000	1.6320	0.0	-0.43932
Max Shear	13	20.63571	1.5679	0.28114	-0.64414
Max BM	19	18.95000	1.4747	0.86051	0.025218
Wall toe	35	14.00000	1.1163	1.6290E-9	-233.54E-12

Node	Level	Displacement	Moment	Shear
		[mm]	[kNm/m]	[kN/m]
	[m]			

STAGE 3 : PARTIAL EXCAVATION TO +20.5MOD

Ground level [m] LEFT: 22.00 RIGHT: 20.50 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	20.50000	0.00000	10.00000

Minimum equivalent fluid pressure parameters

Material	Left			Right		
	a [kN/m²/m]	yo [m]	b [kN/m²]	a [kN/m²/m]	yo [m]	b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 3 : Partial excavation to +20.5mOD (DA1-2)

Summary Results

	Node	Level	Displacement	Moment	Shear
			[mm]	[kNm/m]	[kN/m]
		[m]			
Top wall node	1	23.80000	5.3699	0.0	0.0
Dig level (L)	8	21.90000	4.1607	0.0	0.049642
Max Shear	13	20.63571	3.3612	-9.9476	28.510
Dig level (R)	14	20.36429	3.1984	-19.656	25.319
Max BM	16	19.82143	2.9083	-25.049	1.4055
Wall toe	35	14.00000	1.7249	4.3880E-9	-539.79E-12

STAGE 4 : INSTALL TEMPORARY PROP AT +22.4MOD

Minimum equivalent fluid pressure parameters

Material	Left			Right		
	a [kN/m²/m]	yo [m]	b [kN/m²]	a [kN/m²/m]	yo [m]	b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 4 : Install temporary prop at +22.4mOD (DA1-2)

Surcharge, strut or wall load changes

Strut no. 1 inserted at this stage

Summary Results

	Node	Level	Displacement	Moment	Shear
			[mm]	[kNm/m]	[kN/m]
		[m]			
Top wall node	1	23.80000	5.3699	0.0	0.0
Above strut 1	6	22.40000	4.4790	0.0	0.0
Below strut 1				0.0	-968.33E-6
Dig level (L)	8	21.90000	4.1608	484.17E-6	0.049020
Max Shear	13	20.63571	3.3612	-9.9486	28.510
Dig level (R)	14	20.36429	3.1984	-19.657	25.318
Max BM	16	19.82143	2.9083	-25.049	1.4050
Wall toe	35	14.00000	1.7249	4.3881E-9	-539.79E-12

Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force

		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6	0.00097	0.00097	0.00000	0.00097

STAGE 5 : EXCAVATION TO FL +18.8MOD(ALLOW 0.5M UNPLANNED EXC)

Ground level [m] LEFT: 22.00 RIGHT: 18.80 Soil zones changed

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	18.80000	0.00000	10.00000

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 5 : Excavation to FL +18.8mOD(allow 0.5m unplanned exc) (DA1-2)

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.1014	0.0	0.0
Above strut 1	6	22.40000	5.3688	0.0	0.0
Below strut 1				0.0	-35.596
Dig level (L)	8	21.90000	5.4585	17.798	-32.189
Max BM	15	20.09286	5.3159	49.277	2.8989
Max Shear	19	18.95000	4.6418	17.846	60.293
Dig level (R)	20	18.65000	4.4155	-3.4499	58.176
Wall toe	35	14.00000	2.4543	5.2522E-9	-556.28E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	35.59602	35.59602	0.00000	35.59602

STAGE 6 : CAST B02 SLAB_WET CONCRETE

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 6 : Cast B02 slab_wet concrete (DA1-2)

Surcharge, strut or wall load changes

Surcharge no. 5 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.1505	0.0	0.0

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Above strut 1	6	22.40000	5.3314	0.0	0.0
Below strut 1				0.0	-34.100
Dig level (L)	8	21.90000	5.3904	17.050	-31.030
Max BM	15	20.09286	5.1515	48.390	2.8828
Max Shear	19	18.95000	4.4295	16.263	61.816
Dig level (R)	20	18.65000	4.1930	-5.5813	59.431
Wall toe	35	14.00000	2.2244	5.2685E-9	-586.05E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	34.09957	34.09957	0.00000	35.59602

STAGE 7 : CAST B02 SLAB

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 7 : Cast B02 slab (DA1-2)

Surcharge, strut or wall load changes

Strut no. 3 inserted at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.1505	0.0	0.0
Above strut 1	6	22.40000	5.3314	0.0	0.0
Below strut 1				0.0	-34.100
Dig level (L)	8	21.90000	5.3904	17.050	-31.030
Max BM	15	20.09286	5.1515	48.390	2.8828
Above strut 3	17	19.55000	4.8591	41.343	25.661
Below strut 3				41.343	25.661
Max Shear	19	18.95000	4.4295	16.263	61.816
Dig level (R)	20	18.65000	4.1930	-5.5813	59.431
Wall toe	35	14.00000	2.2244	5.2576E-9	-584.05E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6	34.09957	34.09957	0.00000	35.59602
3	17	-0.00000	-0.00000	0.00000	0.00000

STAGE 8 : CAST B1 ROOF SLAB

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 8 : Cast B1 roof slab (DA1-2)

Surcharge, strut or wall load changes

Strut no. 2 inserted at this stage

Material	Left			Right		
	a	yo	b	a	yo	b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]

Summary Results

	Node	Level	Displacement	Moment	Shear
		[m]	[mm]	[kNm/m]	[kN/m]
Top wall node	1	23.80000	5.1505	0.0	0.0
Above strut 2	2	23.60000	5.1763	0.0	0.0
Below strut 2				0.0	1.9064E-6
Above strut 1	6	22.40000	5.3314	-2.2876E-6	1.9064E-6
Below strut 1				-2.2876E-6	-34.100
Dig level (L)	8	21.90000	5.3904	17.050	-31.030
Max BM	15	20.09286	5.1515	48.390	2.8828
Above strut 3	17	19.55000	4.8591	41.343	25.661
Below strut 3				41.343	25.661
Max Shear	19	18.95000	4.4295	16.263	61.816
Dig level (R)	20	18.65000	4.1930	-5.5813	59.431
Wall toe	35	14.00000	2.2244	5.2472E-9	-582.98E-12

Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6	34.09957	34.09957	0.00000	35.59602
2	2	-0.00000	-0.00000	0.00000	0.00000
3	17	-0.00000	-0.00000	0.00000	0.00000

STAGE 9 : REMOVE TEMPORARY PROP

Minimum equivalent fluid pressure parameters

Material	Left			Right		
	a	yo	b	a	yo	b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 9 : Remove temporary prop (DA1-2)

Surcharge, strut or wall load changes

Strut no. 1 removed at this stage

Summary Results

	Node	Level	Displacement	Moment	Shear
		[m]	[mm]	[kNm/m]	[kN/m]
Top wall node	1	23.80000	5.1218	0.0	0.0
Above strut 2	2	23.60000	5.1816	0.0	0.0
Below strut 2				0.0	-19.151
Dig level (L)	8	21.90000	5.5652	32.557	-16.554
Max BM	14	20.36429	5.3225	46.146	3.5862
Above strut 3	17	19.55000	4.8627	32.190	35.215
Below strut 3				32.190	18.914
Max Shear	19	18.95000	4.4111	10.783	56.371
Dig level (R)	20	18.65000	4.1702	-9.5281	54.744
Wall toe	35	14.00000	2.2228	5.3013E-9	-589.01E-12

Strut Forces

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]
1	6				35.59602
2	2	19.15145	19.15145	0.00000	19.15145
3	17	16.30130	16.30129	0.00000	16.30130

STAGE 10 : LONG TERM SOIL CONDITIONS

Ground level [m] LEFT: 22.00 RIGHT: 18.80 Soil zones changed

No.	Node no.	Strut force	Horiz force	Moment	Max strut force
		[kN/m]	[kN/m]	[kNm/m]	[kN/m]

Water data on LEFT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	22.00000	0.00000	10.00000

Water data on RIGHT side

No.	Level [m]	Pressure [kN/m²]	Unit wt. [kN/m³]
1	18.80000	0.00000	10.00000
2	18.80000	32.00000	10.00000

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

RESULTS FOR STAGE 10 : Long term soil conditions (DA1-2)

Surcharge, strut or wall load changes

Surcharge no. 4 removed at this stage
Surcharge no. 6 applied at this stage
Surcharge no. 7 applied at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.0817	0.0	0.0
Above strut 2	2	23.60000	5.1859	0.0	0.0
Below strut 2				0.0	-34.663
Dig level (L)	8	21.90000	5.8467	58.927	-28.479
Max BM	11	21.21190	5.8136	66.364	6.2316
Above strut 3	17	19.55000	4.9038	-32.386	121.45
Below strut 3				-32.386	-81.249
Dig level (R)	20	18.65000	4.3610	6.4598	-12.911
Wall toe	35	14.00000	1.0987	5.5396E-9	-626.40E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6				35.59602
2	2	34.66279	34.66279	0.00000	34.66279
3	17	202.69521	202.69520	0.00000	202.69521

STAGE 11 : CONCRETE RELAXATION

Analysis details

SAFE model with redistribution
and with friction at wall/soil interface

	Left	Right
E profile Generated		
Boundary distances [m] :	50.00000	3.75000
Wall relaxation 30%		

Minimum equivalent fluid pressure parameters

Material	Left a [kN/m²/m]	Left yo [m]	Left b [kN/m²]	Right a [kN/m²/m]	Right yo [m]	Right b [kN/m²]
LC (weathered)-Undrained	5.00000	22.00000	0.00000	0.00000	0.00000	0.00000
LC (weathered)-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
LC-Undrained	5.00000	21.60000	0.00000	0.00000	0.00000	0.00000
LC-Drained	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Material	Left			Right		
	a	yo	b	a	yo	b
	[kN/m²/m]	[m]	[kN/m²]	[kN/m²/m]	[m]	[kN/m²]

RESULTS FOR STAGE 11 : Concrete relaxation (DA1-2)

Surcharge, strut or wall load changes

Strut no. 2 removed at this stage
Strut no. 3 removed at this stage
Strut no. 4 inserted at this stage
Strut no. 5 inserted at this stage

Summary Results

	Node	Level [m]	Displacement [mm]	Moment [kNm/m]	Shear [kN/m]
Top wall node	1	23.80000	5.0567	0.0	0.0
Above strut 4	2	23.60000	5.2039	0.0	0.0
Below strut 4				0.0	-32.750
Dig level (L)	8	21.90000	6.1515	55.674	-26.721
Max BM	11	21.21190	6.1296	62.393	7.6262
Above strut 5	17	19.55000	4.9943	-39.535	122.63
Below strut 5				-39.535	-82.457
Dig level (R)	20	18.65000	4.3901	0.90637	-14.742
Wall toe	35	14.00000	1.0974	4.8635E-9	-542.12E-12

Strut Forces

No.	Node no.	Strut force [kN/m]	Horiz force [kN/m]	Moment [kNm/m]	Max strut force [kN/m]
1	6				35.59602
2	2				34.66279
3	17				202.69521
4	2	32.74968	32.74968	0.00000	32.74968
5	17	205.09056	205.09056	0.00000	205.09056

Results Envelope

Node	Level [m]	Displacements [mm] Min	Displacements [mm] Max	Moments [kNm/m] Min	Moments [kNm/m] Max	Shears [kN/m] Min	Shears [kN/m] Max
1	23.80000	0.38722	5.36994	0.00000	0.00000	0.00000	0.00000
2	23.60000	0.38497	5.24266	0.00000	0.00000	-34.66279	0.00000
3	23.30000	0.38158	5.42308	-0.00000	10.39888	-34.66279	0.00000
4	23.00000	0.37820	5.63220	-0.00000	20.79769	-34.66279	0.00000
5	22.70000	0.37482	5.82130	-0.00000	31.19650	-34.66279	0.00000
6	22.40000	0.37144	5.98035	-0.00000	41.59538	-34.66279	0.00000
7	22.10000	0.36805	6.09935	0.00000	51.99419	-35.59602	0.00000
8	21.90000	0.36580	6.15148	0.00000	58.92677	-32.18926	0.04964
9	21.70000	0.36354	6.17858	-0.01986	63.38566	-28.21695	0.24870
10	21.50000	0.36128	6.17870	-0.09900	65.95087	-26.05794	1.68532
11	21.21190	0.35800	6.12957	-0.95529	66.36414	-22.48516	7.62618
12	20.92381	0.35472	6.02253	-3.82560	62.36026	-18.01623	24.60244
13	20.63571	0.35142	5.86192	-9.94865	53.29655	-12.30655	42.50845
14	20.36429	0.34828	5.66966	-19.65665	48.85664	-5.43120	61.00455
15	20.09286	0.34507	5.44957	-23.69282	49.27699	-0.50941	80.29348
16	19.82143	0.34178	5.21763	-25.04937	47.28298	-0.38406	100.64444
17	19.55000	0.33840	5.04758	-39.53542	42.34659	-82.45749	122.63306
18	19.25000	0.33454	4.85604	-22.47119	32.72607	-58.13805	41.80055
19	18.95000	0.33054	4.64177	-19.72382	17.84637	-31.94822	61.81579
20	18.65000	0.32640	4.41554	-16.70985	6.45980	-14.74151	59.43061
21	18.34000	0.32198	4.19250	-22.48084	9.29198	-9.48679	34.14423
22	18.03000	0.31743	3.99050	-28.35560	10.32991	-8.53456	15.19967
23	17.72000	0.31276	3.78227	-29.99908	10.05157	-7.34056	3.59135
24	17.41000	0.30797	3.58097	-28.94265	8.85924	-6.09482	4.78578
25	17.10000	0.30307	3.41964	-26.33295	7.08439	-9.78657	6.22249
26	16.79000	0.29808	3.27694	-23.11275	5.00129	-11.50098	6.84450
27	16.48000	0.29300	3.15067	-19.52286	2.84079	-11.82068	6.78232
28	16.17000	0.28784	3.03836	-15.93013	0.79626	-11.28212	6.14247
29	15.86000	0.28261	2.93745	-12.55266	0.37480	-10.36296	5.00918
30	15.55000	0.27732	2.84555	-9.50510	0.32970	-9.22595	3.45705
31	15.24000	0.27197	2.76048	-6.83257	0.27898	-8.00665	1.56721
32	14.93000	0.26657	2.68032	-4.54098	0.21969	-6.78723	0.20702
33	14.62000	0.26114	2.60344	-2.77266	0.15063	-5.55426	0.23353
34	14.31000	0.25568	2.52847	-1.63641	0.07490	-4.47204	0.24295
35	***14.00000***	***0.25021***	***2.45432***	***0.00000***	***0.00000***	***-0.00000***	***0.00000***
36	13.68182	0.24407	2.39689	0.00000	0.00000	-0.00000	0.00000
37	13.36364	0.23795	2.33257	0.00000	0.00000	-0.00000	0.00000
38	13.04545	0.23173	2.26532	0.00000	0.00000	-0.00000	0.00000
39	12.72727	0.22537	2.19666	0.00000	0.00000	-0.00000	0.00000
40	12.40909	0.21884	2.12683	0.00000	0.00000	-0.00000	0.00000

Node	Level [m]	Displacements [mm] Min	Displacements [mm] Max	Moments [kNm/m] Min	Moments [kNm/m] Max	Shears [kN/m] Min	Shears [kN/m] Max
41	12.09091	0.21212	2.05571	0.00000	0.00000	-0.00000	0.00000
42	11.77273	0.20517	1.98308	0.00000	0.00000	-0.00000	0.00000
43	11.45455	0.19798	1.90863	0.00000	0.00000	-0.00000	0.00000
44	11.13636	0.19049	1.83197	0.00000	0.00000	-0.00000	0.00000
45	10.81818	0.18266	1.75263	0.00000	0.00000	-0.00000	0.00000
46	10.50000	0.17443	1.67008	0.00000	0.00000	-0.00000	0.00000
47	10.18182	0.16575	1.58367	0.00000	0.00000	-0.00000	0.00000
48	9.86364	0.15652	1.49258	0.00000	0.00000	-0.00000	0.00000
49	9.54545	0.14665	1.39584	0.00000	0.00000	-0.00000	0.00000
50	9.22727	0.13599	1.29215	0.00000	0.00000	-0.00000	0.00000
51	8.90909	0.12437	1.17981	0.00000	0.00000	-0.00000	0.00000
52	8.59091	0.11155	1.05656	0.00000	0.00000	-0.00000	0.00000
53	8.27273	0.09717	0.91902	0.00000	0.00000	-0.00000	0.00000
54	7.95455	0.08067	0.76197	0.00000	0.00000	-0.00000	0.00000
55	7.63636	0.06103	0.57585	0.00000	0.00000	-0.00000	0.00000
56	7.31818	0.03574	0.33702	0.00000	0.00000	-0.00000	0.00000
57	7.00000	0.00000	0.00000	0.00000	0.00000	-0.00000	0.00000

Job number	281835
Job title	Euston Tower
Calculation heading	Basement 02 contig pile
By	DF

ARUP

1 Units

The following units are used throughout this calculation.

Force	kN	*Density*	t/m^3
Length	m	*Area*	mm^2
Section dimensions	mm	*Second moment of area*	mm^4
Stress	N/mm^2	*Section modulus*	mm^3
Strain	‰	*Area per unit length*	mm^2/m
Moment	kNm	*Angle*	°
Curvature	‰/m	*Axial stiffness*	kN
		Bending stiffness	kNm^2

2 Design code

The following design code is used: Eurocode 2 (part 1), National Annex: UK

3 Materials

The following materials are used in these calculations.

3.1 Concrete

- C32/40 -no permanent casing

Strength, f_{ck}:	$32\ N/mm^2$
Elastic modulus, E:	$33346\ N/mm^2$
Density, ρ:	$2.4\ t/m^3$

3.2 Reinforcement

- 500B

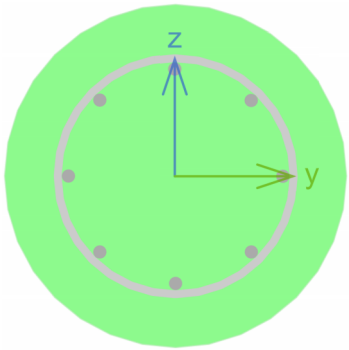
Strength, f_{yk}:	$500\ N/mm^2$
Elastic modulus, E:	$200e3\ N/mm^2$

Elastic modulus, E:

Density, ρ: 7.85 t/m^3

4 Sections

4.1 Section 1 (Circular RC column)



Definition		*Reinforcement*	
Material	Concrete	*Type*	*Description*
Grade	C32/40 -no permanent casing	*LINK*	B12
Profile	STD C 520	*PERIMETER*	8B20
Cover	75mm		

4.1.1 Analysis

4.1.1.1 ULS Results Summary

Case	*F_x (kN)*	*M_{yy} (kNm)*	*M_{zz} (kNm)*	*Utilisation*	*Status*
1	-22	114	0	62%	✓

4.1.1.2 SLS Results Summary

Case	*F_x (kN)*	*M_{yy} (kNm)*	*M_{zz} (kNm)*	*Cracked?*	*Crack width (mm)*	*EA (kN)*	*EI_{yy} (kNm^2)*	*EI_{zz} (kNm^2)*
1	-22	114	0	CRACKED	0.5831	-33460.7	22355.21	0

ARUP

Job Title:	**Euston Tower**	Job No. **281835**	Spreadsheet Verification:
Member:	**1 ULS DA1C1**	Page No. **1**	Rev. r2.2
Calculation:	Shear Design for circular sections with plane (discrete) or spiral links to EN1992 (with UK NA) and Arup 2011 NST 04	Made by DF Date 25/11/2024	Rev. Date: 20/01/2015
		Chk by HT Rev.	Author: AJG

Inputs:	Titles	Variables	Parameter
Outputs:	General	Ok (Pass)	Fail

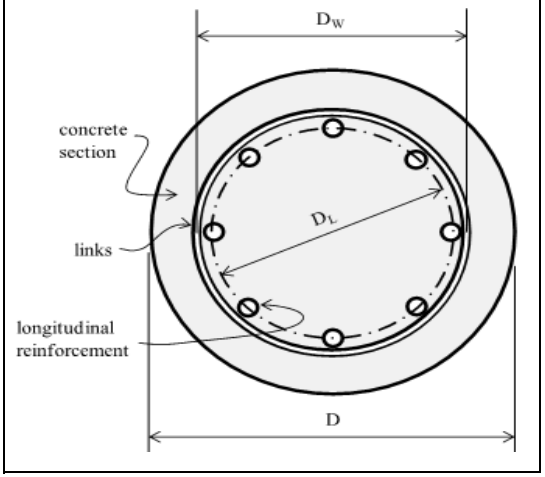
- This spreadsheet does not check the longitudinal shear is adequate, in accordance with cl. 6.2.3(7) for the assumed cotθ.

- References are to BS EN1992-1-1, using the UK NA where applicable; listed as either the clause, expression (in brackets), or table or figures as noted.. * following an expression reference denotes where the expression is modified as per 2011 NST 04.

INPUT DATA & GEOMETRY CHECKS

				Reference
Geometry and Material Parameters:				
Diameter, D =	520	mm	0.520 m	
cover =	75	mm	0.075 m	
A_{gross} =	212,372	mm^2	0.212 m^2	
D_L =	326	mm	0.326 m	
D_w =	358	mm	0.358 m	
f_{ck} =	32	MPa		
γ_C =	1.65	…allowing for cast agair		Table 2.1
ε_{c3} =	1.75	millistrain		Table 3.1
$E_C = f_{cd} / \varepsilon_{c3}$ =	9.42	GPa		Fig 3.4
α_{cc} for shear =	1.00			3.1.6(1)
f_{cd} =	19.39	MPa		3.1.6(1)
$\nu_1 f_{cd}$ =	10.15	MPa		6.2.3(3)
α_{cw}	1.00			6.2.3(3)
f_{yw} =	500	MPa		Annex C
E_S =	210	GPa		3.2.7(4)
γ_S =	1.15			Table 2.1
f_{ywd} =	434.8	MPa		Fig 3.8
Longitudinal Reinforcement:				
Bar diameter, d_b =	20	mm	0.020 m	
No. Bars, n_b =	8			
A_{s_total} =	2513	mm^2	0.003 m^2	
ρ_b =	1.18	%	0.012	
Shear Reinforcement				
Type =	Spiral		1	
Bar diameter, d_{bv} =	12	mm	0.012 m	
Spiral pitch, p =	200	mm	0.200 m	
Asw / p =	565	mm^2/ m	0.0006 m^2/m	
Design Values				
V_{Ed} =	164	kN	0.164 MN	
M_{Ed} / M_{Rd} =	0.63			
N_{Ed} =	22	kN (compression positive)		
σ_{cp} =	0.08	MPa	0.022 MN	

DEFINITIONS



SHEAR RESISTANCE

				Reference
Moment-shear interaction factors				
α_{cMc} =	0.931			
$\alpha_{cMs,circ}$ =	0.983			
$\alpha_{cMs,spir}$ =	0.961			
Link efficiency factors				
β_{circz} =	0.233	m		
$b_w z$ =	0.130	m^2		
β_{circ} =	0.792			
Resistance				
$V_{Rd,s}$ (for cotθ=1) =	84	kN		(6.8)*
$V_{Rd,max}$ (for cotθ=1) =	616	kN		(6.9)*
cotθ =	2.50			
V_{Rd} =	246	kN		
V_{Ed} / V_{Rd} =	0.67	Pass		

DETAILING RULES

			Reference
Minimum shear reinforcement check			6.2.1(4)
$\rho_{w,min}$ =	0.0009		(9.5)
ρ_w =	0.0019		(9.4)*
$\rho_w / \rho_{w,min}$ =	2.07	Pass	

Appendix H – Ground movement calculations

Analysis Options

General

Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -20.00 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic

Elastic : Yes

Consolidation

Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top [mOD]	Number of intermediate displacement levels	Youngs Modulus : Top [kN/m²]	Youngs Modulus : Btm. [kN/m²]	Poissons ratio	Non-linear curve
1	LC	21.600	36	40000.	840000.	0.50000	None
2	LMB	4.0000	35	84000.	127750.	0.50000	None
3	Thanet sands	-13.500	5	400000.	400000.	0.20000	None

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Grid 1	529100.	529280.	182270.	182450.	Soil Profile 1

Polygonal Load Data

Load Value : ref. Normal (local z) [kN/m²]	Name	Position : Level [m]	Position : Polygon : Coords. [m]	Position : Polygon : Rect. tolerance [%]	No. of Rectangles
1	Pinwheel raft at equiv. level load+demo -214.00	8.90000	(5.29e+05,1.82e+05)	10.000	12
	unloading		(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)		
2	Excavation unloading at proposed B2 tank -80.000	19.30000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	1
3	B1 slab lowering unloading at +21.6mOD -12.500	21.60000	(5.29e+05,1.82e+05)	10.000	23
			(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)		
4	B2 tank excavation offset at +21.6mOD 12.500	21.60000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	1
5	Exist pinwheel raft offset at +21.6mOD 12.500	21.60000	(5.29e+05,1.82e+05)	10.000	19
			(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)		

Load Value : ref. Normal	Name	Position : Level	Position : Polygon : Coords.	Position : Polygon Rectangles	No. of
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		

Results : Immediate : Displacement Data : Lines

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [μ]
1	A1	529167.15000	182392.65900	21.60000	0.81633	21.484	-8.4979E-6	-0.10841	1.2021E-6
1	A1	529166.98348	182393.12733	21.60000	0.89771	21.484	-6.9690E-6	-0.099451	1.1028E-6
1	A1	529166.81697	182393.59565	21.60000	0.96869	21.484	-5.7799E-6	-0.091628	1.0160E-6
1	A1	529166.65045	182394.06398	21.60000	1.03032	21.484	-4.8419E-6	-0.084744	939.72E-9
1	A1	529166.48393	182394.53231	21.60000	1.08355	21.484	-4.0926E-6	-0.078646	872.12E-9
1	A1	529166.31742	182395.00064	21.60000	1.12924	21.484	-3.4873E-6	-0.073212	811.88E-9
1	A1	529166.15090	182395.46896	21.60000	1.16815	21.484	-2.9933E-6	-0.068345	757.91E-9
1	A1	529165.98438	182395.93729	21.60000	1.20097	21.484	-2.5863E-6	-0.063965	709.34E-9
1	A1	529165.81786	182396.40562	21.60000	1.22831	21.484	-2.2482E-6	-0.060004	665.43E-9
1	A1	529165.65135	182396.87395	21.60000	1.25074	21.484	-1.9651E-6	-0.056410	625.57E-9
1	A1	529165.48483	182397.34227	21.60000	1.26875	21.484	-1.7265E-6	-0.053135	589.26E-9
1	A1	529165.31831	182397.81060	21.60000	1.28279	21.484	-1.5240E-6	-0.050142	556.07E-9
1	A1	529165.15180	182398.27893	21.60000	1.29329	21.484	-1.3511E-6	-0.047397	525.63E-9
1	A1	529164.98528	182398.74725	21.60000	1.30059	21.484	-1.2026E-6	-0.044873	497.64E-9
1	A1	529164.81876	182399.21558	21.60000	1.30504	21.484	-1.0745E-6	-0.042546	471.84E-9
1	A1	529164.65225	182399.68391	21.60000	1.30694	21.484	-963.36E-9	-0.040395	447.99E-9
1	A1	529164.48573	182400.15224	21.60000	1.30656	21.484	-866.56E-9	-0.038402	425.89E-9
1	A1	529164.31921	182400.62056	21.60000	1.30414	21.484	-781.87E-9	-0.036552	405.37E-9
1	A1	529164.15270	182401.08889	21.60000	1.29991	21.484	-707.48E-9	-0.034830	386.28E-9
1	A1	529163.98618	182401.55722	21.60000	1.29407	21.484	-641.90E-9	-0.033226	368.48E-9
1	A1	529163.81966	182402.02555	21.60000	1.28680	21.484	-583.88E-9	-0.031727	351.87E-9
1	A1	529163.65315	182402.49387	21.60000	1.27827	21.484	-532.37E-9	-0.030326	336.32E-9
1	A1	529163.48663	182402.96220	21.60000	1.26862	21.484	-486.51E-9	-0.029013	321.76E-9
1	A1	529163.32011	182403.43053	21.60000	1.25799	21.484	-445.55E-9	-0.027781	308.10E-9
1	A1	529163.15359	182403.89885	21.60000	1.24650	21.484	-408.88E-9	-0.026623	295.26E-9
1	A1	529162.98708	182404.36718	21.60000	1.23427	21.484	-375.94E-9	-0.025534	283.18E-9
1	A1	529162.82056	182404.83551	21.60000	1.22138	21.484	-346.29E-9	-0.024508	271.80E-9
1	A1	529162.65404	182405.30384	21.60000	1.20795	21.484	-319.54E-9	-0.023540	261.07E-9
1	A1	529162.48753	182405.77216	21.60000	1.19403	21.484	-295.34E-9	-0.022626	250.93E-9
1	A1	529162.32101	182406.24049	21.60000	1.17972	21.484	-273.41E-9	-0.021762	241.35E-9
1	A1	529162.15449	182406.70882	21.60000	1.16507	21.484	-253.50E-9	-0.020944	232.28E-9
1	A1	529161.98798	182407.17715	21.60000	1.15014	21.484	-235.37E-9	-0.020169	223.69E-9
1	A1	529161.82146	182407.64547	21.60000	1.13500	21.484	-218.84E-9	-0.019435	215.54E-9
1	A1	529161.65494	182408.11380	21.60000	1.11969	21.484	-203.75E-9	-0.018737	207.81E-9
1	A1	529161.48843	182408.58213	21.60000	1.10425	21.484	-189.94E-9	-0.018075	200.46E-9
1	A1	529161.32191	182409.05045	21.60000	1.08872	21.484	-177.28E-9	-0.017445	193.48E-9
1	A1	529161.15539	182409.51878	21.60000	1.07314	21.484	-165.66E-9	-0.016846	186.83E-9
1	A1	529160.98888	182409.98711	21.60000	1.05754	21.484	-154.98E-9	-0.016275	180.50E-9
1	A1	529160.82236	182410.45544	21.60000	1.04196	21.484	-145.14E-9	-0.015731	174.47E-9
1	A1	529160.65584	182410.92376	21.60000	1.02640	21.484	-136.07E-9	-0.015213	168.72E-9
1	A1	529160.48932	182411.39209	21.60000	1.01091	21.484	-127.70E-9	-0.014718	163.23E-9
1	A1	529160.32281	182411.86042	21.60000	0.99549	21.484	-119.96E-9	-0.014245	157.98E-9
1	A1	529160.15629	182412.32875	21.60000	0.98017	21.484	-112.79E-9	-0.013793	152.97E-9
1	A1	529159.98977	182412.79707	21.60000	0.96496	21.484	-106.15E-9	-0.013361	148.18E-9
1	A1	529159.82326	182413.26540	21.60000	0.94988	21.484	-99.992E-9	-0.012947	143.59E-9
1	A1	529159.65674	182413.73373	21.60000	0.93494	21.484	-94.269E-9	-0.012551	139.20E-9
1	A1	529159.49022	182414.20205	21.60000	0.92015	21.484	-88.947E-9	-0.012172	135.00E-9
1	A1	529159.32371	182414.67038	21.60000	0.90552	21.484	-83.993E-9	-0.011809	130.97E-9
1	A1	529159.15719	182415.13871	21.60000	0.89106	21.484	-79.376E-9	-0.011460	127.10E-9
1	A1	529158.99067	182415.60704	21.60000	0.87677	21.484	-75.069E-9	-0.011125	123.39E-9
1	A1	529158.82416	182416.07536	21.60000	0.86266	21.484	-71.048E-9	-0.010804	119.83E-9
1	A1	529158.65764	182416.54369	21.60000	0.84874	21.484	-67.290E-9	-0.010496	116.40E-9
1	A1	529158.49112	182417.01202	21.60000	0.83501	21.484	-63.775E-9	-0.010199	113.12E-9
1	A1	529158.32461	182417.48035	21.60000	0.82147	21.484	-60.484E-9	-0.0099142	109.96E-9
1	A1	529158.15809	182417.94867	21.60000	0.80813	21.484	-57.400E-9	-0.0096401	106.92E-9
1	A1	529157.99157	182418.41700	21.60000	0.79499	21.484	-54.508E-9	-0.0093763	103.99E-9
1	A1	529157.82505	182418.88533	21.60000	0.78205	21.484	-51.793E-9	-0.0091223	101.17E-9
1	A1	529157.65854	182419.35365	21.60000	0.76931	21.484	-49.243E-9	-0.0088777	98.460E-9
1	A1	529157.49202	182419.82198	21.60000	0.75677	21.484	-46.847E-9	-0.0086420	95.847E-9
1	A1	529157.32550	182420.29031	21.60000	0.74444	21.484	-44.592E-9	-0.0084149	93.327E-9
1	A1	529157.15899	182420.75864	21.60000	0.73230	21.484	-42.469E-9	-0.0081958	90.898E-9
1	A1	529156.99247	182421.22696	21.60000	0.72037	21.484	-40.469E-9	-0.0079845	88.554E-9
1	A1	529156.82595	182421.69529	21.60000	0.70864	21.484	-38.584E-9	-0.0077806	86.293E-9
1	A1	529156.65944	182422.16362	21.60000	0.69710	21.484	-36.806E-9	-0.0075838	84.110E-9
1	A1	529156.49292	182422.63195	21.60000	0.68577	21.484	-35.127E-9	-0.0073937	82.002E-9
1	A1	529156.32640	182423.10027	21.60000	0.67463	21.484	-33.541E-9	-0.0072101	79.966E-9
1	A1	529156.15989	182423.56860	21.60000	0.66369	21.484	-32.042E-9	-0.0070327	77.998E-9
1	A1	529155.99337	182424.03693	21.60000	0.65293	21.484	-30.625E-9	-0.0068612	76.096E-9
1	A1	529155.82685	182424.50525	21.60000	0.64237	21.484	-29.284E-9	-0.0066953	74.257E-9

ARUP **Arup**

Euston Tower
BIA
Net loading (during construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]
1	A1	529155.66034	182424.97358	21.60000	0.63200	21.484	-28.014E-9	-0.0065349	72.477E-9
1	A1	529155.49382	182425.44191	21.60000	0.62181	21.484	-26.811E-9	-0.0063797	70.756E-9
1	A1	529155.32730	182425.91024	21.60000	0.61181	21.484	-25.671E-9	-0.0062295	69.090E-9
1	A1	529155.16078	182426.37856	21.60000	0.60198	21.484	-24.589E-9	-0.0060840	67.477E-9
1	A1	529154.99427	182426.84689	21.60000	0.59234	21.484	-23.563E-9	-0.0059432	65.915E-9
1	A1	529154.82775	182427.31522	21.60000	0.58287	21.484	-22.588E-9	-0.0058067	64.401E-9
1	A1	529154.66123	182427.78355	21.60000	0.57357	21.484	-21.663E-9	-0.0056745	62.935E-9
1	A1	529154.49472	182428.25187	21.60000	0.56445	21.484	-20.783E-9	-0.0055464	61.514E-9
1	A1	529154.32820	182428.72020	21.60000	0.55549	21.484	-19.947E-9	-0.0054222	60.136E-9
2	A2	529153.41830	182388.83000	21.60000	1.12056	21.484	-6.1099E-6	-0.091248	1.0118E-6
2	A2	529153.88859	182388.95975	21.60000	1.11347	21.484	-6.1997E-6	-0.092157	1.0219E-6
2	A2	529154.35888	182389.08950	21.60000	1.10562	21.484	-6.2881E-6	-0.093028	1.0316E-6
2	A2	529154.82918	182389.21925	21.60000	1.09704	21.484	-6.3751E-6	-0.093862	1.0408E-6
2	A2	529155.29947	182389.34900	21.60000	1.08775	21.484	-6.4610E-6	-0.094661	1.0497E-6
2	A2	529155.76976	182389.47875	21.60000	1.07780	21.484	-6.5457E-6	-0.095426	1.0581E-6
2	A2	529156.24006	182389.60850	21.60000	1.06724	21.484	-6.6295E-6	-0.096160	1.0663E-6
2	A2	529156.71035	182389.73825	21.60000	1.05612	21.484	-6.7123E-6	-0.096863	1.0741E-6
2	A2	529157.18064	182389.86800	21.60000	1.04450	21.484	-6.7941E-6	-0.097537	1.0816E-6
2	A2	529157.65093	182389.99775	21.60000	1.03244	21.484	-6.8751E-6	-0.098185	1.0887E-6
2	A2	529158.12123	182390.12750	21.60000	1.02002	21.484	-6.9552E-6	-0.098807	1.0956E-6
2	A2	529158.59152	182390.25725	21.60000	1.00731	21.484	-7.0345E-6	-0.099405	1.1023E-6
2	A2	529159.06181	182390.38700	21.60000	0.99438	21.484	-7.1131E-6	-0.099982	1.1087E-6
2	A2	529159.53210	182390.51675	21.60000	0.98133	21.484	-7.1911E-6	-0.10054	1.1148E-6
2	A2	529160.00239	182390.64650	21.60000	0.96821	21.484	-7.2687E-6	-0.10108	1.1208E-6
2	A2	529160.47269	182390.77625	21.60000	0.95513	21.484	-7.3460E-6	-0.10161	1.1267E-6
2	A2	529160.94298	182390.90600	21.60000	0.94214	21.484	-7.4234E-6	-0.10212	1.1324E-6
2	A2	529161.41327	182391.03575	21.60000	0.92933	21.484	-7.5011E-6	-0.10263	1.1380E-6
2	A2	529161.88357	182391.16550	21.60000	0.91676	21.484	-7.5797E-6	-0.10313	1.1435E-6
2	A2	529162.35386	182391.29525	21.60000	0.90450	21.484	-7.6594E-6	-0.10362	1.1490E-6
2	A2	529162.82415	182391.42500	21.60000	0.89263	21.484	-7.7408E-6	-0.10412	1.1545E-6
2	A2	529163.29444	182391.55475	21.60000	0.88118	21.484	-7.8244E-6	-0.10462	1.1600E-6
2	A2	529163.76473	182391.68450	21.60000	0.87023	21.484	-7.9105E-6	-0.10512	1.1656E-6
2	A2	529164.23503	182391.81425	21.60000	0.85981	21.484	-7.9995E-6	-0.10563	1.1713E-6
2	A2	529164.70532	182391.94400	21.60000	0.84997	21.484	-8.0918E-6	-0.10616	1.1771E-6
2	A2	529165.17561	182392.07375	21.60000	0.84076	21.484	-8.1877E-6	-0.10670	1.1831E-6
2	A2	529165.64591	182392.20350	21.60000	0.83220	21.484	-8.2873E-6	-0.10725	1.1892E-6
2	A2	529166.11620	182392.33325	21.60000	0.82433	21.484	-8.3909E-6	-0.10782	1.1956E-6
2	A2	529166.58649	182392.46300	21.60000	0.81719	21.484	-8.4986E-6	-0.10841	1.2021E-6
2	A2	529167.05678	182392.59275	21.60000	0.81078	21.484	-8.6104E-6	-0.10903	1.2089E-6
2	A2	529167.52707	182392.72250	21.60000	0.80515	21.484	-8.7266E-6	-0.10966	1.2160E-6
2	A2	529167.99737	182392.85225	21.60000	0.80031	21.484	-8.8470E-6	-0.11032	1.2233E-6
2	A2	529168.46766	182392.98200	21.60000	0.79629	21.484	-8.9719E-6	-0.11101	1.2309E-6
2	A2	529168.93795	182393.11175	21.60000	0.79309	21.484	-9.1012E-6	-0.11172	1.2388E-6
2	A2	529169.40824	182393.24150	21.60000	0.79076	21.484	-9.2350E-6	-0.11246	1.2470E-6
2	A2	529169.87854	182393.37125	21.60000	0.78930	21.484	-9.3734E-6	-0.11323	1.2555E-6
2	A2	529170.34883	182393.50100	21.60000	0.78872	21.484	-9.5164E-6	-0.11403	1.2644E-6
2	A2	529170.81912	182393.63075	21.60000	0.78906	21.484	-9.6641E-6	-0.11486	1.2736E-6
2	A2	529171.28942	182393.76050	21.60000	0.79033	21.484	-9.8166E-6	-0.11572	1.2831E-6
2	A2	529171.75971	182393.89025	21.60000	0.79255	21.484	-9.9739E-6	-0.11661	1.2929E-6
2	A2	529172.23000	182394.02000	21.60000	0.79572	21.484	-10.136E-6	-0.11752	1.3031E-6
3	B1	529173.88330	182394.83000	21.60000	0.87794	21.484	-9.3090E-6	-0.11380	1.2618E-6
3	B1	529174.35887	182394.97562	21.60000	0.88787	21.484	-9.4108E-6	-0.11449	1.2695E-6
3	B1	529174.83445	182395.12125	21.60000	0.89866	21.484	-9.5151E-6	-0.11520	1.2773E-6
3	B1	529175.31002	182395.26688	21.60000	0.91031	21.484	-9.6216E-6	-0.11593	1.2854E-6
3	B1	529175.78559	182395.41250	21.60000	0.92276	21.484	-9.7302E-6	-0.11667	1.2937E-6
3	B1	529176.26117	182395.55812	21.60000	0.93598	21.484	-9.8410E-6	-0.11743	1.3021E-6
3	B1	529176.73674	182395.70375	21.60000	0.94993	21.484	-9.9537E-6	-0.11821	1.3107E-6
3	B1	529177.21231	182395.84937	21.60000	0.96453	21.484	-10.068E-6	-0.11900	1.3194E-6
3	B1	529177.68789	182395.99500	21.60000	0.97973	21.484	-10.185E-6	-0.11980	1.3283E-6
3	B1	529178.16346	182396.14063	21.60000	0.99545	21.484	-10.302E-6	-0.12060	1.3373E-6
3	B1	529178.63903	182396.28625	21.60000	1.01159	21.484	-10.422E-6	-0.12142	1.3463E-6
3	B1	529179.11461	182396.43187	21.60000	1.02806	21.484	-10.542E-6	-0.12224	1.3554E-6
3	B1	529179.59018	182396.57750	21.60000	1.04476	21.484	-10.664E-6	-0.12307	1.3646E-6
3	B1	529180.06575	182396.72312	21.60000	1.06159	21.484	-10.787E-6	-0.12389	1.3737E-6
3	B1	529180.54133	182396.86875	21.60000	1.07843	21.484	-10.911E-6	-0.12472	1.3829E-6
3	B1	529181.01690	182397.01437	21.60000	1.09517	21.484	-11.036E-6	-0.12555	1.3921E-6
3	B1	529181.49247	182397.16000	21.60000	1.11170	21.484	-11.162E-6	-0.12637	1.4012E-6
3	B1	529181.96805	182397.30562	21.60000	1.12790	21.484	-11.288E-6	-0.12719	1.4103E-6
3	B1	529182.44362	182397.45125	21.60000	1.14368	21.484	-11.415E-6	-0.12801	1.4193E-6
3	B1	529182.91920	182397.59687	21.60000	1.15892	21.484	-11.542E-6	-0.12881	1.4283E-6
3	B1	529183.39477	182397.74250	21.60000	1.17355	21.484	-11.670E-6	-0.12961	1.4371E-6
3	B1	529183.87034	182397.88812	21.60000	1.18747	21.484	-11.798E-6	-0.13040	1.4459E-6
3	B1	529184.34592	182398.03375	21.60000	1.20061	21.484	-11.926E-6	-0.13118	1.4545E-6
3	B1	529184.82149	182398.17937	21.60000	1.21292	21.484	-12.054E-6	-0.13194	1.4630E-6
3	B1	529185.29706	182398.32500	21.60000	1.22433	21.484	-12.182E-6	-0.13270	1.4713E-6
3	B1	529185.77264	182398.47062	21.60000	1.23482	21.484	-12.309E-6	-0.13343	1.4795E-6
3	B1	529186.24821	182398.61625	21.60000	1.24435	21.484	-12.436E-6	-0.13415	1.4875E-6

ARUP **Arup**

Euston Tower
BIA
Net loading (during construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]
3	B1	529186.72378	182398.76187	21.60000	1.25290	21.484	-12.562E-6	-0.13486	1.4953E-6
3	B1	529187.19936	182398.90750	21.60000	1.26047	21.484	-12.687E-6	-0.13554	1.5029E-6
3	B1	529187.67493	182399.05312	21.60000	1.26706	21.484	-12.811E-6	-0.13621	1.5102E-6
3	B1	529188.15050	182399.19875	21.60000	1.27268	21.484	-12.933E-6	-0.13685	1.5174E-6
3	B1	529188.62608	182399.34437	21.60000	1.27735	21.484	-13.054E-6	-0.13748	1.5243E-6
3	B1	529189.10165	182399.49000	21.60000	1.28108	21.484	-13.172E-6	-0.13808	1.5309E-6
3	B1	529189.57722	182399.63562	21.60000	1.28392	21.484	-13.287E-6	-0.13865	1.5373E-6
3	B1	529190.05280	182399.78125	21.60000	1.28589	21.484	-13.401E-6	-0.13921	1.5435E-6
3	B1	529190.52837	182399.92688	21.60000	1.28704	21.484	-13.512E-6	-0.13973	1.5493E-6
3	B1	529191.00394	182400.07250	21.60000	1.28741	21.484	-13.621E-6	-0.14024	1.5549E-6
3	B1	529191.47952	182400.21812	21.60000	1.28703	21.484	-13.729E-6	-0.14072	1.5603E-6
3	B1	529191.95509	182400.36375	21.60000	1.28596	21.484	-13.836E-6	-0.14118	1.5654E-6
3	B1	529192.43066	182400.50937	21.60000	1.28423	21.484	-13.943E-6	-0.14162	1.5702E-6
3	B1	529192.90624	182400.65500	21.60000	1.28191	21.484	-14.051E-6	-0.14203	1.5748E-6
3	B1	529193.38181	182400.80063	21.60000	1.27902	21.484	-14.160E-6	-0.14242	1.5791E-6
3	B1	529193.85738	182400.94625	21.60000	1.27563	21.484	-14.271E-6	-0.14279	1.5831E-6
3	B1	529194.33296	182401.09187	21.60000	1.27177	21.484	-14.383E-6	-0.14313	1.5870E-6
3	B1	529194.80853	182401.23750	21.60000	1.26748	21.484	-14.497E-6	-0.14345	1.5905E-6
3	B1	529195.28410	182401.38312	21.60000	1.26281	21.484	-14.613E-6	-0.14374	1.5937E-6
3	B1	529195.75968	182401.52875	21.60000	1.25780	21.484	-14.730E-6	-0.14400	1.5967E-6
3	B1	529196.23525	182401.67438	21.60000	1.25248	21.484	-14.848E-6	-0.14424	1.5992E-6
3	B1	529196.71082	182401.82000	21.60000	1.24690	21.484	-14.966E-6	-0.14444	1.6015E-6
3	B1	529197.18640	182401.96562	21.60000	1.24107	21.484	-15.085E-6	-0.14461	1.6033E-6
3	B1	529197.66197	182402.11125	21.60000	1.23505	21.484	-15.203E-6	-0.14474	1.6048E-6
3	B1	529198.13755	182402.25687	21.60000	1.22884	21.484	-15.321E-6	-0.14482	1.6057E-6
3	B1	529198.61312	182402.40250	21.60000	1.22249	21.484	-15.439E-6	-0.14487	1.6062E-6
3	B1	529199.08869	182402.54813	21.60000	1.21601	21.484	-15.555E-6	-0.14487	1.6062E-6
3	B1	529199.56427	182402.69375	21.60000	1.20942	21.484	-15.670E-6	-0.14482	1.6056E-6
3	B1	529200.03984	182402.83937	21.60000	1.20275	21.484	-15.784E-6	-0.14471	1.6044E-6
3	B1	529200.51541	182402.98500	21.60000	1.19602	21.484	-15.897E-6	-0.14455	1.6026E-6
3	B1	529200.99099	182403.13062	21.60000	1.18923	21.484	-16.008E-6	-0.14433	1.6002E-6
3	B1	529201.46656	182403.27625	21.60000	1.18240	21.484	-16.118E-6	-0.14404	1.5970E-6
3	B1	529201.94213	182403.42188	21.60000	1.17554	21.484	-16.225E-6	-0.14368	1.5930E-6
3	B1	529202.41771	182403.56750	21.60000	1.16867	21.484	-16.330E-6	-0.14324	1.5881E-6
3	B1	529202.89328	182403.71312	21.60000	1.16179	21.484	-16.430E-6	-0.14272	1.5823E-6
3	B1	529203.36885	182403.85875	21.60000	1.15491	21.484	-16.524E-6	-0.14210	1.5755E-6
3	B1	529203.84443	182404.00437	21.60000	1.14803	21.484	-16.611E-6	-0.14139	1.5676E-6
3	B1	529204.32000	182404.15000	21.60000	1.14116	21.484	-16.689E-6	-0.14056	1.5584E-6
4	B2	529206.12000	182399.49000	21.60000	0.98157	21.484	-0.0026639	-1.0827	11.920E-6
4	B2	529206.60167	182399.64000	21.60000	0.98376	21.484	-0.0028058	-1.0999	12.105E-6
4	B2	529207.08333	182399.79000	21.60000	0.98579	21.484	-0.0029579	-1.1173	12.293E-6
4	B2	529207.56500	182399.94000	21.60000	0.98765	21.484	-0.0031212	-1.1350	12.484E-6
4	B2	529208.04667	182400.09000	21.60000	0.98931	21.484	-0.0032968	-1.1529	12.677E-6
4	B2	529208.52833	182400.24000	21.60000	0.99077	21.484	-0.0034858	-1.1711	12.873E-6
4	B2	529209.01000	182400.39000	21.60000	0.99202	21.484	-0.0036896	-1.1894	13.069E-6
4	B2	529209.49167	182400.54000	21.60000	0.99306	21.484	-0.0039095	-1.2079	13.267E-6
4	B2	529209.97333	182400.69000	21.60000	0.99388	21.484	-0.0041457	-1.2264	13.464E-6
4	B2	529210.45500	182400.84000	21.60000	0.99450	21.484	-0.0043926	-1.2447	13.658E-6
4	B2	529210.93667	182400.99000	21.60000	0.99492	21.484	-0.0046320	-1.2628	13.851E-6
4	B2	529211.41833	182401.14000	21.60000	0.99512	21.484	-0.0049298	-1.2853	14.091E-6
4	B2	529211.90000	182401.29000	21.60000	0.99515	21.484	-0.0055104	-1.3172	14.426E-6
4	B2	529212.38167	182401.44000	21.60000	0.99544	21.484	-0.0060584	-1.3354	14.610E-6
4	B2	529212.86333	182401.59000	21.60000	0.99643	21.484	-0.0065508	-1.3228	14.453E-6
4	B2	529213.34500	182401.74000	21.60000	0.99864	21.484	-0.0066225	-1.2467	13.606E-6
4	B2	529213.82667	182401.89000	21.60000	1.00247	21.484	-0.0054530	-1.0669	11.652E-6
4	B2	529214.30833	182402.04000	21.60000	1.00724	21.484	-0.0033400	-0.81543	8.9327E-6
4	B2	529214.79000	182402.19000	21.60000	1.01149	21.484	-0.0014640	-0.57875	6.3701E-6
5	B3	529206.13650	182399.46000	21.60000	0.97911	21.484	-0.0029098	-1.1182	12.305E-6
5	B3	529205.98317	182399.93040	21.60000	1.01186	21.484	-978.45E-6	-0.74619	8.2434E-6
5	B3	529205.82984	182400.40080	21.60000	1.03821	21.484	-439.36E-6	-0.54903	6.0747E-6
5	B3	529205.67651	182400.87120	21.60000	1.06000	21.484	-233.05E-6	-0.42757	4.7344E-6
5	B3	529205.52318	182401.34160	21.60000	1.07821	21.484	-137.72E-6	-0.34565	3.8290E-6
5	B3	529205.36985	182401.81200	21.60000	1.09345	21.484	-87.782E-6	-0.28694	3.1795E-6
5	B3	529205.21652	182402.28240	21.60000	1.10615	21.484	-59.162E-6	-0.24300	2.6931E-6
5	B3	529205.06319	182402.75280	21.60000	1.11661	21.484	-41.618E-6	-0.20902	2.3169E-6
5	B3	529204.90986	182403.22320	21.60000	1.12508	21.484	-30.287E-6	-0.18208	2.0184E-6
5	B3	529204.75653	182403.69360	21.60000	1.13176	21.484	-22.656E-6	-0.16027	1.7768E-6
5	B3	529204.60320	182404.16400	21.60000	1.13681	21.484	-17.339E-6	-0.14233	1.5779E-6
5	B3	529204.44987	182404.63440	21.60000	1.14037	21.484	-13.528E-6	-0.12735	1.4120E-6
5	B3	529204.29654	182405.10480	21.60000	1.14257	21.484	-10.730E-6	-0.11470	1.2717E-6
5	B3	529204.14321	182405.57520	21.60000	1.14351	21.484	-8.6332E-6	-0.10390	1.1521E-6
5	B3	529203.98988	182406.04560	21.60000	1.14331	21.484	-7.0336E-6	-0.094605	1.0490E-6
5	B3	529203.83655	182406.51600	21.60000	1.14204	21.484	-5.7943E-6	-0.086537	959.58E-9
5	B3	529203.68322	182406.98640	21.60000	1.13979	21.484	-4.8208E-6	-0.079484	881.39E-9
5	B3	529203.52989	182407.45680	21.60000	1.13663	21.484	-4.0467E-6	-0.073280	812.60E-9
5	B3	529203.37656	182407.92720	21.60000	1.13264	21.484	-3.4243E-6	-0.067790	751.74E-9
5	B3	529203.22323	182408.39760	21.60000	1.12787	21.484	-2.9189E-6	-0.062907	697.60E-9

ARUP **Arup**

Euston Tower
BIA
Net loading (during construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x	y	z	δz	Stress: Calc. Level	Stress: Vertical	Stress: Sum Princ.	Vert. Strain
		[m]	[m]	[mOD]	[mm]	[mOD]	[kN/m²]	[kN/m²]	[u]
5	B3	529203.06990	182408.86800	21.60000	1.12240	21.484	-2.5047E-6	-0.058543	649.21E-9
5	B3	529202.91657	182409.33840	21.60000	1.11627	21.484	-2.1626E-6	-0.054625	605.77E-9
5	B3	529202.76324	182409.80880	21.60000	1.10954	21.484	-1.8777E-6	-0.051094	566.62E-9
5	B3	529202.60991	182410.27920	21.60000	1.10225	21.484	-1.6389E-6	-0.047900	531.20E-9
5	B3	529202.45658	182410.74960	21.60000	1.09446	21.484	-1.4375E-6	-0.045000	499.04E-9
5	B3	529202.30325	182411.22000	21.60000	1.08621	21.484	-1.2664E-6	-0.042358	469.75E-9
5	B3	529202.14992	182411.69040	21.60000	1.07754	21.484	-1.1204E-6	-0.039945	442.99E-9
5	B3	529201.99659	182412.16080	21.60000	1.06849	21.484	-995.19E-9	-0.037734	418.47E-9
5	B3	529201.84326	182412.63120	21.60000	1.05909	21.484	-887.19E-9	-0.035703	395.95E-9
5	B3	529201.68993	182413.10160	21.60000	1.04939	21.484	-793.65E-9	-0.033833	375.21E-9
5	B3	529201.53660	182413.57200	21.60000	1.03940	21.484	-712.27E-9	-0.032106	356.06E-9
5	B3	529201.38327	182414.04240	21.60000	1.02917	21.484	-641.20E-9	-0.030509	338.35E-9
5	B3	529201.22994	182414.51280	21.60000	1.01872	21.484	-578.89E-9	-0.029028	321.93E-9
5	B3	529201.07661	182414.98320	21.60000	1.00808	21.484	-524.06E-9	-0.027653	306.68E-9
5	B3	529200.92328	182415.45360	21.60000	0.99726	21.484	-475.65E-9	-0.026373	292.48E-9
5	B3	529200.76995	182415.92400	21.60000	0.98631	21.484	-432.77E-9	-0.025180	279.25E-9
5	B3	529200.61662	182416.39440	21.60000	0.97524	21.484	-394.68E-9	-0.024065	266.89E-9
5	B3	529200.46329	182416.86480	21.60000	0.96406	21.484	-360.73E-9	-0.023023	255.33E-9
5	B3	529200.30996	182417.33520	21.60000	0.95280	21.484	-330.40E-9	-0.022046	244.50E-9
5	B3	529200.15663	182417.80560	21.60000	0.94148	21.484	-303.23E-9	-0.021130	234.34E-9
5	B3	529200.00330	182418.27600	21.60000	0.93012	21.484	-278.82E-9	-0.020269	224.80E-9
5	B3	529199.84997	182418.74640	21.60000	0.91872	21.484	-256.85E-9	-0.019460	215.82E-9
5	B3	529199.69664	182419.21680	21.60000	0.90731	21.484	-237.02E-9	-0.018697	207.36E-9
5	B3	529199.54331	182419.68720	21.60000	0.89589	21.484	-219.09E-9	-0.017977	199.38E-9
5	B3	529199.38998	182420.15760	21.60000	0.88448	21.484	-202.84E-9	-0.017298	191.85E-9
5	B3	529199.23665	182420.62800	21.60000	0.87310	21.484	-188.08E-9	-0.016656	184.73E-9
5	B3	529199.08332	182421.09840	21.60000	0.86174	21.484	-174.66E-9	-0.016049	177.99E-9
5	B3	529198.92999	182421.56880	21.60000	0.85043	21.484	-162.42E-9	-0.015473	171.61E-9
5	B3	529198.77666	182422.03920	21.60000	0.83917	21.484	-151.25E-9	-0.014927	165.55E-9
5	B3	529198.62333	182422.50960	21.60000	0.82797	21.484	-141.02E-9	-0.014410	159.81E-9
5	B3	529198.47000	182422.98000	21.60000	0.81683	21.484	-131.66E-9	-0.013918	154.35E-9
6	B4	529173.89290	182394.83000	21.60000	0.87763	21.484	-9.3219E-6	-0.11387	1.2626E-6
6	B4	529173.72839	182395.30222	21.60000	0.95791	21.484	-7.5971E-6	-0.10423	1.1558E-6
6	B4	529173.56388	182395.77444	21.60000	1.02773	21.484	-6.2663E-6	-0.095851	1.0629E-6
6	B4	529173.39937	182396.24667	21.60000	1.08816	21.484	-5.2239E-6	-0.088504	981.42E-9
6	B4	529173.23486	182396.71889	21.60000	1.14017	21.484	-4.3965E-6	-0.082018	909.51E-9
6	B4	529173.07036	182397.19111	21.60000	1.18462	21.484	-3.7318E-6	-0.076256	845.62E-9
6	B4	529172.90585	182397.66333	21.60000	1.22229	21.484	-3.1921E-6	-0.071108	788.55E-9
6	B4	529172.74134	182398.13556	21.60000	1.25386	21.484	-2.7496E-6	-0.066486	737.29E-9
6	B4	529172.57683	182398.60778	21.60000	1.27997	21.484	-2.3835E-6	-0.062316	691.06E-9
6	B4	529172.41232	182399.08000	21.60000	1.30117	21.484	-2.0782E-6	-0.058538	649.17E-9
6	B4	529172.24781	182399.55222	21.60000	1.31797	21.484	-1.8217E-6	-0.055103	611.08E-9
6	B4	529172.08330	182400.02444	21.60000	1.33081	21.484	-1.6047E-6	-0.051967	576.31E-9
6	B4	529171.91879	182400.49667	21.60000	1.34011	21.484	-1.4200E-6	-0.049096	544.48E-9
6	B4	529171.75428	182400.96889	21.60000	1.34625	21.484	-1.2619E-6	-0.046459	515.24E-9
6	B4	529171.58978	182401.44111	21.60000	1.34955	21.484	-1.1257E-6	-0.044031	488.31E-9
6	B4	529171.42527	182401.91333	21.60000	1.35031	21.484	-1.0079E-6	-0.041788	463.44E-9
6	B4	529171.26076	182402.38556	21.60000	1.34881	21.484	-905.51E-9	-0.039712	440.42E-9
6	B4	529171.09625	182402.85778	21.60000	1.34529	21.484	-816.10E-9	-0.037787	419.06E-9
6	B4	529170.93174	182403.33000	21.60000	1.33998	21.484	-737.70E-9	-0.035996	399.20E-9
6	B4	529170.76723	182403.80222	21.60000	1.33307	21.484	-668.70E-9	-0.034328	380.71E-9
6	B4	529170.60272	182404.27444	21.60000	1.32476	21.484	-607.75E-9	-0.032771	363.44E-9
6	B4	529170.43821	182404.74667	21.60000	1.31520	21.484	-553.72E-9	-0.031316	347.30E-9
6	B4	529170.27370	182405.21889	21.60000	1.30455	21.484	-505.68E-9	-0.029952	332.18E-9
6	B4	529170.10920	182405.69111	21.60000	1.29293	21.484	-462.82E-9	-0.028674	318.01E-9
6	B4	529169.94469	182406.16333	21.60000	1.28048	21.484	-424.48E-9	-0.027473	304.69E-9
6	B4	529169.78018	182406.63556	21.60000	1.26730	21.484	-390.09E-9	-0.026343	292.16E-9
6	B4	529169.61567	182407.10778	21.60000	1.25349	21.484	-359.16E-9	-0.025279	280.36E-9
6	B4	529169.45116	182407.58000	21.60000	1.23915	21.484	-331.27E-9	-0.024276	269.23E-9
6	B4	529169.28665	182408.05222	21.60000	1.22435	21.484	-306.07E-9	-0.023329	258.73E-9
6	B4	529169.12214	182408.52444	21.60000	1.20916	21.484	-283.25E-9	-0.022433	248.80E-9
6	B4	529168.95763	182408.99667	21.60000	1.19367	21.484	-262.53E-9	-0.021586	239.40E-9
6	B4	529168.79312	182409.46889	21.60000	1.17792	21.484	-243.68E-9	-0.020783	230.50E-9
6	B4	529168.62862	182409.94111	21.60000	1.16196	21.484	-226.51E-9	-0.020022	222.06E-9
6	B4	529168.46411	182410.41333	21.60000	1.14586	21.484	-210.83E-9	-0.019300	214.05E-9
6	B4	529168.29960	182410.88556	21.60000	1.12965	21.484	-196.50E-9	-0.018614	206.44E-9
6	B4	529168.13509	182411.35778	21.60000	1.11337	21.484	-183.36E-9	-0.017962	199.20E-9
6	B4	529167.97058	182411.83000	21.60000	1.09706	21.484	-171.30E-9	-0.017341	192.32E-9
6	B4	529167.80607	182412.30222	21.60000	1.08075	21.484	-160.23E-9	-0.016750	185.77E-9
6	B4	529167.64156	182412.77444	21.60000	1.06446	21.484	-150.03E-9	-0.016187	179.52E-9
6	B4	529167.47705	182413.24667	21.60000	1.04823	21.484	-140.63E-9	-0.015649	173.56E-9
6	B4	529167.31254	182413.71889	21.60000	1.03207	21.484	-131.95E-9	-0.015137	167.88E-9
6	B4	529167.14804	182414.19111	21.60000	1.01601	21.484	-123.93E-9	-0.014647	162.45E-9
6	B4	529166.98353	182414.66333	21.60000	1.00006	21.484	-116.51E-9	-0.014179	157.26E-9
6	B4	529166.81902	182415.13556	21.60000	0.98425	21.484	-109.63E-9	-0.013732	152.30E-9
6	B4	529166.65451	182415.60778	21.60000	0.96857	21.484	-103.25E-9	-0.013304	147.55E-9
6	B4	529166.49000	182416.08000	21.60000	0.95305	21.484	-97.326E-9	-0.012894	143.00E-9

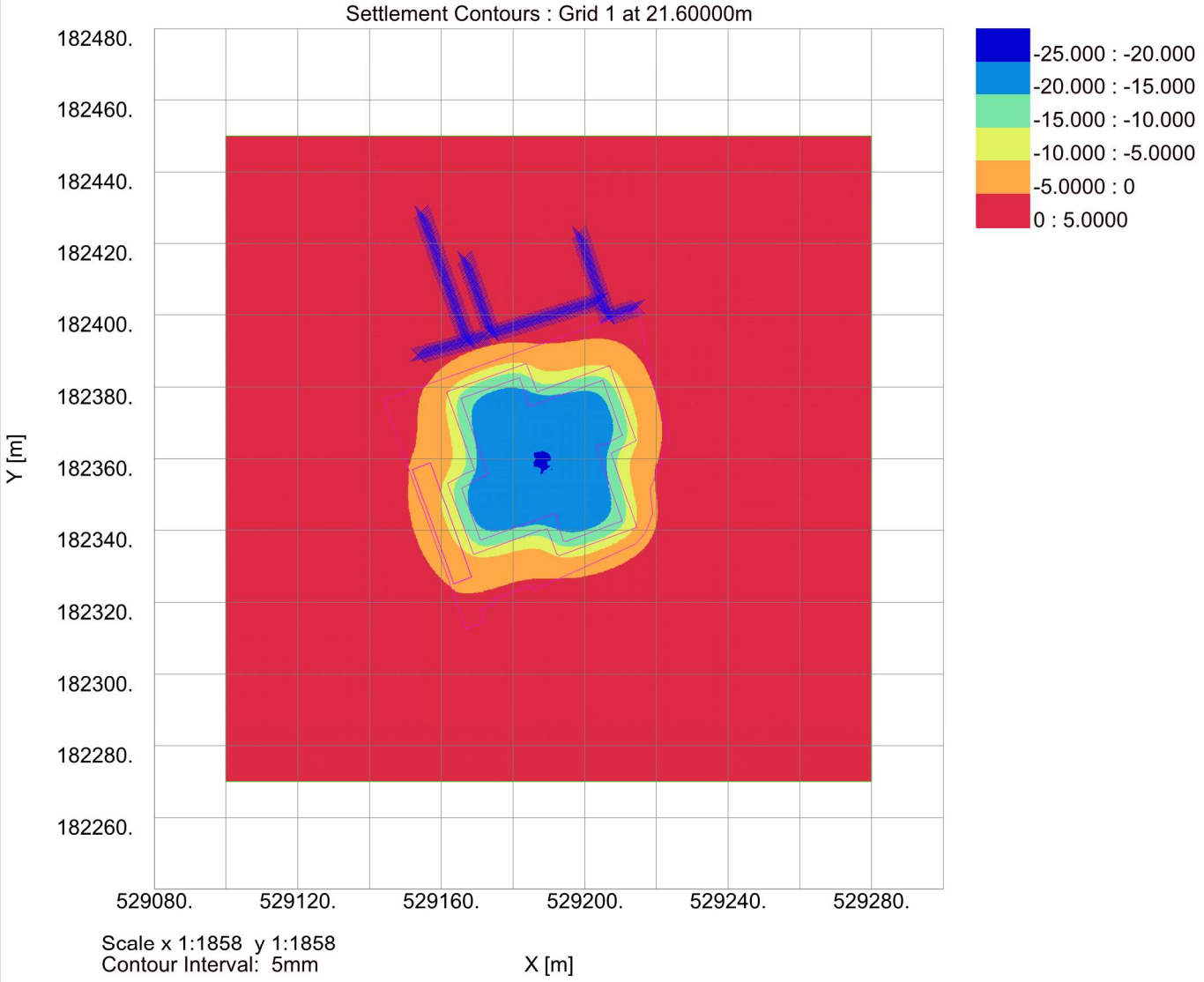
ARUP **Arup**

Euston Tower
BIA
Net loading (during construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024



Analysis Options

General

Global Poisson's ratio: 0.50
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -20.00 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic

Elastic : Yes

Consolidation

Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top [mOD]	Number of intermediate displacement levels	Youngs Modulus : Top [kN/m²]	Youngs Modulus : Btm. [kN/m²]	Poissons ratio	Non-linear curve
1	LC	21.600	36	40000.	840000.	0.50000	None
2	LMB	4.0000	35	84000.	127750.	0.50000	None
3	Thanet sands	-13.500	5	400000.	400000.	0.20000	None

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Grid 1	529100.	529280.	182270.	182450.	Soil Profile 1

Polygonal Load Data

Load Value : ref. Normal (local z) [kN/m²]	Name	Position : Level [m]	Position : Polygon : Coords. [m]	Position : Polygon : Rect. tolerance [%]	No. of Rectangles
1	Pinwheel raft at equiv. level offset -204.00	8.90000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	12
2	New piled raft at equiv. level 204.00	8.90000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	13
3	Pinwheel raft at equiv. level load+demo unloading -88.000	8.90000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	12
4	Excavation unloading at proposed B2 tank -80.000	19.30000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	1
5	B1 slab lowering unloading at +21.6mOD -12.500	21.60000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	23

Load ref.	Name	Position : Level	Position : Polygon : Coords.	Position : Polygon	No. of Rectangles	Value : Normal
			(5.29e+05,1.82e+05) (5.29e+05,1.82e+05)			
6	B2 tank excavation offset at +21.6mOD	21.60000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	1	12.500
7	Exist pinwheel raft offset at +21.6mOD	21.60000	(5.29e+05,1.82e+05) (5.29e+05,1.82e+05)	10.000	19	12.500

Results : Immediate : Displacement Data : Lines

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [μ]
1	A1	529167.15000	182392.65900	21.60000	0.12268	21.484	-8.4979E-6	-0.10841	1.2021E-6
1	A1	529166.98348	182393.12733	21.60000	0.10058	21.484	-6.9690E-6	-0.099451	1.1028E-6
1	A1	529166.81697	182393.59565	21.60000	0.08068	21.484	-5.7799E-6	-0.091628	1.0160E-6
1	A1	529166.65045	182394.06398	21.60000	0.06281	21.484	-4.8419E-6	-0.084744	939.72E-9
1	A1	529166.48393	182394.53231	21.60000	0.04680	21.484	-4.0926E-6	-0.078646	872.12E-9
1	A1	529166.31742	182395.00064	21.60000	0.03248	21.484	-3.4873E-6	-0.073212	811.88E-9
1	A1	529166.15090	182395.46896	21.60000	0.01972	21.484	-2.9933E-6	-0.068345	757.91E-9
1	A1	529165.98438	182395.93729	21.60000	0.00838	21.484	-2.5863E-6	-0.063965	709.34E-9
1	A1	529165.81786	182396.40562	21.60000	-0.00166	21.484	-2.2482E-6	-0.060004	665.43E-9
1	A1	529165.65135	182396.87395	21.60000	-0.01053	21.484	-1.9651E-6	-0.056410	625.57E-9
1	A1	529165.48483	182397.34227	21.60000	-0.01832	21.484	-1.7265E-6	-0.053135	589.26E-9
1	A1	529165.31831	182397.81060	21.60000	-0.02514	21.484	-1.5240E-6	-0.050142	556.07E-9
1	A1	529165.15180	182398.27893	21.60000	-0.03106	21.484	-1.3511E-6	-0.047397	525.63E-9
1	A1	529164.98528	182398.74725	21.60000	-0.03618	21.484	-1.2026E-6	-0.044873	497.64E-9
1	A1	529164.81876	182399.21558	21.60000	-0.04056	21.484	-1.0745E-6	-0.042546	471.84E-9
1	A1	529164.65225	182399.68391	21.60000	-0.04428	21.484	-963.36E-9	-0.040395	447.99E-9
1	A1	529164.48573	182400.15224	21.60000	-0.04740	21.484	-866.56E-9	-0.038402	425.89E-9
1	A1	529164.31921	182400.62056	21.60000	-0.04998	21.484	-781.87E-9	-0.036552	405.37E-9
1	A1	529164.15270	182401.08889	21.60000	-0.05207	21.484	-707.48E-9	-0.034830	386.28E-9
1	A1	529163.98618	182401.55722	21.60000	-0.05372	21.484	-641.90E-9	-0.033226	368.48E-9
1	A1	529163.81966	182402.02555	21.60000	-0.05497	21.484	-583.88E-9	-0.031727	351.87E-9
1	A1	529163.65315	182402.49387	21.60000	-0.05587	21.484	-532.37E-9	-0.030326	336.32E-9
1	A1	529163.48663	182402.96220	21.60000	-0.05646	21.484	-486.51E-9	-0.029013	321.76E-9
1	A1	529163.32011	182403.43053	21.60000	-0.05676	21.484	-445.55E-9	-0.027781	308.10E-9
1	A1	529163.15359	182403.89885	21.60000	-0.05682	21.484	-408.88E-9	-0.026623	295.26E-9
1	A1	529162.98708	182404.36718	21.60000	-0.05665	21.484	-375.94E-9	-0.025534	283.18E-9
1	A1	529162.82056	182404.83551	21.60000	-0.05628	21.484	-346.29E-9	-0.024508	271.80E-9
1	A1	529162.65404	182405.30384	21.60000	-0.05574	21.484	-319.54E-9	-0.023540	261.07E-9
1	A1	529162.48753	182405.77216	21.60000	-0.05506	21.484	-295.34E-9	-0.022626	250.93E-9
1	A1	529162.32101	182406.24049	21.60000	-0.05424	21.484	-273.41E-9	-0.021762	241.35E-9
1	A1	529162.15449	182406.70882	21.60000	-0.05330	21.484	-253.50E-9	-0.020944	232.28E-9
1	A1	529161.98798	182407.17715	21.60000	-0.05227	21.484	-235.37E-9	-0.020169	223.69E-9
1	A1	529161.82146	182407.64547	21.60000	-0.05116	21.484	-218.84E-9	-0.019435	215.54E-9
1	A1	529161.65494	182408.11380	21.60000	-0.04998	21.484	-203.75E-9	-0.018737	207.81E-9
1	A1	529161.48843	182408.58213	21.60000	-0.04874	21.484	-189.94E-9	-0.018075	200.46E-9
1	A1	529161.32191	182409.05045	21.60000	-0.04745	21.484	-177.28E-9	-0.017445	193.48E-9
1	A1	529161.15539	182409.51878	21.60000	-0.04612	21.484	-165.66E-9	-0.016846	186.83E-9
1	A1	529160.98888	182409.98711	21.60000	-0.04477	21.484	-154.98E-9	-0.016275	180.50E-9
1	A1	529160.82236	182410.45544	21.60000	-0.04339	21.484	-145.14E-9	-0.015731	174.47E-9
1	A1	529160.65584	182410.92376	21.60000	-0.04200	21.484	-136.07E-9	-0.015213	168.72E-9
1	A1	529160.48932	182411.39209	21.60000	-0.04060	21.484	-127.70E-9	-0.014718	163.23E-9
1	A1	529160.32281	182411.86042	21.60000	-0.03920	21.484	-119.96E-9	-0.014245	157.98E-9
1	A1	529160.15629	182412.32875	21.60000	-0.03780	21.484	-112.79E-9	-0.013793	152.97E-9
1	A1	529159.98977	182412.79707	21.60000	-0.03641	21.484	-106.15E-9	-0.013361	148.18E-9
1	A1	529159.82326	182413.26540	21.60000	-0.03502	21.484	-99.992E-9	-0.012947	143.59E-9
1	A1	529159.65674	182413.73373	21.60000	-0.03365	21.484	-94.269E-9	-0.012551	139.20E-9
1	A1	529159.49022	182414.20205	21.60000	-0.03230	21.484	-88.947E-9	-0.012172	135.00E-9
1	A1	529159.32371	182414.67038	21.60000	-0.03096	21.484	-83.993E-9	-0.011809	130.97E-9
1	A1	529159.15719	182415.13871	21.60000	-0.02965	21.484	-79.376E-9	-0.011460	127.10E-9
1	A1	529158.99067	182415.60704	21.60000	-0.02836	21.484	-75.069E-9	-0.011125	123.39E-9
1	A1	529158.82416	182416.07536	21.60000	-0.02709	21.484	-71.048E-9	-0.010804	119.83E-9
1	A1	529158.65764	182416.54369	21.60000	-0.02585	21.484	-67.290E-9	-0.010496	116.40E-9
1	A1	529158.49112	182417.01202	21.60000	-0.02463	21.484	-63.775E-9	-0.010199	113.12E-9
1	A1	529158.32461	182417.48035	21.60000	-0.02345	21.484	-60.484E-9	-0.0099142	109.96E-9
1	A1	529158.15809	182417.94867	21.60000	-0.02229	21.484	-57.400E-9	-0.0096401	106.92E-9
1	A1	529157.99157	182418.41700	21.60000	-0.02115	21.484	-54.508E-9	-0.0093763	103.99E-9
1	A1	529157.82505	182418.88533	21.60000	-0.02005	21.484	-51.793E-9	-0.0091223	101.17E-9
1	A1	529157.65854	182419.35365	21.60000	-0.01898	21.484	-49.243E-9	-0.0088777	98.460E-9
1	A1	529157.49202	182419.82198	21.60000	-0.01793	21.484	-46.847E-9	-0.0086420	95.847E-9
1	A1	529157.32550	182420.29031	21.60000	-0.01692	21.484	-44.592E-9	-0.0084149	93.327E-9
1	A1	529157.15899	182420.75864	21.60000	-0.01593	21.484	-42.469E-9	-0.0081958	90.898E-9
1	A1	529156.99247	182421.22696	21.60000	-0.01498	21.484	-40.469E-9	-0.0079845	88.554E-9
1	A1	529156.82595	182421.69529	21.60000	-0.01405	21.484	-38.584E-9	-0.0077806	86.293E-9
1	A1	529156.65944	182422.16362	21.60000	-0.01315	21.484	-36.806E-9	-0.0075838	84.110E-9
1	A1	529156.49292	182422.63195	21.60000	-0.01228	21.484	-35.127E-9	-0.0073937	82.002E-9
1	A1	529156.32640	182423.10027	21.60000	-0.01144	21.484	-33.541E-9	-0.0072101	79.966E-9
1	A1	529156.15989	182423.56860	21.60000	-0.01062	21.484	-32.042E-9	-0.0070327	77.998E-9
1	A1	529155.99337	182424.03693	21.60000	-0.00983	21.484	-30.625E-9	-0.0068612	76.096E-9
1	A1	529155.82685	182424.50525	21.60000	-0.00907	21.484	-29.284E-9	-0.0066953	74.257E-9

ARUP **Arup**

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Euston Tower
BIA
Net loading (end of construction, short term)

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]
1	A1	529155.66034	182424.97358	21.60000	-0.00834	21.484	-28.014E-9	-0.0065349	72.477E-9
1	A1	529155.49382	182425.44191	21.60000	-0.00762	21.484	-26.811E-9	-0.0063797	70.756E-9
1	A1	529155.32730	182425.91024	21.60000	-0.00694	21.484	-25.671E-9	-0.0062295	69.090E-9
1	A1	529155.16078	182426.37856	21.60000	-0.00628	21.484	-24.589E-9	-0.0060840	67.477E-9
1	A1	529154.99427	182426.84689	21.60000	-0.00564	21.484	-23.563E-9	-0.0059432	65.915E-9
1	A1	529154.82775	182427.31522	21.60000	-0.00502	21.484	-22.588E-9	-0.0058067	64.401E-9
1	A1	529154.66123	182427.78355	21.60000	-0.00443	21.484	-21.663E-9	-0.0056745	62.935E-9
1	A1	529154.49472	182428.25187	21.60000	-0.00386	21.484	-20.783E-9	-0.0055464	61.514E-9
1	A1	529154.32820	182428.72020	21.60000	-0.00331	21.484	-19.947E-9	-0.0054222	60.136E-9
2	A2	529153.41830	182388.83000	21.60000	0.26620	21.484	-6.1099E-6	-0.091248	1.0118E-6
2	A2	529153.88859	182388.95975	21.60000	0.27266	21.484	-6.1997E-6	-0.092157	1.0219E-6
2	A2	529154.35888	182389.08950	21.60000	0.27782	21.484	-6.2881E-6	-0.093028	1.0316E-6
2	A2	529154.82918	182389.21925	21.60000	0.28163	21.484	-6.3751E-6	-0.093862	1.0408E-6
2	A2	529155.29947	182389.34900	21.60000	0.28406	21.484	-6.4610E-6	-0.094661	1.0497E-6
2	A2	529155.76976	182389.47875	21.60000	0.28511	21.484	-6.5457E-6	-0.095426	1.0581E-6
2	A2	529156.24006	182389.60850	21.60000	0.28479	21.484	-6.6295E-6	-0.096160	1.0663E-6
2	A2	529156.71035	182389.73825	21.60000	0.28315	21.484	-6.7123E-6	-0.096863	1.0741E-6
2	A2	529157.18064	182389.86800	21.60000	0.28022	21.484	-6.7941E-6	-0.097537	1.0816E-6
2	A2	529157.65093	182389.99775	21.60000	0.27610	21.484	-6.8751E-6	-0.098185	1.0887E-6
2	A2	529158.12123	182390.12750	21.60000	0.27085	21.484	-6.9552E-6	-0.098807	1.0956E-6
2	A2	529158.59152	182390.25725	21.60000	0.26460	21.484	-7.0345E-6	-0.099405	1.1023E-6
2	A2	529159.06181	182390.38700	21.60000	0.25745	21.484	-7.1131E-6	-0.099982	1.1087E-6
2	A2	529159.53210	182390.51675	21.60000	0.24953	21.484	-7.1911E-6	-0.10054	1.1148E-6
2	A2	529160.00239	182390.64650	21.60000	0.24097	21.484	-7.2687E-6	-0.10108	1.1208E-6
2	A2	529160.47269	182390.77625	21.60000	0.23191	21.484	-7.3460E-6	-0.10161	1.1267E-6
2	A2	529160.94298	182390.90600	21.60000	0.22249	21.484	-7.4234E-6	-0.10212	1.1324E-6
2	A2	529161.41327	182391.03575	21.60000	0.21285	21.484	-7.5011E-6	-0.10263	1.1380E-6
2	A2	529161.88357	182391.16550	21.60000	0.20312	21.484	-7.5797E-6	-0.10313	1.1435E-6
2	A2	529162.35386	182391.29525	21.60000	0.19344	21.484	-7.6594E-6	-0.10362	1.1490E-6
2	A2	529162.82415	182391.42500	21.60000	0.18394	21.484	-7.7408E-6	-0.10412	1.1545E-6
2	A2	529163.29444	182391.55475	21.60000	0.17475	21.484	-7.8244E-6	-0.10462	1.1600E-6
2	A2	529163.76473	182391.68450	21.60000	0.16599	21.484	-7.9105E-6	-0.10512	1.1656E-6
2	A2	529164.23503	182391.81425	21.60000	0.15776	21.484	-7.9995E-6	-0.10563	1.1713E-6
2	A2	529164.70532	182391.94400	21.60000	0.15017	21.484	-8.0918E-6	-0.10616	1.1771E-6
2	A2	529165.17561	182392.07375	21.60000	0.14333	21.484	-8.1877E-6	-0.10670	1.1831E-6
2	A2	529165.64591	182392.20350	21.60000	0.13731	21.484	-8.2873E-6	-0.10725	1.1892E-6
2	A2	529166.11620	182392.33325	21.60000	0.13221	21.484	-8.3909E-6	-0.10782	1.1956E-6
2	A2	529166.58649	182392.46300	21.60000	0.12810	21.484	-8.4986E-6	-0.10841	1.2021E-6
2	A2	529167.05678	182392.59275	21.60000	0.12506	21.484	-8.6104E-6	-0.10903	1.2089E-6
2	A2	529167.52707	182392.72250	21.60000	0.12315	21.484	-8.7266E-6	-0.10966	1.2160E-6
2	A2	529167.99737	182392.85225	21.60000	0.12243	21.484	-8.8470E-6	-0.11032	1.2233E-6
2	A2	529168.46766	182392.98200	21.60000	0.12297	21.484	-8.9719E-6	-0.11101	1.2309E-6
2	A2	529168.93795	182393.11175	21.60000	0.12483	21.484	-9.1012E-6	-0.11172	1.2388E-6
2	A2	529169.40824	182393.24150	21.60000	0.12807	21.484	-9.2350E-6	-0.11246	1.2470E-6
2	A2	529169.87854	182393.37125	21.60000	0.13273	21.484	-9.3734E-6	-0.11323	1.2555E-6
2	A2	529170.34883	182393.50100	21.60000	0.13888	21.484	-9.5164E-6	-0.11403	1.2644E-6
2	A2	529170.81912	182393.63075	21.60000	0.14656	21.484	-9.6641E-6	-0.11486	1.2736E-6
2	A2	529171.28942	182393.76050	21.60000	0.15583	21.484	-9.8166E-6	-0.11572	1.2831E-6
2	A2	529171.75971	182393.89025	21.60000	0.16674	21.484	-9.9739E-6	-0.11661	1.2929E-6
2	A2	529172.23000	182394.02000	21.60000	0.17933	21.484	-10.136E-6	-0.11752	1.3031E-6
3	B1	529173.88330	182394.83000	21.60000	0.21775	21.484	-9.3090E-6	-0.11380	1.2618E-6
3	B1	529174.35887	182394.97562	21.60000	0.23654	21.484	-9.4108E-6	-0.11449	1.2695E-6
3	B1	529174.83445	182395.12125	21.60000	0.25693	21.484	-9.5151E-6	-0.11520	1.2773E-6
3	B1	529175.31002	182395.26688	21.60000	0.27890	21.484	-9.6216E-6	-0.11593	1.2854E-6
3	B1	529175.78559	182395.41250	21.60000	0.30240	21.484	-9.7302E-6	-0.11667	1.2937E-6
3	B1	529176.26117	182395.55812	21.60000	0.32739	21.484	-9.8410E-6	-0.11743	1.3021E-6
3	B1	529176.73674	182395.70375	21.60000	0.35379	21.484	-9.9537E-6	-0.11821	1.3107E-6
3	B1	529177.21231	182395.84937	21.60000	0.38153	21.484	-10.068E-6	-0.11900	1.3194E-6
3	B1	529177.68789	182395.99500	21.60000	0.41049	21.484	-10.185E-6	-0.11980	1.3283E-6
3	B1	529178.16346	182396.14063	21.60000	0.44056	21.484	-10.302E-6	-0.12060	1.3373E-6
3	B1	529178.63903	182396.28625	21.60000	0.47162	21.484	-10.422E-6	-0.12142	1.3463E-6
3	B1	529179.11461	182396.43187	21.60000	0.50353	21.484	-10.542E-6	-0.12224	1.3554E-6
3	B1	529179.59018	182396.57750	21.60000	0.53613	21.484	-10.664E-6	-0.12307	1.3646E-6
3	B1	529180.06575	182396.72312	21.60000	0.56927	21.484	-10.787E-6	-0.12389	1.3737E-6
3	B1	529180.54133	182396.86875	21.60000	0.60277	21.484	-10.911E-6	-0.12472	1.3829E-6
3	B1	529181.01690	182397.01437	21.60000	0.63647	21.484	-11.036E-6	-0.12555	1.3921E-6
3	B1	529181.49247	182397.16000	21.60000	0.67020	21.484	-11.162E-6	-0.12637	1.4012E-6
3	B1	529181.96805	182397.30562	21.60000	0.70379	21.484	-11.288E-6	-0.12719	1.4103E-6
3	B1	529182.44362	182397.45125	21.60000	0.73706	21.484	-11.415E-6	-0.12801	1.4193E-6
3	B1	529182.91920	182397.59687	21.60000	0.76987	21.484	-11.542E-6	-0.12881	1.4283E-6
3	B1	529183.39477	182397.74250	21.60000	0.80205	21.484	-11.670E-6	-0.12961	1.4371E-6
3	B1	529183.87034	182397.88812	21.60000	0.83347	21.484	-11.798E-6	-0.13040	1.4459E-6
3	B1	529184.34592	182398.03375	21.60000	0.86400	21.484	-11.926E-6	-0.13118	1.4545E-6
3	B1	529184.82149	182398.17937	21.60000	0.89349	21.484	-12.054E-6	-0.13194	1.4630E-6
3	B1	529185.29706	182398.32500	21.60000	0.92186	21.484	-12.182E-6	-0.13270	1.4713E-6
3	B1	529185.77264	182398.47062	21.60000	0.94899	21.484	-12.309E-6	-0.13343	1.4795E-6
3	B1	529186.24821	182398.61625	21.60000	0.97479	21.484	-12.436E-6	-0.13415	1.4875E-6

ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]
3	B1	529186.72378	182398.76187	21.60000	0.99919	21.484	-12.562E-6	-0.13486	1.4953E-6
3	B1	529187.19936	182398.90750	21.60000	1.02210	21.484	-12.687E-6	-0.13554	1.5029E-6
3	B1	529187.67493	182399.05312	21.60000	1.04347	21.484	-12.811E-6	-0.13621	1.5102E-6
3	B1	529188.15050	182399.19875	21.60000	1.06324	21.484	-12.933E-6	-0.13685	1.5174E-6
3	B1	529188.62608	182399.34437	21.60000	1.08135	21.484	-13.054E-6	-0.13748	1.5243E-6
3	B1	529189.10165	182399.49000	21.60000	1.09777	21.484	-13.172E-6	-0.13808	1.5309E-6
3	B1	529189.57722	182399.63562	21.60000	1.11245	21.484	-13.287E-6	-0.13865	1.5373E-6
3	B1	529190.05280	182399.78125	21.60000	1.12536	21.484	-13.401E-6	-0.13921	1.5435E-6
3	B1	529190.52837	182399.92688	21.60000	1.13645	21.484	-13.512E-6	-0.13973	1.5493E-6
3	B1	529191.00394	182400.07250	21.60000	1.14570	21.484	-13.621E-6	-0.14024	1.5549E-6
3	B1	529191.47952	182400.21812	21.60000	1.15308	21.484	-13.729E-6	-0.14072	1.5603E-6
3	B1	529191.95509	182400.36375	21.60000	1.15855	21.484	-13.836E-6	-0.14118	1.5654E-6
3	B1	529192.43066	182400.50937	21.60000	1.16206	21.484	-13.943E-6	-0.14162	1.5702E-6
3	B1	529192.90624	182400.65500	21.60000	1.16360	21.484	-14.051E-6	-0.14203	1.5748E-6
3	B1	529193.38181	182400.80063	21.60000	1.16311	21.484	-14.160E-6	-0.14242	1.5791E-6
3	B1	529193.85738	182400.94625	21.60000	1.16056	21.484	-14.271E-6	-0.14279	1.5831E-6
3	B1	529194.33296	182401.09187	21.60000	1.15589	21.484	-14.383E-6	-0.14313	1.5870E-6
3	B1	529194.80853	182401.23750	21.60000	1.14907	21.484	-14.497E-6	-0.14345	1.5905E-6
3	B1	529195.28410	182401.38312	21.60000	1.14004	21.484	-14.613E-6	-0.14374	1.5937E-6
3	B1	529195.75968	182401.52875	21.60000	1.12875	21.484	-14.730E-6	-0.14400	1.5967E-6
3	B1	529196.23525	182401.67438	21.60000	1.11516	21.484	-14.848E-6	-0.14424	1.5992E-6
3	B1	529196.71082	182401.82000	21.60000	1.09921	21.484	-14.966E-6	-0.14444	1.6015E-6
3	B1	529197.18640	182401.96562	21.60000	1.08088	21.484	-15.085E-6	-0.14461	1.6033E-6
3	B1	529197.66197	182402.11125	21.60000	1.06012	21.484	-15.203E-6	-0.14474	1.6048E-6
3	B1	529198.13755	182402.25687	21.60000	1.03691	21.484	-15.321E-6	-0.14482	1.6057E-6
3	B1	529198.61312	182402.40250	21.60000	1.01125	21.484	-15.439E-6	-0.14487	1.6062E-6
3	B1	529199.08869	182402.54813	21.60000	0.98315	21.484	-15.555E-6	-0.14487	1.6062E-6
3	B1	529199.56427	182402.69375	21.60000	0.95264	21.484	-15.670E-6	-0.14482	1.6056E-6
3	B1	529200.03984	182402.83937	21.60000	0.91978	21.484	-15.784E-6	-0.14471	1.6044E-6
3	B1	529200.51541	182402.98500	21.60000	0.88467	21.484	-15.897E-6	-0.14455	1.6026E-6
3	B1	529200.99099	182403.13062	21.60000	0.84743	21.484	-16.008E-6	-0.14433	1.6002E-6
3	B1	529201.46656	182403.27625	21.60000	0.80822	21.484	-16.118E-6	-0.14404	1.5970E-6
3	B1	529201.94213	182403.42188	21.60000	0.76725	21.484	-16.225E-6	-0.14368	1.5930E-6
3	B1	529202.41771	182403.56750	21.60000	0.72473	21.484	-16.330E-6	-0.14324	1.5881E-6
3	B1	529202.89328	182403.71312	21.60000	0.68095	21.484	-16.430E-6	-0.14272	1.5823E-6
3	B1	529203.36885	182403.85875	21.60000	0.63619	21.484	-16.524E-6	-0.14210	1.5755E-6
3	B1	529203.84443	182404.00437	21.60000	0.59076	21.484	-16.611E-6	-0.14139	1.5676E-6
3	B1	529204.32000	182404.15000	21.60000	0.54500	21.484	-16.689E-6	-0.14056	1.5584E-6
4	B2	529206.12000	182399.49000	21.60000	1.97104	21.484	-0.0026639	-1.0827	11.920E-6
4	B2	529206.60167	182399.64000	21.60000	1.78882	21.484	-0.0028058	-1.0999	12.105E-6
4	B2	529207.08333	182399.79000	21.60000	1.61160	21.484	-0.0029579	-1.1173	12.293E-6
4	B2	529207.56500	182399.94000	21.60000	1.44139	21.484	-0.0031212	-1.1350	12.484E-6
4	B2	529208.04667	182400.09000	21.60000	1.27976	21.484	-0.0032968	-1.1529	12.677E-6
4	B2	529208.52833	182400.24000	21.60000	1.12779	21.484	-0.0034858	-1.1711	12.873E-6
4	B2	529209.01000	182400.39000	21.60000	0.98615	21.484	-0.0036896	-1.1894	13.069E-6
4	B2	529209.49167	182400.54000	21.60000	0.85513	21.484	-0.0039095	-1.2079	13.267E-6
4	B2	529209.97333	182400.69000	21.60000	0.73473	21.484	-0.0041457	-1.2264	13.464E-6
4	B2	529210.45500	182400.84000	21.60000	0.62473	21.484	-0.0043926	-1.2447	13.658E-6
4	B2	529210.93667	182400.99000	21.60000	0.52472	21.484	-0.0046320	-1.2628	13.851E-6
4	B2	529211.41833	182401.14000	21.60000	0.43419	21.484	-0.0049298	-1.2853	14.091E-6
4	B2	529211.90000	182401.29000	21.60000	0.35264	21.484	-0.0055104	-1.3172	14.426E-6
4	B2	529212.38167	182401.44000	21.60000	0.27988	21.484	-0.0060584	-1.3354	14.610E-6
4	B2	529212.86333	182401.59000	21.60000	0.21575	21.484	-0.0065508	-1.3228	14.453E-6
4	B2	529213.34500	182401.74000	21.60000	0.16020	21.484	-0.0066225	-1.2467	13.606E-6
4	B2	529213.82667	182401.89000	21.60000	0.11303	21.484	-0.0054530	-1.0669	11.652E-6
4	B2	529214.30833	182402.04000	21.60000	0.07303	21.484	-0.0033400	-0.81543	8.9327E-6
4	B2	529214.79000	182402.19000	21.60000	0.03823	21.484	-0.0014640	-0.57875	6.3701E-6
5	B3	529206.13650	182399.46000	21.60000	1.98349	21.484	-0.0029098	-1.1182	12.305E-6
5	B3	529205.98317	182399.93040	21.60000	1.77172	21.484	-978.45E-6	-0.74619	8.2434E-6
5	B3	529205.82984	182400.40080	21.60000	1.57499	21.484	-439.36E-6	-0.54903	6.0747E-6
5	B3	529205.67651	182400.87120	21.60000	1.39443	21.484	-233.05E-6	-0.42757	4.7344E-6
5	B3	529205.52318	182401.34160	21.60000	1.22995	21.484	-137.72E-6	-0.34565	3.8290E-6
5	B3	529205.36985	182401.81200	21.60000	1.08091	21.484	-87.782E-6	-0.28694	3.1795E-6
5	B3	529205.21652	182402.28240	21.60000	0.94634	21.484	-59.162E-6	-0.24300	2.6931E-6
5	B3	529205.06319	182402.75280	21.60000	0.82520	21.484	-41.618E-6	-0.20902	2.3169E-6
5	B3	529204.90986	182403.22320	21.60000	0.71636	21.484	-30.287E-6	-0.18208	2.0184E-6
5	B3	529204.75653	182403.69360	21.60000	0.61875	21.484	-22.656E-6	-0.16027	1.7768E-6
5	B3	529204.60320	182404.16400	21.60000	0.53133	21.484	-17.339E-6	-0.14233	1.5779E-6
5	B3	529204.44987	182404.63440	21.60000	0.45315	21.484	-13.528E-6	-0.12735	1.4120E-6
5	B3	529204.29654	182405.10480	21.60000	0.38332	21.484	-10.730E-6	-0.11470	1.2717E-6
5	B3	529204.14321	182405.57520	21.60000	0.32101	21.484	-8.6332E-6	-0.10390	1.1521E-6
5	B3	529203.98988	182406.04560	21.60000	0.26549	21.484	-7.0336E-6	-0.094605	1.0490E-6
5	B3	529203.83655	182406.51600	21.60000	0.21609	21.484	-5.7943E-6	-0.086537	959.58E-9
5	B3	529203.68322	182406.98640	21.60000	0.17218	21.484	-4.8208E-6	-0.079484	881.39E-9
5	B3	529203.52989	182407.45680	21.60000	0.13323	21.484	-4.0467E-6	-0.073280	812.60E-9
5	B3	529203.37656	182407.92720	21.60000	0.09874	21.484	-3.4243E-6	-0.067790	751.74E-9
5	B3	529203.22323	182408.39760	21.60000	0.06825	21.484	-2.9189E-6	-0.062907	697.60E-9

ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x	y	z	δz	Stress: Calc. Level	Stress: Vertical	Stress: Sum Princ.	Vert. Strain
		[m]	[m]	[mOD]	[mm]	[mOD]	[kN/m²]	[kN/m²]	[u]
5	B3	529203.06990	182408.86800	21.60000	0.04135	21.484	-2.5047E-6	-0.058543	649.21E-9
5	B3	529202.91657	182409.33840	21.60000	0.01770	21.484	-2.1626E-6	-0.054625	605.77E-9
5	B3	529202.76324	182409.80880	21.60000	-0.00306	21.484	-1.8777E-6	-0.051094	566.62E-9
5	B3	529202.60991	182410.27920	21.60000	-0.02120	21.484	-1.6389E-6	-0.047900	531.20E-9
5	B3	529202.45658	182410.74960	21.60000	-0.03701	21.484	-1.4375E-6	-0.045000	499.04E-9
5	B3	529202.30325	182411.22000	21.60000	-0.05071	21.484	-1.2664E-6	-0.042358	469.75E-9
5	B3	529202.14992	182411.69040	21.60000	-0.06254	21.484	-1.1204E-6	-0.039945	442.99E-9
5	B3	529201.99659	182412.16080	21.60000	-0.07268	21.484	-995.19E-9	-0.037734	418.47E-9
5	B3	529201.84326	182412.63120	21.60000	-0.08132	21.484	-887.19E-9	-0.035703	395.95E-9
5	B3	529201.68993	182413.10160	21.60000	-0.08861	21.484	-793.65E-9	-0.033833	375.21E-9
5	B3	529201.53660	182413.57200	21.60000	-0.09470	21.484	-712.27E-9	-0.032106	356.06E-9
5	B3	529201.38327	182414.04240	21.60000	-0.09971	21.484	-641.20E-9	-0.030509	338.35E-9
5	B3	529201.22994	182414.51280	21.60000	-0.10377	21.484	-578.89E-9	-0.029028	321.93E-9
5	B3	529201.07661	182414.98320	21.60000	-0.10698	21.484	-524.06E-9	-0.027653	306.68E-9
5	B3	529200.92328	182415.45360	21.60000	-0.10943	21.484	-475.65E-9	-0.026373	292.48E-9
5	B3	529200.76995	182415.92400	21.60000	-0.11122	21.484	-432.77E-9	-0.025180	279.25E-9
5	B3	529200.61662	182416.39440	21.60000	-0.11241	21.484	-394.68E-9	-0.024065	266.89E-9
5	B3	529200.46329	182416.86480	21.60000	-0.11308	21.484	-360.73E-9	-0.023023	255.33E-9
5	B3	529200.30996	182417.33520	21.60000	-0.11329	21.484	-330.40E-9	-0.022046	244.50E-9
5	B3	529200.15663	182417.80560	21.60000	-0.11309	21.484	-303.23E-9	-0.021130	234.34E-9
5	B3	529200.00330	182418.27600	21.60000	-0.11255	21.484	-278.82E-9	-0.020269	224.80E-9
5	B3	529199.84997	182418.74640	21.60000	-0.11169	21.484	-256.85E-9	-0.019460	215.82E-9
5	B3	529199.69664	182419.21680	21.60000	-0.11056	21.484	-237.02E-9	-0.018697	207.36E-9
5	B3	529199.54331	182419.68720	21.60000	-0.10921	21.484	-219.09E-9	-0.017977	199.38E-9
5	B3	529199.38998	182420.15760	21.60000	-0.10766	21.484	-202.84E-9	-0.017298	191.85E-9
5	B3	529199.23665	182420.62800	21.60000	-0.10593	21.484	-188.08E-9	-0.016656	184.73E-9
5	B3	529199.08332	182421.09840	21.60000	-0.10407	21.484	-174.66E-9	-0.016049	177.99E-9
5	B3	529198.92999	182421.56880	21.60000	-0.10208	21.484	-162.42E-9	-0.015473	171.61E-9
5	B3	529198.77666	182422.03920	21.60000	-0.10000	21.484	-151.25E-9	-0.014927	165.55E-9
5	B3	529198.62333	182422.50960	21.60000	-0.09784	21.484	-141.02E-9	-0.014410	159.81E-9
5	B3	529198.47000	182422.98000	21.60000	-0.09561	21.484	-131.66E-9	-0.013918	154.35E-9
6	B4	529173.89290	182394.83000	21.60000	0.21827	21.484	-9.3219E-6	-0.11387	1.2626E-6
6	B4	529173.72839	182395.30222	21.60000	0.18522	21.484	-7.5971E-6	-0.10423	1.1558E-6
6	B4	529173.56388	182395.77444	21.60000	0.15535	21.484	-6.2663E-6	-0.095851	1.0629E-6
6	B4	529173.39937	182396.24667	21.60000	0.12841	21.484	-5.2239E-6	-0.088504	981.42E-9
6	B4	529173.23486	182396.71889	21.60000	0.10416	21.484	-4.3965E-6	-0.082018	909.51E-9
6	B4	529173.07036	182397.19111	21.60000	0.08237	21.484	-3.7318E-6	-0.076256	845.62E-9
6	B4	529172.90585	182397.66333	21.60000	0.06283	21.484	-3.1921E-6	-0.071108	788.55E-9
6	B4	529172.74134	182398.13556	21.60000	0.04535	21.484	-2.7496E-6	-0.066486	737.29E-9
6	B4	529172.57683	182398.60778	21.60000	0.02975	21.484	-2.3835E-6	-0.062316	691.06E-9
6	B4	529172.41232	182399.08000	21.60000	0.01587	21.484	-2.0782E-6	-0.058538	649.17E-9
6	B4	529172.24781	182399.55222	21.60000	0.00355	21.484	-1.8217E-6	-0.055103	611.08E-9
6	B4	529172.08330	182400.02444	21.60000	-0.00734	21.484	-1.6047E-6	-0.051967	576.31E-9
6	B4	529171.91879	182400.49667	21.60000	-0.01694	21.484	-1.4200E-6	-0.049096	544.48E-9
6	B4	529171.75428	182400.96889	21.60000	-0.02536	21.484	-1.2619E-6	-0.046459	515.24E-9
6	B4	529171.58978	182401.44111	21.60000	-0.03271	21.484	-1.1257E-6	-0.044031	488.31E-9
6	B4	529171.42527	182401.91333	21.60000	-0.03909	21.484	-1.0079E-6	-0.041788	463.44E-9
6	B4	529171.26076	182402.38556	21.60000	-0.04458	21.484	-905.51E-9	-0.039712	440.42E-9
6	B4	529171.09625	182402.85778	21.60000	-0.04928	21.484	-816.10E-9	-0.037787	419.06E-9
6	B4	529170.93174	182403.33000	21.60000	-0.05326	21.484	-737.70E-9	-0.035996	399.20E-9
6	B4	529170.76723	182403.80222	21.60000	-0.05658	21.484	-668.70E-9	-0.034328	380.71E-9
6	B4	529170.60272	182404.27444	21.60000	-0.05932	21.484	-607.75E-9	-0.032771	363.44E-9
6	B4	529170.43821	182404.74667	21.60000	-0.06153	21.484	-553.72E-9	-0.031316	347.30E-9
6	B4	529170.27370	182405.21889	21.60000	-0.06326	21.484	-505.68E-9	-0.029952	332.18E-9
6	B4	529170.10920	182405.69111	21.60000	-0.06457	21.484	-462.82E-9	-0.028674	318.01E-9
6	B4	529169.94469	182406.16333	21.60000	-0.06550	21.484	-424.48E-9	-0.027473	304.69E-9
6	B4	529169.78018	182406.63556	21.60000	-0.06608	21.484	-390.09E-9	-0.026343	292.16E-9
6	B4	529169.61567	182407.10778	21.60000	-0.06637	21.484	-359.16E-9	-0.025279	280.36E-9
6	B4	529169.45116	182407.58000	21.60000	-0.06638	21.484	-331.27E-9	-0.024276	269.23E-9
6	B4	529169.28665	182408.05222	21.60000	-0.06616	21.484	-306.07E-9	-0.023329	258.73E-9
6	B4	529169.12214	182408.52444	21.60000	-0.06572	21.484	-283.25E-9	-0.022433	248.80E-9
6	B4	529168.95763	182408.99667	21.60000	-0.06510	21.484	-262.53E-9	-0.021586	239.40E-9
6	B4	529168.79312	182409.46889	21.60000	-0.06432	21.484	-243.68E-9	-0.020783	230.50E-9
6	B4	529168.62862	182409.94111	21.60000	-0.06339	21.484	-226.51E-9	-0.020022	222.06E-9
6	B4	529168.46411	182410.41333	21.60000	-0.06235	21.484	-210.83E-9	-0.019300	214.05E-9
6	B4	529168.29960	182410.88556	21.60000	-0.06120	21.484	-196.50E-9	-0.018614	206.44E-9
6	B4	529168.13509	182411.35778	21.60000	-0.05996	21.484	-183.36E-9	-0.017962	199.20E-9
6	B4	529167.97058	182411.83000	21.60000	-0.05865	21.484	-171.30E-9	-0.017341	192.32E-9
6	B4	529167.80607	182412.30222	21.60000	-0.05728	21.484	-160.23E-9	-0.016750	185.77E-9
6	B4	529167.64156	182412.77444	21.60000	-0.05585	21.484	-150.03E-9	-0.016187	179.52E-9
6	B4	529167.47705	182413.24667	21.60000	-0.05439	21.484	-140.63E-9	-0.015649	173.56E-9
6	B4	529167.31254	182413.71889	21.60000	-0.05289	21.484	-131.95E-9	-0.015137	167.88E-9
6	B4	529167.14804	182414.19111	21.60000	-0.05138	21.484	-123.93E-9	-0.014647	162.45E-9
6	B4	529166.98353	182414.66333	21.60000	-0.04984	21.484	-116.51E-9	-0.014179	157.26E-9
6	B4	529166.81902	182415.13556	21.60000	-0.04830	21.484	-109.63E-9	-0.013732	152.30E-9
6	B4	529166.65451	182415.60778	21.60000	-0.04675	21.484	-103.25E-9	-0.013304	147.55E-9
6	B4	529166.49000	182416.08000	21.60000	-0.04521	21.484	-97.326E-9	-0.012894	143.00E-9

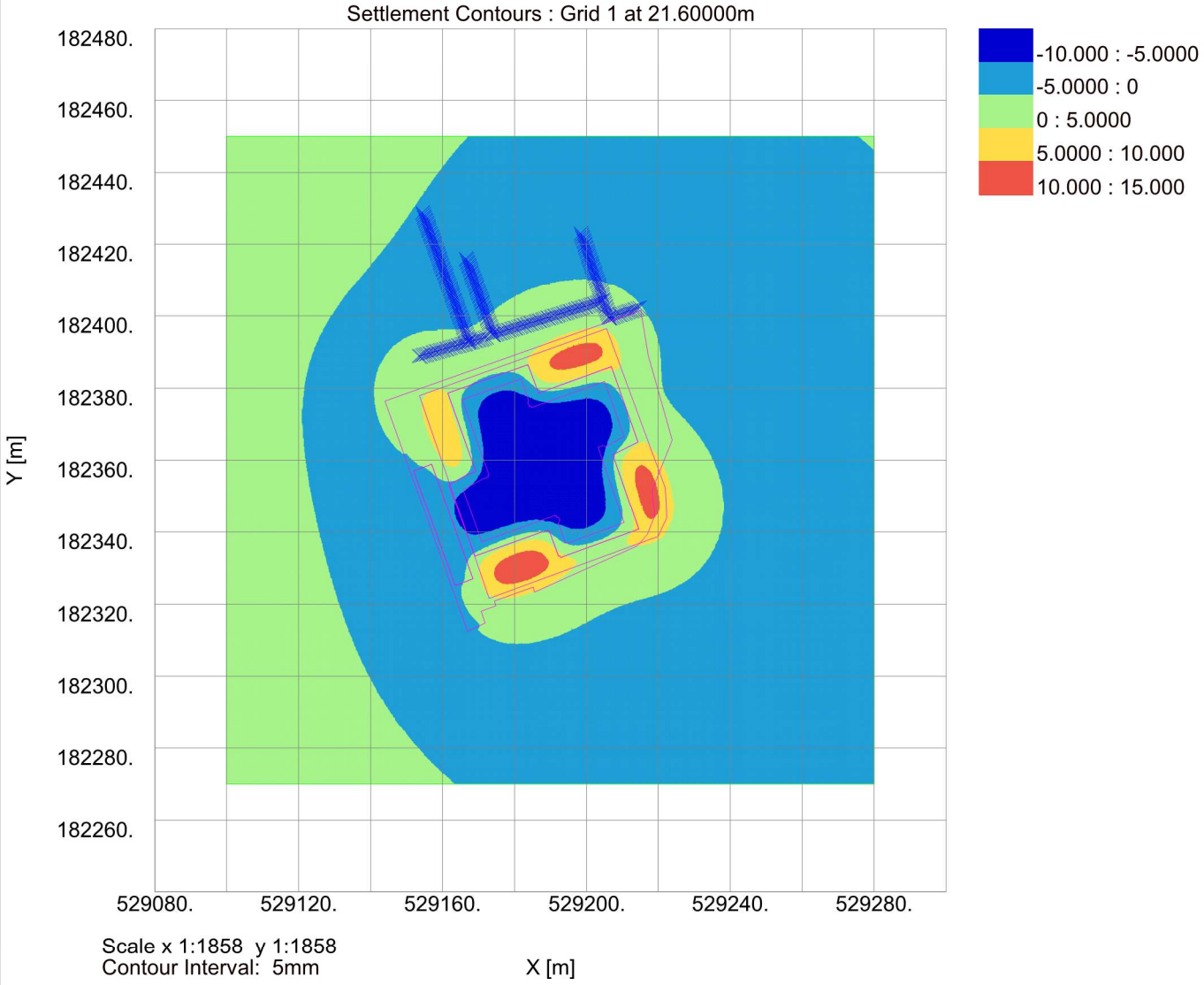
ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, short term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024



Analysis Options

General

Global Poisson's ratio: 0.20
Maximum allowable ratio between values of E: 1.5
Horizontal rigid boundary level: -20.00 [m OD]
Displacements at load centroids: Yes
GSA piled raft data : No

Elastic

Elastic : Yes

Consolidation

Consolidation : No

Soil ProfilesSoil Profile 1

Layer ref.	Name	Level at top [mOD]	Number of intermediate displacement levels	Youngs Modulus : Top [kN/m²]	Youngs Modulus : Btm. [kN/m²]	Poissons ratio	Non-linear curve
1	LC	21.600	36	25600.	53760.	0.20000	None
2	LMB	4.0000	35	53760.	81760.	0.20000	None
3	Thanet sands	-13.500	5	400000.	400000.	0.20000	None

Soil Zones

Zone	Name	X min [m]	X max [m]	Y min [m]	Y max [m]	Profile
1	Grid 1	529140.	529240.	182310.	182410.	Soil Profile 1

Polygonal Load Data

Load Value : ref. Normal (local z) [kN/m²]	Name	Position : Level [m]	Position : Polygon : Coords. [m]	Position : Polygon : Rect. tolerance [%]	No. of Rectangles
1	Pinwheel raft at equiv. level offset -204.00	8.90000	(5.29e+05,1.82e+05)	10.000	12
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
2	New piled raft at equiv. level 204.00	8.90000	(5.29e+05,1.82e+05)	10.000	13
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
3	Pinwheel raft at equiv. level load + -88.000	8.90000	(5.29e+05,1.82e+05)	10.000	12
	demo unloading		(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
4	Excavation unloading at proposed B2 tank -80.000	19.30000	(5.29e+05,1.82e+05)	10.000	1
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
5	B1 slab lowering unloading at +21.6mOD -12.500	21.60000	(5.29e+05,1.82e+05)	10.000	23
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		
			(5.29e+05,1.82e+05)		

Load ref.	Name	Position : Level	Position : Polygon : Coords.	Position : Polygon	No. of Rectangles	Value : Normal
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
6	B2 tank excavation offset at +21.6mOD	21.60000	(5.29e+05,1.82e+05)	10.000	1	12.500
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
7	Exist pinwheel raft offset at +21.6mOD	21.60000	(5.29e+05,1.82e+05)	10.000	19	12.500
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
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			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			
			(5.29e+05,1.82e+05)			

Results : Immediate : Displacement Data : Lines

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [μ]	
1	A1	529167.15000	182392.65900	21.60000	0.08473	21.398	-44.745E-6	-0.15087	1.1620E-6	
1	A1	529166.98348	182393.12733	21.60000	0.07634	21.398	-36.698E-6	-0.13841	1.0662E-6	
1	A1	529166.81697	182393.59565	21.60000	0.06824	21.398	-30.438E-6	-0.12753	982.50E-9	
1	A1	529166.65045	182394.06398	21.60000	0.06048	21.398	-25.499E-6	-0.11795	908.82E-9	
1	A1	529166.48393	182394.53231	21.60000	0.05305	21.398	-21.554E-6	-0.10946	843.53E-9	
1	A1	529166.31742	182395.00064	21.60000	0.04599	21.398	-18.367E-6	-0.10190	785.35E-9	
1	A1	529166.15090	182395.46896	21.60000	0.03931	21.398	-15.765E-6	-0.095128	733.21E-9	
1	A1	529165.98438	182395.93729	21.60000	0.03301	21.398	-13.622E-6	-0.089032	686.27E-9	
1	A1	529165.81786	182396.40562	21.60000	0.02710	21.398	-11.842E-6	-0.083520	643.83E-9	
1	A1	529165.65135	182396.87395	21.60000	0.02158	21.398	-10.351E-6	-0.078517	605.30E-9	
1	A1	529165.48483	182397.34227	21.60000	0.01646	21.398	-9.0942E-6	-0.073960	570.20E-9	
1	A1	529165.31831	182397.81060	21.60000	0.01172	21.398	-8.0276E-6	-0.069794	538.11E-9	
1	A1	529165.15180	182398.27893	21.60000	0.00736	21.398	-7.1169E-6	-0.065974	508.68E-9	
1	A1	529164.98528	182398.74725	21.60000	0.00336	21.398	-6.3349E-6	-0.062461	481.61E-9	
1	A1	529164.81876	182399.21558	21.60000	-0.00028	21.398	-5.6601E-6	-0.059222	456.65E-9	
1	A1	529164.65225	182399.68391	21.60000	-0.00358	21.398	-5.0748E-6	-0.056228	433.58E-9	
1	A1	529164.48573	182400.15224	21.60000	-0.00656	21.398	-4.5649E-6	-0.053454	412.20E-9	
1	A1	529164.31921	182400.62056	21.60000	-0.00923	21.398	-4.1188E-6	-0.050879	392.35E-9	
1	A1	529164.15270	182401.08889	21.60000	-0.01160	21.398	-3.7270E-6	-0.048483	373.89E-9	
1	A1	529163.98618	182401.55722	21.60000	-0.01371	21.398	-3.3815E-6	-0.046249	356.67E-9	
1	A1	529163.81966	182402.02555	21.60000	-0.01555	21.398	-3.0759E-6	-0.044164	340.59E-9	
1	A1	529163.65315	182402.49387	21.60000	-0.01715	21.398	-2.8046E-6	-0.042213	325.56E-9	
1	A1	529163.48663	182402.96220	21.60000	-0.01852	21.398	-2.5630E-6	-0.040385	311.47E-9	
1	A1	529163.32011	182403.43053	21.60000	-0.01969	21.398	-2.3472E-6	-0.038670	298.24E-9	
1	A1	529163.15359	182403.89885	21.60000	-0.02066	21.398	-2.1540E-6	-0.037059	285.82E-9	
1	A1	529162.98708	182404.36718	21.60000	-0.02146	21.398	-1.9805E-6	-0.035543	274.13E-9	
1	A1	529162.82056	182404.83551	21.60000	-0.02209	21.398	-1.8243E-6	-0.034115	263.12E-9	
1	A1	529162.65404	182405.30384	21.60000	-0.02257	21.398	-1.6834E-6	-0.032767	252.73E-9	
1	A1	529162.48753	182405.77216	21.60000	-0.02291	21.398	-1.5559E-6	-0.031495	242.92E-9	
1	A1	529162.32101	182406.24049	21.60000	-0.02312	21.398	-1.4404E-6	-0.030292	233.65E-9	
1	A1	529162.15449	182406.70882	21.60000	-0.02322	21.398	-1.3355E-6	-0.029154	224.87E-9	
1	A1	529161.98798	182407.17715	21.60000	-0.02322	21.398	-1.2400E-6	-0.028076	216.55E-9	
1	A1	529161.82146	182407.64547	21.60000	-0.02312	21.398	-1.1529E-6	-0.027053	208.67E-9	
1	A1	529161.65494	182408.11380	21.60000	-0.02295	21.398	-1.0734E-6	-0.026083	201.19E-9	
1	A1	529161.48843	182408.58213	21.60000	-0.02269	21.398	-1.0006E-6	-0.025161	194.08E-9	
1	A1	529161.32191	182409.05045	21.60000	-0.02238	21.398	-933.96E-9	-0.024284	187.31E-9	
1	A1	529161.15539	182409.51878	21.60000	-0.02200	21.398	-872.74E-9	-0.023450	180.88E-9	
1	A1	529160.98888	182409.98711	21.60000	-0.02157	21.398	-816.46E-9	-0.022655	174.76E-9	
1	A1	529160.82236	182410.45544	21.60000	-0.02110	21.398	-764.65E-9	-0.021898	168.92E-9	!
1	A1	529160.65584	182410.92376	21.60000	-0.02058	21.398	-716.87E-9	-0.021176	163.35E-9	!
1	A1	529160.48932	182411.39209	21.60000	-0.02004	21.398	-672.76E-9	-0.020487	158.03E-9	!
1	A1	529160.32281	182411.86042	21.60000	-0.01946	21.398	-631.99E-9	-0.019829	152.96E-9	!
1	A1	529160.15629	182412.32875	21.60000	-0.01887	21.398	-594.24E-9	-0.019200	148.11E-9	!
1	A1	529159.98977	182412.79707	21.60000	-0.01825	21.398	-559.26E-9	-0.018598	143.47E-9	!
1	A1	529159.82326	182413.26540	21.60000	-0.01762	21.398	-526.80E-9	-0.018023	139.03E-9	!
1	A1	529159.65674	182413.73373	21.60000	-0.01697	21.398	-496.65E-9	-0.017472	134.78E-9	!
1	A1	529159.49022	182414.20205	21.60000	-0.01632	21.398	-468.61E-9	-0.016944	130.71E-9	!
1	A1	529159.32371	182414.67038	21.60000	-0.01566	21.398	-442.51E-9	-0.016438	126.80E-9	!
1	A1	529159.15719	182415.13871	21.60000	-0.01500	21.398	-418.19E-9	-0.015953	123.06E-9	!
1	A1	529158.99067	182415.60704	21.60000	-0.01434	21.398	-395.50E-9	-0.015487	119.47E-9	!
1	A1	529158.82416	182416.07536	21.60000	-0.01368	21.398	-374.32E-9	-0.015040	116.02E-9	!
1	A1	529158.65764	182416.54369	21.60000	-0.01302	21.398	-354.52E-9	-0.014610	112.71E-9	!
1	A1	529158.49112	182417.01202	21.60000	-0.01236	21.398	-336.00E-9	-0.014198	109.52E-9	!
1	A1	529158.32461	182417.48035	21.60000	-0.01171	21.398	-318.66E-9	-0.013801	106.46E-9	!
1	A1	529158.15809	182417.94867	21.60000	-0.01107	21.398	-302.41E-9	-0.013419	103.52E-9	!
1	A1	529157.99157	182418.41700	21.60000	-0.01044	21.398	-287.17E-9	-0.013052	100.69E-9	!
1	A1	529157.82505	182418.88533	21.60000	-0.00982	21.398	-272.87E-9	-0.012699	97.960E-9	!
1	A1	529157.65854	182419.35365	21.60000	-0.00921	21.398	-259.44E-9	-0.012358	95.334E-9	!
1	A1	529157.49202	182419.82198	21.60000	-0.00861	21.398	-246.81E-9	-0.012030	92.803E-9	!
1	A1	529157.32550	182420.29031	21.60000	-0.00802	21.398	-234.93E-9	-0.011714	90.364E-9	!
1	A1	529157.15899	182420.75864	21.60000	-0.00744	21.398	-223.75E-9	-0.011409	88.012E-9	!
1	A1	529156.99247	182421.22696	21.60000	-0.00688	21.398	-213.21E-9	-0.011115	85.744E-9	!
1	A1	529156.82595	182421.69529	21.60000	-0.00633	21.398	-203.28E-9	-0.010831	83.554E-9	!
1	A1	529156.65944	182422.16362	21.60000	-0.00579	21.398	-193.91E-9	-0.010557	81.441E-9	!
1	A1	529156.49292	182422.63195	21.60000	-0.00527	21.398	-185.07E-9	-0.010292	79.400E-9	!
1	A1	529156.32640	182423.10027	21.60000	-0.00476	21.398	-176.71E-9	-0.010037	77.428E-9	!
1	A1	529156.15989	182423.56860	21.60000	-0.00426	21.398	-168.82E-9	-0.0097898	75.523E-9	!
1	A1	529155.99337	182424.03693	21.60000	-0.00378	21.398	-161.35E-9	-0.0095510	73.681E-9	!
1	A1	529155.82685	182424.50525	21.60000	-0.00331	21.398	-154.28E-9	-0.0093202	71.901E-9	!

ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, long term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]	
1	A1	529155.66034	182424.97358	21.60000	-0.00286	21.398	-147.59E-9	-0.0090969	70.178E-9	!
1	A1	529155.49382	182425.44191	21.60000	-0.00242	21.398	-141.25E-9	-0.0088808	68.511E-9	!
1	A1	529155.32730	182425.91024	21.60000	-0.00199	21.398	-135.25E-9	-0.0086717	66.898E-9	!
1	A1	529155.16078	182426.37856	21.60000	-0.00158	21.398	-129.55E-9	-0.0084692	65.336E-9	!
1	A1	529154.99427	182426.84689	21.60000	-0.00118	21.398	-124.14E-9	-0.0082732	63.824E-9	!
1	A1	529154.82775	182427.31522	21.60000	-0.00079	21.398	-119.01E-9	-0.0080832	62.359E-9	!
1	A1	529154.66123	182427.78355	21.60000	-0.00042	21.398	-114.13E-9	-0.0078992	60.939E-9	!
1	A1	529154.49472	182428.25187	21.60000	-0.00006	21.398	-109.50E-9	-0.0077208	59.563E-9	!
1	A1	529154.32820	182428.72020	21.60000	0.00029	21.398	-105.09E-9	-0.0075479	58.229E-9	!
2	A2	529153.41830	182388.83000	21.60000	0.46750	21.398	-32.175E-6	-0.12700	978.33E-9	
2	A2	529153.88859	182388.95975	21.60000	0.47544	21.398	-32.648E-6	-0.12826	988.06E-9	
2	A2	529154.35888	182389.08950	21.60000	0.48080	21.398	-33.113E-6	-0.12947	997.39E-9	
2	A2	529154.82918	182389.21925	21.60000	0.48350	21.398	-33.571E-6	-0.13063	1.0063E-6	
2	A2	529155.29947	182389.34900	21.60000	0.48349	21.398	-34.024E-6	-0.13175	1.0149E-6	
2	A2	529155.76976	182389.47875	21.60000	0.48079	21.398	-34.470E-6	-0.13281	1.0231E-6	
2	A2	529156.24006	182389.60850	21.60000	0.47544	21.398	-34.911E-6	-0.13383	1.0309E-6	
2	A2	529156.71035	182389.73825	21.60000	0.46751	21.398	-35.346E-6	-0.13481	1.0385E-6	
2	A2	529157.18064	182389.86800	21.60000	0.45713	21.398	-35.777E-6	-0.13575	1.0457E-6	
2	A2	529157.65093	182389.99775	21.60000	0.44444	21.398	-36.204E-6	-0.13665	1.0526E-6	
2	A2	529158.12123	182390.12750	21.60000	0.42964	21.398	-36.625E-6	-0.13751	1.0593E-6	
2	A2	529158.59152	182390.25725	21.60000	0.41294	21.398	-37.043E-6	-0.13835	1.0657E-6	
2	A2	529159.06181	182390.38700	21.60000	0.39456	21.398	-37.457E-6	-0.13915	1.0719E-6	
2	A2	529159.53210	182390.51675	21.60000	0.37477	21.398	-37.867E-6	-0.13993	1.0778E-6	
2	A2	529160.00239	182390.64650	21.60000	0.35383	21.398	-38.275E-6	-0.14068	1.0836E-6	
2	A2	529160.47269	182390.77625	21.60000	0.33202	21.398	-38.682E-6	-0.14141	1.0892E-6	
2	A2	529160.94298	182390.90600	21.60000	0.30963	21.398	-39.090E-6	-0.14213	1.0947E-6	
2	A2	529161.41327	182391.03575	21.60000	0.28694	21.398	-39.499E-6	-0.14283	1.1001E-6	
2	A2	529161.88357	182391.16550	21.60000	0.26425	21.398	-39.912E-6	-0.14352	1.1055E-6	
2	A2	529162.35386	182391.29525	21.60000	0.24182	21.398	-40.332E-6	-0.14421	1.1108E-6	
2	A2	529162.82415	182391.42500	21.60000	0.21993	21.398	-40.761E-6	-0.14490	1.1161E-6	
2	A2	529163.29444	182391.55475	21.60000	0.19885	21.398	-41.200E-6	-0.14560	1.1214E-6	
2	A2	529163.76473	182391.68450	21.60000	0.17882	21.398	-41.654E-6	-0.14630	1.1268E-6	
2	A2	529164.23503	182391.81425	21.60000	0.16008	21.398	-42.122E-6	-0.14701	1.1323E-6	
2	A2	529164.70532	182391.94400	21.60000	0.14287	21.398	-42.608E-6	-0.14774	1.1379E-6	
2	A2	529165.17561	182392.07375	21.60000	0.12739	21.398	-43.113E-6	-0.14849	1.1437E-6	
2	A2	529165.64591	182392.20350	21.60000	0.11383	21.398	-43.637E-6	-0.14926	1.1496E-6	
2	A2	529166.11620	182392.33325	21.60000	0.10240	21.398	-44.182E-6	-0.15006	1.1557E-6	
2	A2	529166.58649	182392.46300	21.60000	0.09325	21.398	-44.749E-6	-0.15088	1.1620E-6	
2	A2	529167.05678	182392.59275	21.60000	0.08656	21.398	-45.338E-6	-0.15173	1.1686E-6	
2	A2	529167.52707	182392.72250	21.60000	0.08247	21.398	-45.949E-6	-0.15262	1.1754E-6	
2	A2	529167.99737	182392.85225	21.60000	0.08114	21.398	-46.583E-6	-0.15354	1.1824E-6	
2	A2	529168.46766	182392.98200	21.60000	0.08269	21.398	-47.240E-6	-0.15449	1.1898E-6	
2	A2	529168.93795	182393.11175	21.60000	0.08726	21.398	-47.920E-6	-0.15549	1.1974E-6	
2	A2	529169.40824	182393.24150	21.60000	0.09497	21.398	-48.625E-6	-0.15652	1.2053E-6	
2	A2	529169.87854	182393.37125	21.60000	0.10593	21.398	-49.353E-6	-0.15759	1.2135E-6	
2	A2	529170.34883	182393.50100	21.60000	0.12026	21.398	-50.106E-6	-0.15870	1.2221E-6	
2	A2	529170.81912	182393.63075	21.60000	0.13807	21.398	-50.884E-6	-0.15985	1.2309E-6	
2	A2	529171.28942	182393.76050	21.60000	0.15945	21.398	-51.686E-6	-0.16104	1.2401E-6	
2	A2	529171.75971	182393.89025	21.60000	0.18450	21.398	-52.514E-6	-0.16228	1.2496E-6	
2	A2	529172.23000	182394.02000	21.60000	0.21330	21.398	-53.367E-6	-0.16356	1.2594E-6	
3	B1	529173.88330	182394.83000	21.60000	0.33640	21.398	-49.015E-6	-0.15837	1.2196E-6	
3	B1	529174.35887	182394.97562	21.60000	0.38089	21.398	-49.551E-6	-0.15933	1.2270E-6	
3	B1	529174.83445	182395.12125	21.60000	0.42895	21.398	-50.099E-6	-0.16032	1.2346E-6	
3	B1	529175.31002	182395.26688	21.60000	0.48049	21.398	-50.660E-6	-0.16133	1.2424E-6	
3	B1	529175.78559	182395.41250	21.60000	0.53543	21.398	-51.232E-6	-0.16237	1.2504E-6	
3	B1	529176.26117	182395.55812	21.60000	0.59364	21.398	-51.815E-6	-0.16343	1.2585E-6	
3	B1	529176.73674	182395.70375	21.60000	0.65496	21.398	-52.408E-6	-0.16451	1.2668E-6	
3	B1	529177.21231	182395.84937	21.60000	0.71920	21.398	-53.011E-6	-0.16561	1.2753E-6	
3	B1	529177.68789	182395.99500	21.60000	0.78616	21.398	-53.623E-6	-0.16672	1.2838E-6	
3	B1	529178.16346	182396.14063	21.60000	0.85559	21.398	-54.244E-6	-0.16784	1.2924E-6	
3	B1	529178.63903	182396.28625	21.60000	0.92721	21.398	-54.872E-6	-0.16898	1.3012E-6	
3	B1	529179.11461	182396.43187	21.60000	1.00074	21.398	-55.507E-6	-0.17012	1.3100E-6	
3	B1	529179.59018	182396.57750	21.60000	1.07586	21.398	-56.149E-6	-0.17127	1.3188E-6	
3	B1	529180.06575	182396.72312	21.60000	1.15222	21.398	-56.796E-6	-0.17242	1.3276E-6	
3	B1	529180.54133	182396.86875	21.60000	1.22950	21.398	-57.449E-6	-0.17357	1.3365E-6	
3	B1	529181.01690	182397.01437	21.60000	1.30733	21.398	-58.106E-6	-0.17472	1.3454E-6	
3	B1	529181.49247	182397.16000	21.60000	1.38536	21.398	-58.767E-6	-0.17587	1.3542E-6	
3	B1	529181.96805	182397.30562	21.60000	1.46323	21.398	-59.431E-6	-0.17701	1.3629E-6	
3	B1	529182.44362	182397.45125	21.60000	1.54059	21.398	-60.099E-6	-0.17814	1.3717E-6	
3	B1	529182.91920	182397.59687	21.60000	1.61711	21.398	-60.769E-6	-0.17927	1.3803E-6	
3	B1	529183.39477	182397.74250	21.60000	1.69246	21.398	-61.441E-6	-0.18038	1.3888E-6	
3	B1	529183.87034	182397.88812	21.60000	1.76632	21.398	-62.114E-6	-0.18148	1.3973E-6	
3	B1	529184.34592	182398.03375	21.60000	1.83841	21.398	-62.787E-6	-0.18256	1.4056E-6	
3	B1	529184.82149	182398.17937	21.60000	1.90845	21.398	-63.461E-6	-0.18362	1.4138E-6	
3	B1	529185.29706	182398.32500	21.60000	1.97618	21.398	-64.134E-6	-0.18467	1.4218E-6	
3	B1	529185.77264	182398.47062	21.60000	2.04138	21.398	-64.805E-6	-0.18569	1.4297E-6	
3	B1	529186.24821	182398.61625	21.60000	2.10383	21.398	-65.474E-6	-0.18670	1.4374E-6	

ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, long term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]
3	B1	529186.72378	182398.76187	21.60000	2.16332	21.398	-66.138E-6	-0.18768	1.4449E-6
3	B1	529187.19936	182398.90750	21.60000	2.21969	21.398	-66.796E-6	-0.18863	1.4522E-6
3	B1	529187.67493	182399.05312	21.60000	2.27277	21.398	-67.448E-6	-0.18955	1.4593E-6
3	B1	529188.15050	182399.19875	21.60000	2.32242	21.398	-68.091E-6	-0.19045	1.4662E-6
3	B1	529188.62608	182399.34437	21.60000	2.36848	21.398	-68.723E-6	-0.19132	1.4729E-6
3	B1	529189.10165	182399.49000	21.60000	2.41086	21.398	-69.344E-6	-0.19215	1.4793E-6
3	B1	529189.57722	182399.63562	21.60000	2.44943	21.398	-69.953E-6	-0.19296	1.4855E-6
3	B1	529190.05280	182399.78125	21.60000	2.48408	21.398	-70.549E-6	-0.19373	1.4914E-6
3	B1	529190.52837	182399.92688	21.60000	2.51473	21.398	-71.134E-6	-0.19446	1.4970E-6
3	B1	529191.00394	182400.07250	21.60000	2.54128	21.398	-71.709E-6	-0.19516	1.5024E-6
3	B1	529191.47952	182400.21812	21.60000	2.56365	21.398	-72.277E-6	-0.19583	1.5076E-6
3	B1	529191.95509	182400.36375	21.60000	2.58174	21.398	-72.841E-6	-0.19647	1.5125E-6
3	B1	529192.43066	182400.50937	21.60000	2.59547	21.398	-73.405E-6	-0.19708	1.5171E-6
3	B1	529192.90624	182400.65500	21.60000	2.60477	21.398	-73.973E-6	-0.19765	1.5215E-6
3	B1	529193.38181	182400.80063	21.60000	2.60954	21.398	-74.547E-6	-0.19819	1.5257E-6
3	B1	529193.85738	182400.94625	21.60000	2.60969	21.398	-75.129E-6	-0.19871	1.5296E-6
3	B1	529194.33296	182401.09187	21.60000	2.60516	21.398	-75.720E-6	-0.19918	1.5332E-6
3	B1	529194.80853	182401.23750	21.60000	2.59583	21.398	-76.320E-6	-0.19963	1.5366E-6
3	B1	529195.28410	182401.38312	21.60000	2.58165	21.398	-76.928E-6	-0.20003	1.5398E-6
3	B1	529195.75968	182401.52875	21.60000	2.56252	21.398	-77.544E-6	-0.20040	1.5426E-6
3	B1	529196.23525	182401.67438	21.60000	2.53836	21.398	-78.164E-6	-0.20073	1.5450E-6
3	B1	529196.71082	182401.82000	21.60000	2.50913	21.398	-78.787E-6	-0.20101	1.5472E-6
3	B1	529197.18640	182401.96562	21.60000	2.47476	21.398	-79.412E-6	-0.20124	1.5489E-6
3	B1	529197.66197	182402.11125	21.60000	2.43521	21.398	-80.036E-6	-0.20142	1.5503E-6
3	B1	529198.13755	182402.25687	21.60000	2.39049	21.398	-80.656E-6	-0.20154	1.5512E-6
3	B1	529198.61312	182402.40250	21.60000	2.34059	21.398	-81.273E-6	-0.20160	1.5516E-6
3	B1	529199.08869	182402.54813	21.60000	2.28558	21.398	-81.884E-6	-0.20160	1.5516E-6
3	B1	529199.56427	182402.69375	21.60000	2.22556	21.398	-82.490E-6	-0.20152	1.5510E-6
3	B1	529200.03984	182402.83937	21.60000	2.16066	21.398	-83.089E-6	-0.20138	1.5498E-6
3	B1	529200.51541	182402.98500	21.60000	2.09110	21.398	-83.683E-6	-0.20115	1.5481E-6
3	B1	529200.99099	182403.13062	21.60000	2.01714	21.398	-84.269E-6	-0.20084	1.5456E-6
3	B1	529201.46656	182403.27625	21.60000	1.93912	21.398	-84.846E-6	-0.20044	1.5425E-6
3	B1	529201.94213	182403.42188	21.60000	1.85744	21.398	-85.410E-6	-0.19994	1.5386E-6
3	B1	529202.41771	182403.56750	21.60000	1.77258	21.398	-85.959E-6	-0.19933	1.5339E-6
3	B1	529202.89328	182403.71312	21.60000	1.68508	21.398	-86.485E-6	-0.19860	1.5283E-6
3	B1	529203.36885	182403.85875	21.60000	1.59552	21.398	-86.981E-6	-0.19775	1.5216E-6
3	B1	529203.84443	182404.00437	21.60000	1.50455	21.398	-87.439E-6	-0.19675	1.5139E-6
3	B1	529204.32000	182404.15000	21.60000	1.41281	21.398	-87.847E-6	-0.19560	1.5051E-6
4	B2	529206.12000	182399.49000	21.60000	3.37967	21.398	-0.013700	-1.4961	10.909E-6
4	B2	529206.60167	182399.64000	21.60000	3.00739	21.398	-0.014417	-1.5193	11.055E-6
4	B2	529207.08333	182399.79000	21.60000	2.64862	21.398	-0.015186	-1.5430	11.201E-6
4	B2	529207.56500	182399.94000	21.60000	2.30796	21.398	-0.016009	-1.5669	11.348E-6
4	B2	529208.04667	182400.09000	21.60000	1.98870	21.398	-0.016893	-1.5912	11.494E-6
4	B2	529208.52833	182400.24000	21.60000	1.69290	21.398	-0.017843	-1.6157	11.640E-6
4	B2	529209.01000	182400.39000	21.60000	1.42147	21.398	-0.018865	-1.6404	11.783E-6
4	B2	529209.49167	182400.54000	21.60000	1.17451	21.398	-0.019966	-1.6652	11.923E-6
4	B2	529209.97333	182400.69000	21.60000	0.95161	21.398	-0.021147	-1.6899	12.059E-6
4	B2	529210.45500	182400.84000	21.60000	0.75209	21.398	-0.022379	-1.7143	12.191E-6
4	B2	529210.93667	182400.99000	21.60000	0.57518	21.398	-0.023580	-1.7386	12.322E-6
4	B2	529211.41833	182401.14000	21.60000	0.42012	21.398	-0.025088	-1.7687	12.485E-6
4	B2	529211.90000	182401.29000	21.60000	0.28693	21.398	-0.027978	-1.8108	12.675E-6
4	B2	529212.38167	182401.44000	21.60000	0.17776	21.398	-0.030706	-1.8338	12.727E-6
4	B2	529212.86333	182401.59000	21.60000	0.09484	21.398	-0.033110	-1.8143	12.465E-6
4	B2	529213.34500	182401.74000	21.60000	0.04034	21.398	-0.033357	-1.7080	11.634E-6
4	B2	529213.82667	182401.89000	21.60000	0.01424	21.398	-0.027452	-1.4627	10.014E-6
4	B2	529214.30833	182402.04000	21.60000	0.00944	21.398	-0.016895	-1.1213	7.8688E-6
4	B2	529214.79000	182402.19000	21.60000	0.01388	21.398	-0.0075113	-0.79953	5.8209E-6
5	B3	529206.13650	182399.46000	21.60000	3.39434	21.398	-0.014943	-1.5445	11.224E-6
5	B3	529205.98317	182399.93040	21.60000	3.11355	21.398	-0.0050911	-1.0346	7.7467E-6
5	B3	529205.82984	182400.40080	21.60000	2.84985	21.398	-0.0022978	-0.76243	5.7760E-6
5	B3	529205.67651	182400.87120	21.60000	2.60573	21.398	-0.0012219	-0.59422	4.5280E-6
5	B3	529205.52318	182401.34160	21.60000	2.38118	21.398	-723.10E-6	-0.48058	3.6743E-6
5	B3	529205.36985	182401.81200	21.60000	2.17526	21.398	-461.30E-6	-0.39906	3.0575E-6
5	B3	529205.21652	182402.28240	21.60000	1.98671	21.398	-311.08E-6	-0.33802	2.5935E-6
5	B3	529205.06319	182402.75280	21.60000	1.81417	21.398	-218.92E-6	-0.29080	2.2334E-6
5	B3	529204.90986	182403.22320	21.60000	1.65633	21.398	-159.36E-6	-0.25334	1.9472E-6
5	B3	529204.75653	182403.69360	21.60000	1.51196	21.398	-119.24E-6	-0.22301	1.7151E-6
5	B3	529204.60320	182404.16400	21.60000	1.37990	21.398	-91.269E-6	-0.19805	1.5238E-6
5	B3	529204.44987	182404.63440	21.60000	1.25909	21.398	-71.217E-6	-0.17722	1.3640E-6
5	B3	529204.29654	182405.10480	21.60000	1.14857	21.398	-56.493E-6	-0.15962	1.2289E-6
5	B3	529204.14321	182405.57520	21.60000	1.04746	21.398	-45.457E-6	-0.14460	1.1135E-6
5	B3	529203.98988	182406.04560	21.60000	0.95495	21.398	-37.037E-6	-0.13167	1.0141E-6
5	B3	529203.83655	182406.51600	21.60000	0.87031	21.398	-30.513E-6	-0.12044	927.82E-9
5	B3	529203.68322	182406.98640	21.60000	0.79286	21.398	-25.388E-6	-0.11063	852.34E-9
5	B3	529203.52989	182407.45680	21.60000	0.72201	21.398	-21.312E-6	-0.10199	785.91E-9
5	B3	529203.37656	182407.92720	21.60000	0.65720	21.398	-18.035E-6	-0.094353	727.12E-9
5	B3	529203.22323	182408.39760	21.60000	0.59791	21.398	-15.373E-6	-0.087558	674.82E-9

ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, long term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024

Ref.	Name	x [m]	y [m]	z [mOD]	δz [mm]	Stress: Calc. Level [mOD]	Stress: Vertical [kN/m²]	Stress: Sum Princ. [kN/m²]	Vert. Strain [u]	
5	B3	529203.06990	182408.86800	21.60000	0.54369	21.398	-13.193E-6	-0.081484	628.06E-9	
5	B3	529202.91657	182409.33840	21.60000	0.49410	21.398	-11.391E-6	-0.076032	586.08E-9	
5	B3	529202.76324	182409.80880	21.60000	0.44875	21.398	-9.8906E-6	-0.071118	548.24E-9	
5	B3	529202.60991	182410.27920	21.60000	0.40730	21.398	-8.6329E-6	-0.066672	514.00E-9	!
5	B3	529202.45658	182410.74960	21.60000	0.36942	21.398	-7.5718E-6	-0.062636	482.90E-9	!
5	B3	529202.30325	182411.22000	21.60000	0.33480	21.398	-6.6710E-6	-0.058960	454.58E-9	!
5	B3	529202.14992	182411.69040	21.60000	0.30317	21.398	-5.9021E-6	-0.055601	428.70E-9	!
5	B3	529201.99659	182412.16080	21.60000	0.27429	21.398	-5.2424E-6	-0.052524	404.99E-9	!
5	B3	529201.84326	182412.63120	21.60000	0.24791	21.398	-4.6735E-6	-0.049697	383.21E-9	!
5	B3	529201.68993	182413.10160	21.60000	0.22384	21.398	-4.1808E-6	-0.047094	363.15E-9	!
5	B3	529201.53660	182413.57200	21.60000	0.20188	21.398	-3.7522E-6	-0.044691	344.63E-9	!
5	B3	529201.38327	182414.04240	21.60000	0.18184	21.398	-3.3778E-6	-0.042467	327.49E-9	!
5	B3	529201.22994	182414.51280	21.60000	0.16357	21.398	-3.0496E-6	-0.040407	311.61E-9	!
5	B3	529201.07661	182414.98320	21.60000	0.14692	21.398	-2.7607E-6	-0.038492	296.85E-9	!
5	B3	529200.92328	182415.45360	21.60000	0.13176	21.398	-2.5057E-6	-0.036711	283.12E-9	!
5	B3	529200.76995	182415.92400	21.60000	0.11794	21.398	-2.2799E-6	-0.035050	270.31E-9	!
5	B3	529200.61662	182416.39440	21.60000	0.10538	21.398	-2.0792E-6	-0.033498	258.35E-9	!
5	B3	529200.46329	182416.86480	21.60000	0.09394	21.398	-1.9004E-6	-0.032047	247.17E-9	!
5	B3	529200.30996	182417.33520	21.60000	0.08355	21.398	-1.7406E-6	-0.030688	236.69E-9	!
5	B3	529200.15663	182417.80560	21.60000	0.07411	21.398	-1.5975E-6	-0.029413	226.85E-9	!
5	B3	529200.00330	182418.27600	21.60000	0.06554	21.398	-1.4689E-6	-0.028215	217.62E-9	!
5	B3	529199.84997	182418.74640	21.60000	0.05776	21.398	-1.3531E-6	-0.027088	208.93E-9	!
5	B3	529199.69664	182419.21680	21.60000	0.05072	21.398	-1.2487E-6	-0.026026	200.74E-9	!
5	B3	529199.54331	182419.68720	21.60000	0.04434	21.398	-1.1542E-6	-0.025025	193.02E-9	!
5	B3	529199.38998	182420.15760	21.60000	0.03856	21.398	-1.0686E-6	-0.024079	185.73E-9	!
5	B3	529199.23665	182420.62800	21.60000	0.03335	21.398	-990.88E-9	-0.023186	178.84E-9	!
5	B3	529199.08332	182421.09840	21.60000	0.02864	21.398	-920.15E-9	-0.022340	172.32E-9	!
5	B3	529198.92999	182421.56880	21.60000	0.02439	21.398	-855.68E-9	-0.021539	166.14E-9	!
5	B3	529198.77666	182422.03920	21.60000	0.02057	21.398	-796.81E-9	-0.020779	160.28E-9	!
5	B3	529198.62333	182422.50960	21.60000	0.01713	21.398	-742.96E-9	-0.020058	154.72E-9	!
5	B3	529198.47000	182422.98000	21.60000	0.01405	21.398	-693.62E-9	-0.019373	149.44E-9	!
6	B4	529173.89290	182394.83000	21.60000	0.33734	21.398	-49.082E-6	-0.15847	1.2204E-6	
6	B4	529173.72839	182395.30222	21.60000	0.30995	21.398	-40.004E-6	-0.14506	1.1174E-6	
6	B4	529173.56388	182395.77444	21.60000	0.28425	21.398	-32.998E-6	-0.13340	1.0277E-6	
6	B4	529173.39937	182396.24667	21.60000	0.26016	21.398	-27.511E-6	-0.12318	949.10E-9	
6	B4	529173.23486	182396.71889	21.60000	0.23763	21.398	-23.154E-6	-0.11415	879.67E-9	
6	B4	529173.07036	182397.19111	21.60000	0.21657	21.398	-19.655E-6	-0.10614	817.96E-9	
6	B4	529172.90585	182397.66333	21.60000	0.19692	21.398	-16.813E-6	-0.098973	762.83E-9	
6	B4	529172.74134	182398.13556	21.60000	0.17863	21.398	-14.482E-6	-0.092540	713.30E-9	
6	B4	529172.57683	182398.60778	21.60000	0.16161	21.398	-12.554E-6	-0.086737	668.62E-9	
6	B4	529172.41232	182399.08000	21.60000	0.14582	21.398	-10.946E-6	-0.081480	628.13E-9	
6	B4	529172.24781	182399.55222	21.60000	0.13118	21.398	-9.5955E-6	-0.076698	591.31E-9	
6	B4	529172.08330	182400.02444	21.60000	0.11763	21.398	-8.4528E-6	-0.072335	557.69E-9	
6	B4	529171.91879	182400.49667	21.60000	0.10512	21.398	-7.4800E-6	-0.068339	526.91E-9	
6	B4	529171.75428	182400.96889	21.60000	0.09358	21.398	-6.6470E-6	-0.064669	498.63E-9	
6	B4	529171.58978	182401.44111	21.60000	0.08296	21.398	-5.9299E-6	-0.061289	472.59E-9	
6	B4	529171.42527	182401.91333	21.60000	0.07320	21.398	-5.3095E-6	-0.058167	448.53E-9	
6	B4	529171.26076	182402.38556	21.60000	0.06424	21.398	-4.7701E-6	-0.055278	426.27E-9	
6	B4	529171.09625	182402.85778	21.60000	0.05604	21.398	-4.2991E-6	-0.052598	405.61E-9	
6	B4	529170.93174	182403.33000	21.60000	0.04855	21.398	-3.8862E-6	-0.050105	386.40E-9	
6	B4	529170.76723	182403.80222	21.60000	0.04171	21.398	-3.5227E-6	-0.047784	368.50E-9	
6	B4	529170.60272	182404.27444	21.60000	0.03549	21.398	-3.2016E-6	-0.045617	351.80E-9	
6	B4	529170.43821	182404.74667	21.60000	0.02984	21.398	-2.9170E-6	-0.043591	336.18E-9	
6	B4	529170.27370	182405.21889	21.60000	0.02472	21.398	-2.6639E-6	-0.041693	321.55E-9	
6	B4	529170.10920	182405.69111	21.60000	0.02008	21.398	-2.4382E-6	-0.039914	307.83E-9	
6	B4	529169.94469	182406.16333	21.60000	0.01591	21.398	-2.2362E-6	-0.038242	294.95E-9	
6	B4	529169.78018	182406.63556	21.60000	0.01215	21.398	-2.0551E-6	-0.036670	282.82E-9	
6	B4	529169.61567	182407.10778	21.60000	0.00878	21.398	-1.8921E-6	-0.035189	271.41E-9	
6	B4	529169.45116	182407.58000	21.60000	0.00577	21.398	-1.7452E-6	-0.033792	260.64E-9	
6	B4	529169.28665	182408.05222	21.60000	0.00308	21.398	-1.6125E-6	-0.032474	250.47E-9	
6	B4	529169.12214	182408.52444	21.60000	0.00070	21.398	-1.4922E-6	-0.031227	240.86E-9	
6	B4	529168.95763	182408.99667	21.60000	-0.00140	21.398	-1.3831E-6	-0.030048	231.76E-9	
6	B4	529168.79312	182409.46889	21.60000	-0.00324	21.398	-1.2838E-6	-0.028930	223.15E-9	
6	B4	529168.62862	182409.94111	21.60000	-0.00486	21.398	-1.1933E-6	-0.027871	214.98E-9	
6	B4	529168.46411	182410.41333	21.60000	-0.00625	21.398	-1.1107E-6	-0.026866	207.23E-9	!
6	B4	529168.29960	182410.88556	21.60000	-0.00746	21.398	-1.0352E-6	-0.025911	199.86E-9	!
6	B4	529168.13509	182411.35778	21.60000	-0.00848	21.398	-965.99E-9	-0.025003	192.86E-9	!
6	B4	529167.97058	182411.83000	21.60000	-0.00935	21.398	-902.49E-9	-0.024139	186.20E-9	!
6	B4	529167.80607	182412.30222	21.60000	-0.01007	21.398	-844.12E-9	-0.023316	179.85E-9	!
6	B4	529167.64156	182412.77444	21.60000	-0.01065	21.398	-790.40E-9	-0.022532	173.80E-9	!
6	B4	529167.47705	182413.24667	21.60000	-0.01111	21.398	-740.88E-9	-0.021784	168.04E-9	!
6	B4	529167.31254	182413.71889	21.60000	-0.01146	21.398	-695.17E-9	-0.021071	162.53E-9	!
6	B4	529167.14804	182414.19111	21.60000	-0.01172	21.398	-652.92E-9	-0.020389	157.28E-9	!
6	B4	529166.98353	182414.66333	21.60000	-0.01189	21.398	-613.82E-9	-0.019738	152.25E-9	!
6	B4	529166.81902	182415.13556	21.60000	-0.01197	21.398	-577.59E-9	-0.019115	147.45E-9	!
6	B4	529166.65451	182415.60778	21.60000	-0.01199	21.398	-543.98E-9	-0.018519	142.86E-9	!
6	B4	529166.49000	182416.08000	21.60000	-0.01194	21.398	-512.76E-9	-0.017949	138.45E-9	!

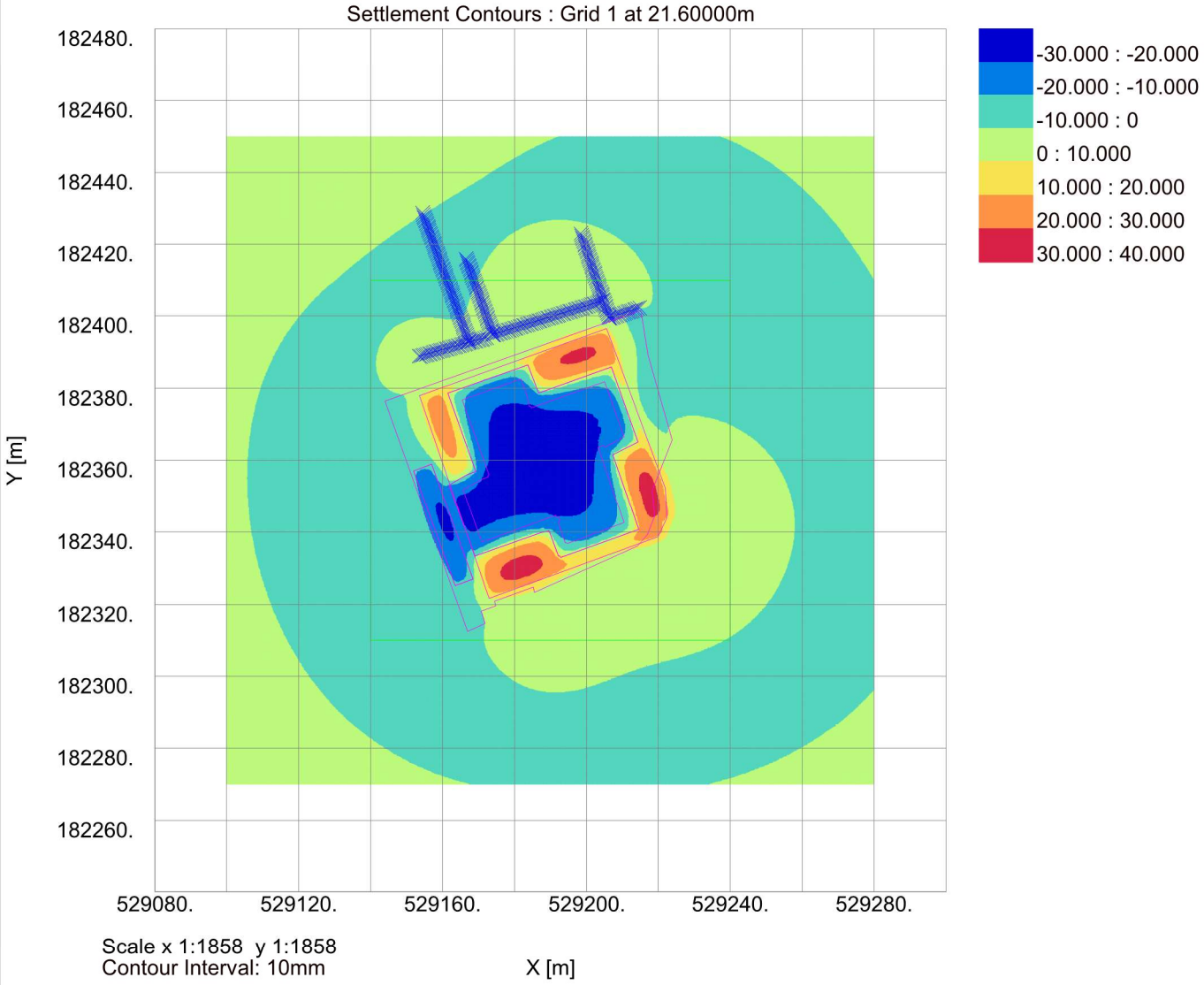
ARUP **Arup**

Euston Tower
BIA
Net loading (end of construction, long term)

Job No.	Sheet No.	Rev.
281835		

Drg. Ref.

Made by	Date	Checked	Date
DF	25/11/2024	HT	28/11/2024



Displacement Lines

Ref.	Name	x1 [m]	y1 [m]	z1 [m]	x2 [m]	y2 [m]	z2 [m]	Intervals [No.]	Surface type for tunnels	Interpolate imported displacements	Calculate
1	SW_NE section	529110.00000	182320.00000	4.00000	529270.00000	182400.00000	4.00000	179	Surface	No	Yes
2	A1	529167.15000	182392.65900	21.60000	529154.32820	182428.72020	21.60000	77	Surface	No	Yes
3	A2	529153.41830	182388.83000	21.60000	529172.23000	182394.02000	21.60000	40	Surface	No	Yes
4	B1	529173.88330	182394.83000	21.60000	529204.32000	182404.15000	21.60000	64	Surface	No	Yes
5	B2	529206.12000	182399.49000	21.60000	529214.79000	182402.19000	21.60000	18	Surface	No	Yes
6	B3	529206.13650	182399.46000	21.60000	529198.47000	182422.98000	21.60000	50	Surface	No	Yes
7	B4	529173.89290	182394.83000	21.60000	529166.49000	182416.08000	21.60000	45	Surface	No	Yes

Displacement Grids

Ref.	Name	Extrusion: Direction	Base line start: X [m]	Base line start: Y [m]	Base line start: Z(level) [m]	Base line end: X [m]	Base line end: Y [m]	Base line end: Z(level) [m]	Base line: Intervals [No.]	Extrusion: Distance [m]	Extrusion: Intervals [No.]	Surface type for tunnels	Calculate
1	Disp grid 1	Global X	529100.00000	182270.00000	21.60000	-	182450.00000	21.60000	180	180.00000	180	Surface	Yes

Damage Category Strains

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

Specific Buildings - Geometry

Ref.	Building Name	Sub-Building Name	Displacement Line	Distance Along Line: Start [m]	Distance Along Line: End [m]	Vertical Offsets from Line for Vertical Movement Calculations [m]	Vertical Displacement Limit Sensitivity [mm]	Damage Category Strains	Poisson's Ratio	E/G
1	10 Brook Street	West wall	A1	0.00000	38.27200	0.0	0.10000	Burland Strain Limits	0.30000	12.500
2	10 Brook Street	South wall	A2	0.00000	19.51400	0.0	0.10000	Burland Strain Limits	0.30000	12.500
3	20-30 Brook Street	South wall 1	B1	0.00000	31.83100	0.0	0.10000	Burland Strain Limits	0.30000	12.500
4	20-30 Brook Street	South wall 2	B2	0.00000	9.08000	0.0	0.10000	Burland Strain Limits	0.30000	12.500
5	20-30 Brook Street	East wall 1	B3	0.00000	24.73700	0.0	0.10000	Burland Strain Limits	0.30000	12.500
6	20-30 Brook Street	East wall 2	B4	0.00000	22.50200	0.0	0.10000	Burland Strain Limits	0.30000	12.500

Specific Buildings - Bending Parameters

Ref.	Building Name	Sub-Building Name	Height [m]	Default	Hogging: 2nd Mom. of Area (per unit width) [m³]	Hogging: Dist. of Bending Strain from N.A. [m]	Hogging: Dist. of N.A. from Edge of Beam in Tension [m]	Sagging: 2nd Mom. of Area (per unit width) [m³]	Sagging: Dist. of Bending Strain from N.A. [m]	Sagging: Dist. of N.A. from Edge of Beam in Tension [m]
1	10 Brook Street	West wall	40.000	Yes	21333.	40.000	40.000	5333.3	20.000	20.000
2	10 Brook Street	South wall	40.000	Yes	21333.	40.000	40.000	5333.3	20.000	20.000
3	20-30 Brook Street	South wall 1	36.000	Yes	15552.	36.000	36.000	3888.0	18.000	18.000
4	20-30 Brook Street	South wall 2	36.000	Yes	15552.	36.000	36.000	3888.0	18.000	18.000
5	20-30 Brook Street	East wall 1	36.000	Yes	15552.	36.000	36.000	3888.0	18.000	18.000
6	20-30 Brook Street	East wall 2	36.000	Yes	15552.	36.000	36.000	3888.0	18.000	18.000

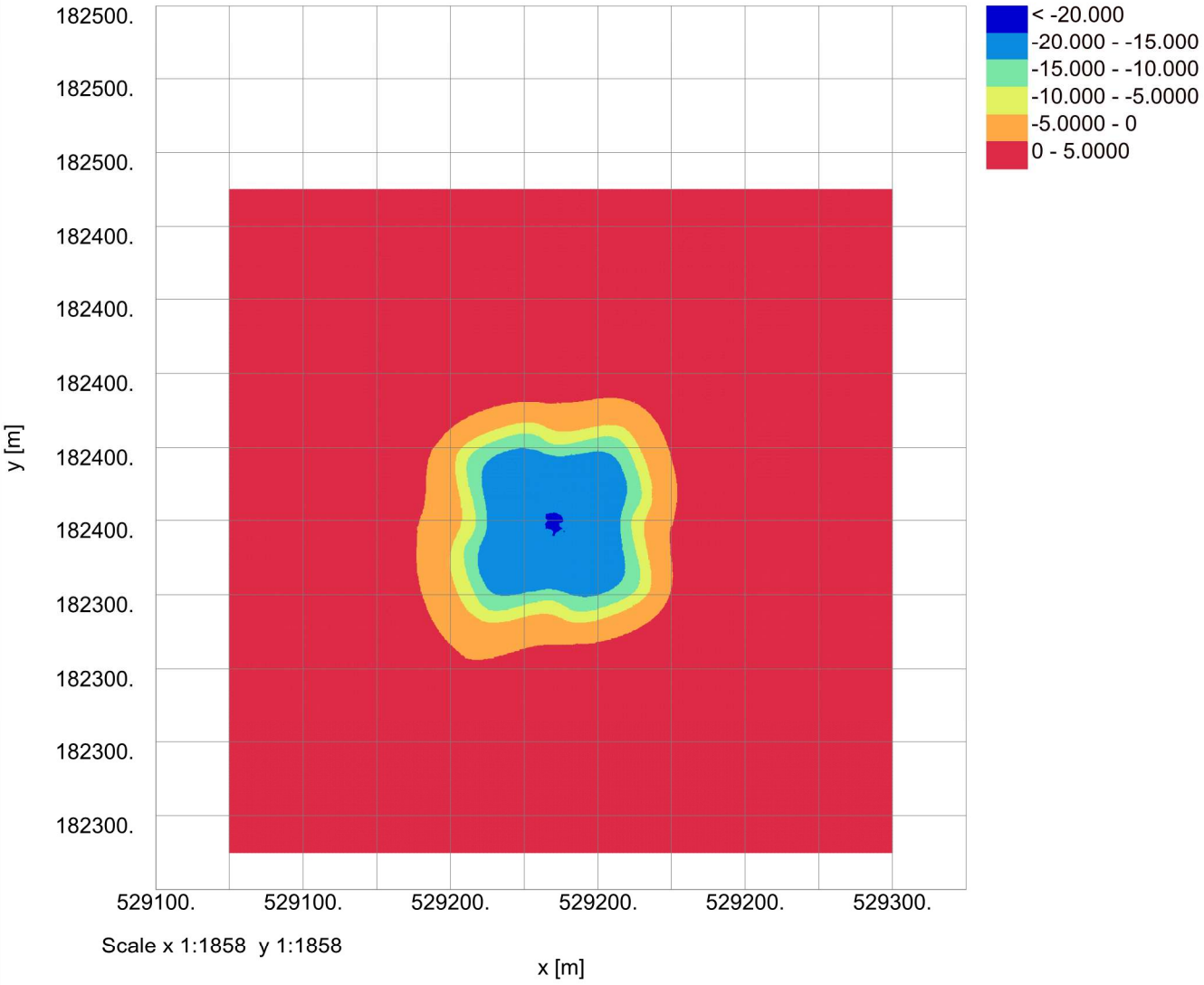
Stages

Ref.	Name	Tunnels	Excavations: Polygonal	Excavations: Circular
1	During construction	none	none	none
2	End of construction (short term)	none	none	none
3	End of construction (long term)	none	none	none

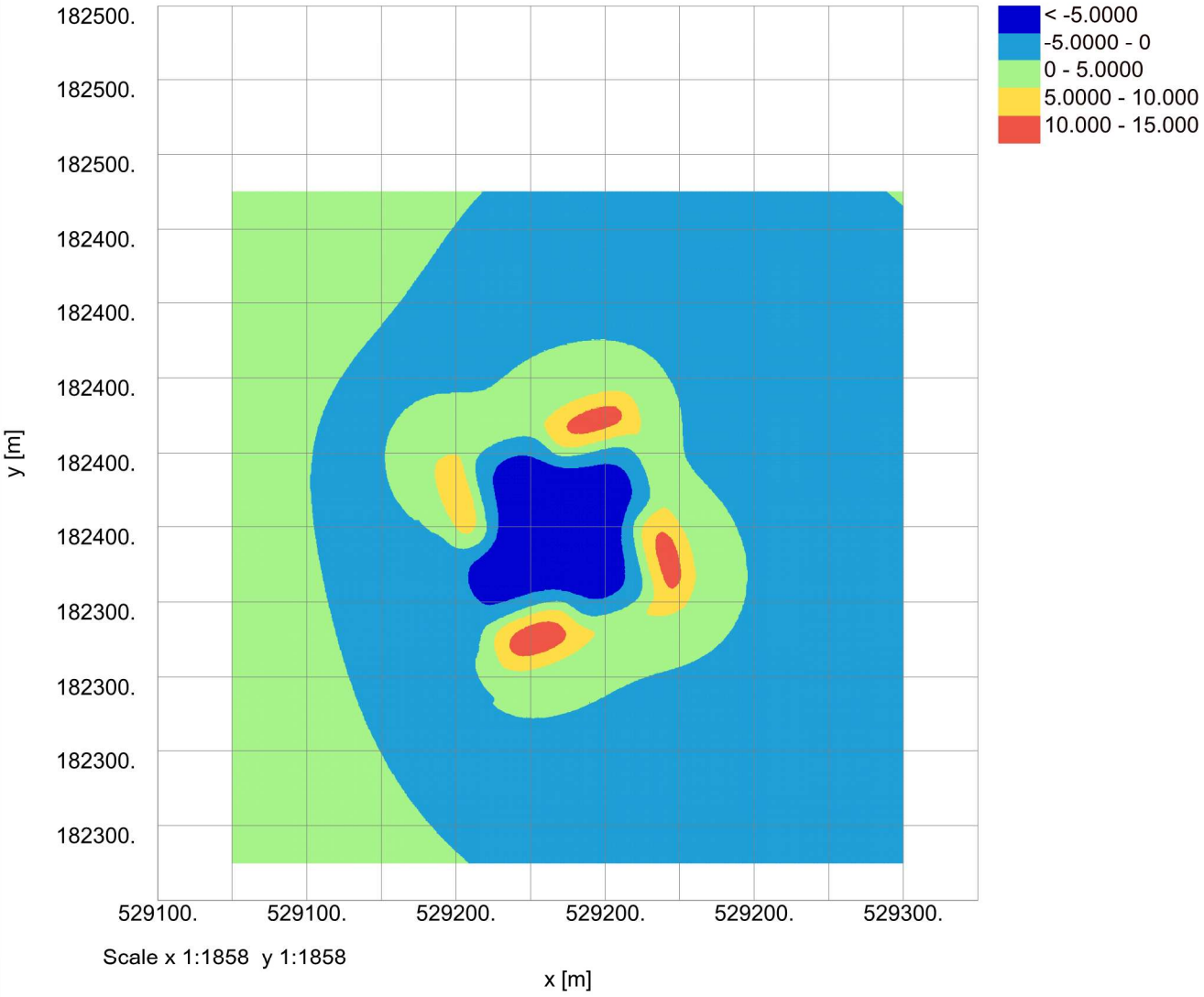
Specific Building Damage Results - Critical Values for All Segments within Each Sub-Building

Stage: Ref.	Stage: Name	Specific Building: Ref.	Specific Building: Name	Sub-building Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Deflection Ratio [%]	Average Horizontal Strain [%]	Max Slope	Max Settlement [mm]	Max Tensile Strain [%]	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging) [m]	Min Radius of Curvature (Sagging) [m]	Damage Category
0	Base Model	1	10 Brook Street	West wall	0.0	0.0014530	0.0	-102.36E-6	1.2696	0.0014403	0.0	-102.36E-6	-	-	0 (Negligible)
		2	10 Brook Street	South wall	0.0	0.0025214	0.0	92.536E-6	1.8642	0.0025107	0.0	92.536E-6	-	-	0 (Negligible)
		3	20-30 Brook Street	South wall 1	0.0	0.0081259	0.0	290.24E-6	5.0513	0.0079322	0.0	290.24E-6	-	31734.	0 (Negligible)
		4	20-30 Brook Street	South wall 2	0.0	0.014592	0.0	0.0010948	6.3323	0.014580	0.0	0.0010948	6769.1	-	0 (Negligible)
		5	20-30 Brook Street	East wall 1	0.0	0.0099181	0.0	929.36E-6	6.3569	0.0098561	0.0	929.36E-6	7749.8	-	0 (Negligible)
		6	20-30 Brook Street	East wall 2	0.0	888.41E-6	0.0	-39.653E-6	1.4834	883.59E-6	0.0	-39.653E-6	-	-	0 (Negligible)
1	During construction	1	10 Brook Street	West wall	0.0	0.0021772	0.0	-163.73E-6	1.3069	0.0021533	0.0	-163.73E-6	-	-	0 (Negligible)
		2	10 Brook Street	South wall	0.0	459.96E-6	0.0	26.877E-6	1.1206	457.44E-6	0.0	26.877E-6	-	-	0 (Negligible)
		3	20-30 Brook Street	South wall 1	0.0	754.15E-6	0.0	-33.858E-6	1.2874	736.82E-6	0.0	-33.858E-6	-	-	0 (Negligible)
		4	20-30 Brook Street	South wall 2	0.0	151.54E-6	0.0	-9.4476E-6	1.0115	151.46E-6	0.0	-9.4476E-6	-	-	0 (Negligible)
		5	20-30 Brook Street	East wall 1	0.0	906.10E-6	0.0	-66.206E-6	1.1435	890.10E-6	0.0	-66.206E-6	-	-	0 (Negligible)
		6	20-30 Brook Street	East wall 2	0.0	0.0021620	0.0	-160.54E-6	1.3503	0.0021334	0.0	-160.54E-6	-	-	0 (Negligible)
2	End of construction (short term)	1	10 Brook Street	West wall	0.0	0.0	0.0	44.477E-6	0.12268	35.763E-9	0.0	44.477E-6	-	-	0 (Negligible)
		2	10 Brook Street	South wall	0.0	626.66E-6	0.0	-25.806E-6	0.28510	624.17E-6	0.0	-25.806E-6	-	-	0 (Negligible)
		3	20-30 Brook Street	South wall 1	0.0	0.0023560	0.0	91.998E-6	1.1634	0.0023002	0.0	91.998E-6	-	-	0 (Negligible)
		4	20-30 Brook Street	South wall 2	0.0	0.0038029	0.0	361.20E-6	1.9710	0.0037927	0.0	361.20E-6	-	-	0 (Negligible)
		5	20-30 Brook Street	East wall 1	0.0	0.0047027	0.0	428.03E-6	1.9835	0.0045960	0.0	428.03E-6	-	-	0 (Negligible)
		6	20-30 Brook Street	East wall 2	0.0	292.08E-6	0.0	66.110E-6	0.21827	292.00E-6	0.0	66.110E-6	-	-	0 (Negligible)
3	End of construction (long term)	2	10 Brook Street	South wall	0.0	0.0014501	0.0	-59.039E-6	0.48350	0.0014441	0.0	-59.039E-6	-	-	0 (Negligible)
		3	20-30 Brook Street	South wall 1	0.0	0.0050888	0.0	184.44E-6	2.6097	0.0049701	0.0	184.44E-6	-	47807.	0 (Negligible)
		4	20-30 Brook Street	South wall 2	0.0	0.0073348	0.0	737.95E-6	3.3797	0.0073218	0.0	737.95E-6	-	-	0 (Negligible)
		5	20-30 Brook Street	East wall 1	0.0	0.0065135	0.0	567.54E-6	3.3943	0.0064923	0.0	567.54E-6	12682.	-	0 (Negligible)
		6	20-30 Brook Street	East wall 2	0.0	404.74E-6	0.0	54.775E-6	0.33734	404.16E-6	0.0	54.775E-6	-	-	0 (Negligible)

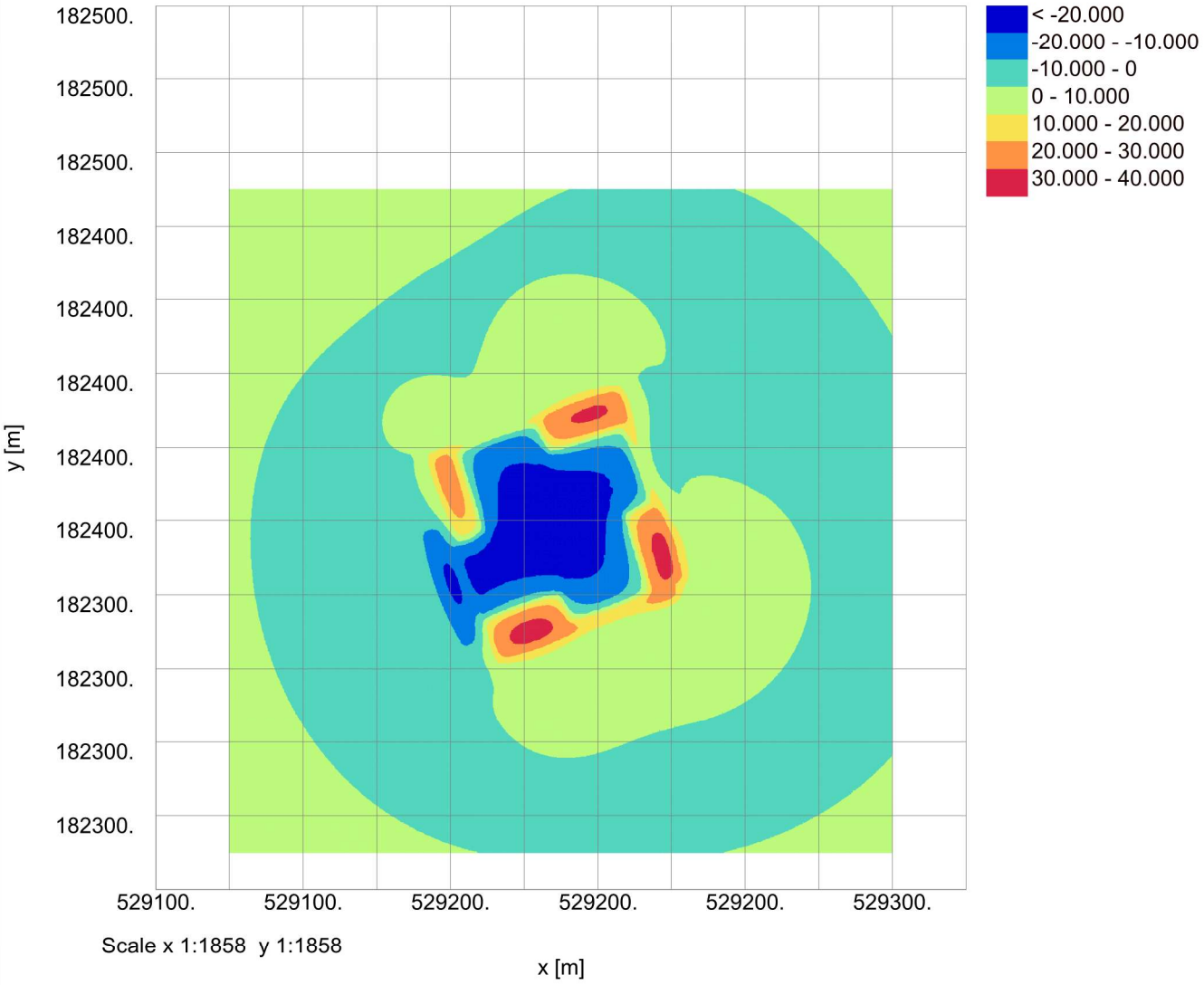
Vertical Settlement Contours: Grid 1 (level 21.600m) (Interval 5mm)



Vertical Settlement Contours: Grid 1 (level 21.600m) (Interval 5mm)



Vertical Settlement Contours: Grid 1 (level 21.600m) (Interval 10mm)



Scale x 1:1858 y 1:1858