The Hop Exchange
London

Structural and Civil Engineering
Stage 2 Report

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Contents

Introduction

Price & Myers have been appointed by Peer Group to advise on the structural implications for the redevelopment of The Hop Exchange. The building is located adjacent to Borough Market, London Bridge, in the London Borough of Southwark. The existing building is currently six storeys high including two subterranean levels with an irregular footprint covering 1900 square metres at ground level.

The proposals broadly comprise:

- complete removal of the existing three storey structure below the 'Lightwell', to be replaced with seven storeys for office and commercial use;
- reconfiguration of the 'Area to the front of the Lightwell' for future office and commercial use;
- a double storey office roof extension with a stepped back façade over the 'West Wing' and Lightwell';
- provision of lifts shafts and stairwells servicing the existing buildings and additional floors;
- a new atrium roof over the 'Exchange Hall' to replace the existing roof with an increased ridge height, behind a faux front façade.

The purpose of this report is to:

- describe the existing structure and site constraints;
- describe and advise on the capacity of the existing structure and its ability to support load from additional storeys, based on exploratory works and preliminary calculations;
- propose possible construction types for the new stories and reconfigured spaces;
- suggest work that will be required to allow the existing structure to carry the proposed loads;
- advise on the change of load on the LUL tunnels, based on high level calculations.
- comment on considerations for compliance with Building Control, National Rail and other regulatory bodies.

1 The Site

Location

The site is currently known as The Hop Exchange and is situated in Southwark, London, SE1 1TY. The approximate site boundary for the address is shown in red on the location plan and 3d below in Figure 1.

Figure 1: Site Location Plan and 3D (Google Maps)

The site is bounded immediately by: Railway lines to the northwest, set at high level on a series of traditional masonry railway arches strengthened with reinforced concrete piers and slabs cantilevering over part of the lightwell; Southwark Street to the south, a busy, main road containing several bus routes; several commercial buildings along Stoney Street forming part of Borough Market to the east - these include a Public House, "The Southwark Tavern", and a series of cafes and restaurants.

Underground Structures

A desk study has been carried out to determine whether any underground structures are located within the site. The London Underground Ltd (LUL) infrastructure asset map is presented as Figure 2 overleaf.

The Jubilee line runs east to west within the site, approximately 23m below OD. This section was built as part of the Jubilee Line extension, for which planning began in the 1970s. The extension was authorised in 1990, and construction officially began in December 1993. The extended Jubilee Line opened for use on 20th November 1999. The Northern line runs to the east of the site under Borough High Street, approximately 50 metres away. The approximate depth of the tunnels relative to the Hop Exchange is shown below in Figure 2 and 3.

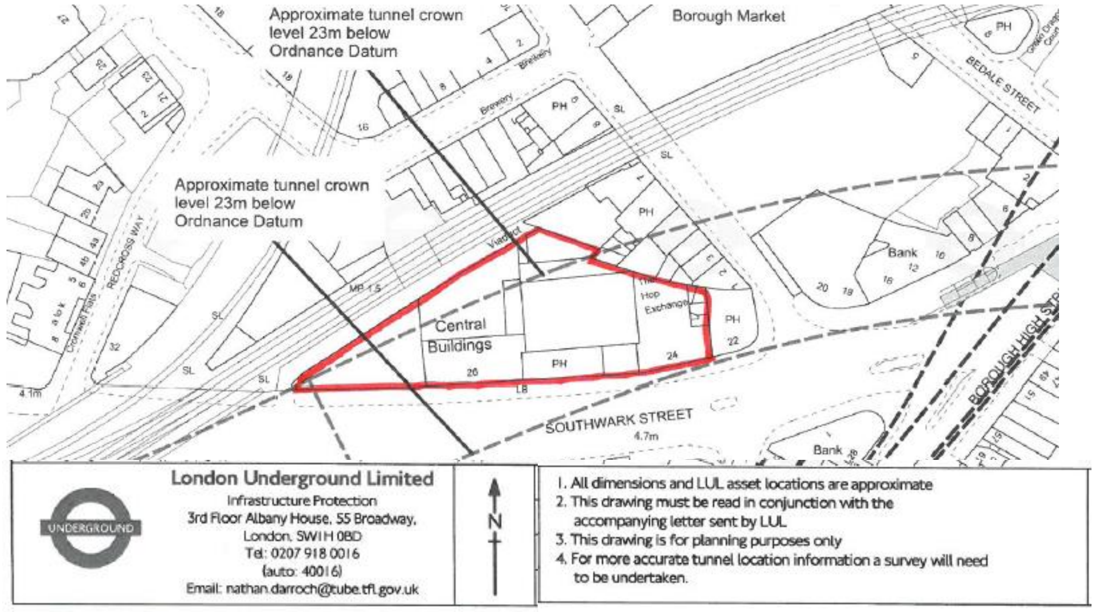


Figure 2: LUL Infrastructure plan.

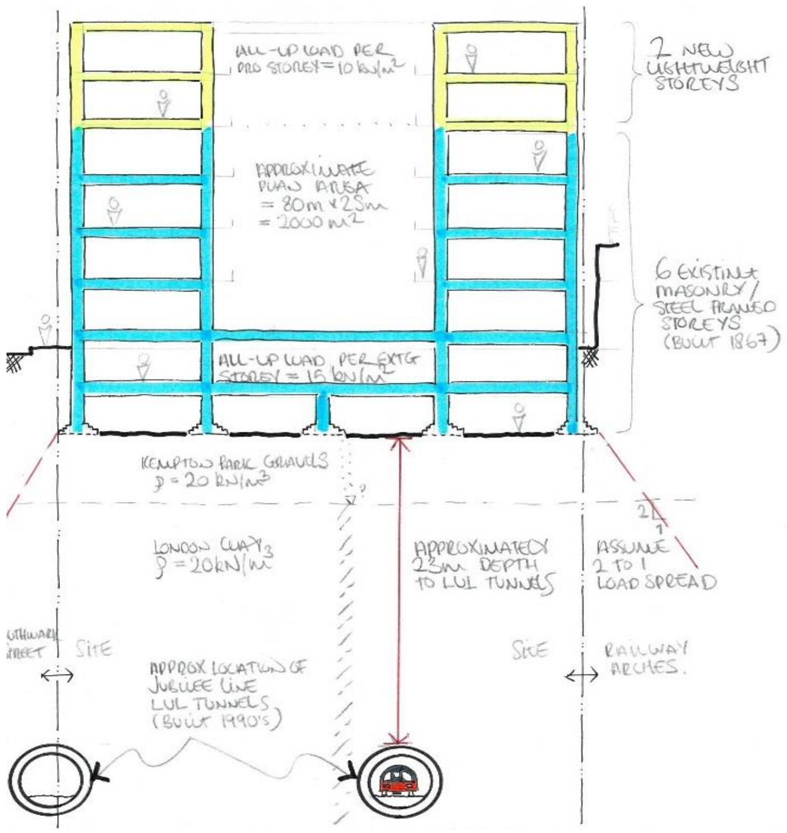


Figure 3: Section through LUL tunnels and the Exchange Hall with 2 additional storeys.

Network Rail

To the north of the site the rear of the proposed Hop Exchange is a railway viaduct carrying the lines between London Bridge station and Charing Cross, with a 3m wide ally between the building and the viaduct and the building at street level. The viaduct was widened to the north and south as part of Network Rail's Thameslink works, bringing the viaduct closer to the building and over-sailing a portion of the 'Lightwell'. This will need to be taken into consideration when positioning the new rear elevation and is discussed later in Section 10 - Construction Sequence/Logistics.

Figure 4 below shows a plan issued in 2008 by Network Rail as part of an application by Peer Group to obtain permission for a three-storey development to the 'Lightwell'. The plan describes the permitted edge of the consented extension adjacent to the railway. A 2m offset from the railway was permitted and has been used in the initial development of the proposed scheme and assumed construction sequence for this report, however this consent may now have expired.

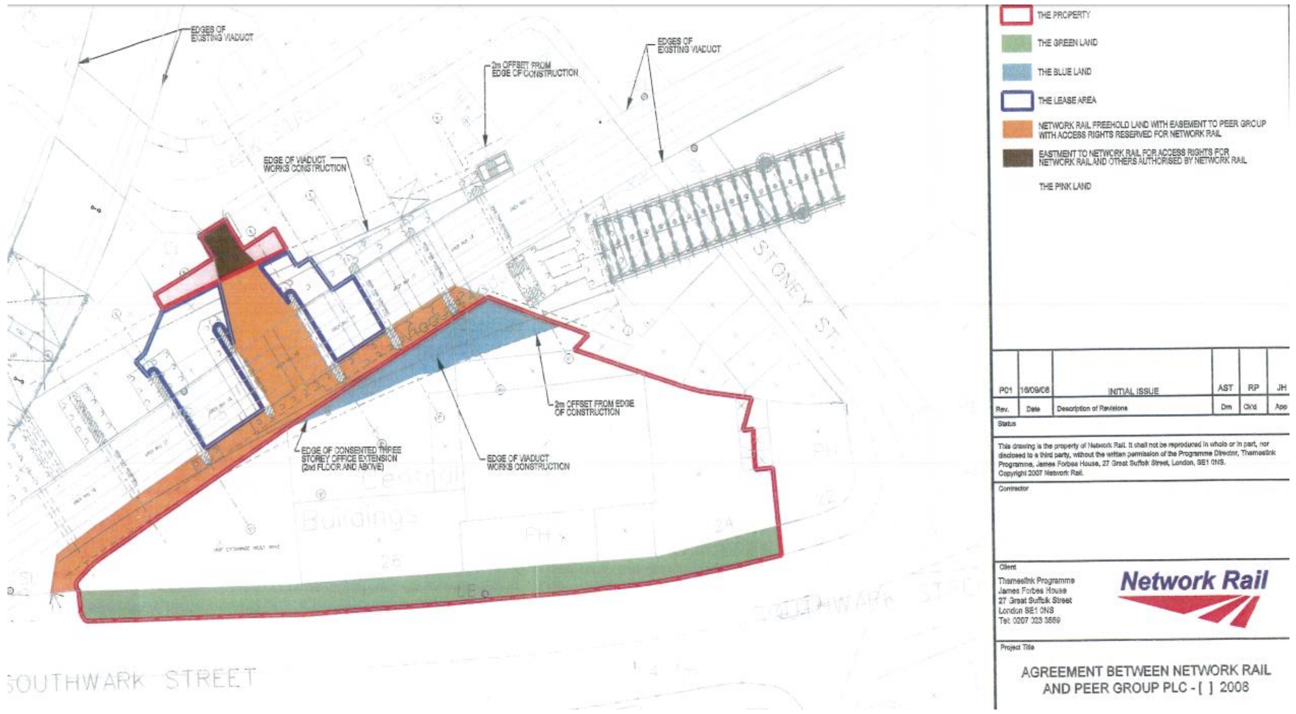


Figure 4: Network rail assets previously approved 2m offset allowance

The approximate position of the LUL tunnels and Network Rail assets relative to the Hop Exchange is shown in Figure 5 overleaf.

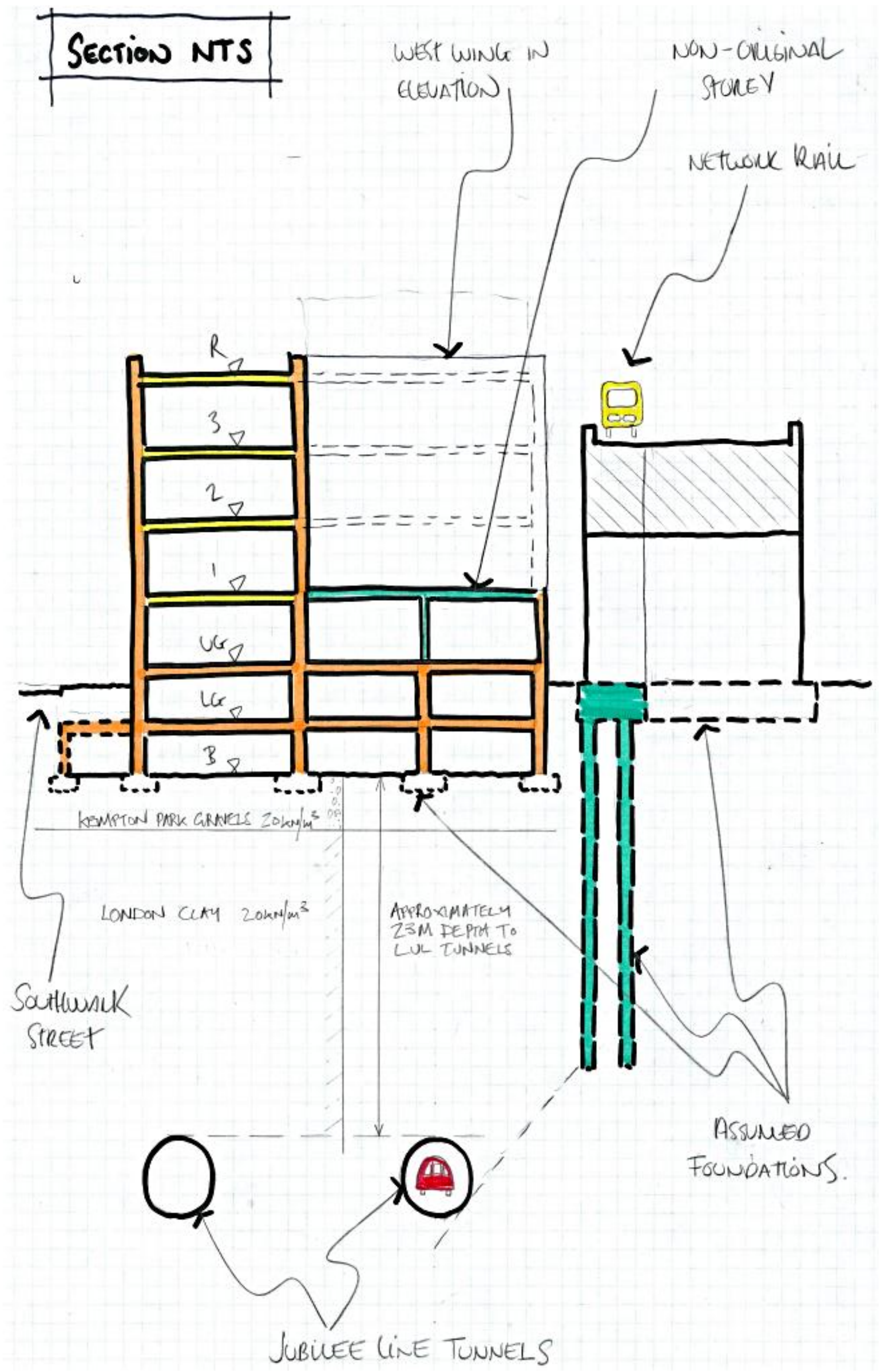


Figure 5: Section through the Lightwell of The Hop Exchange and The Site Constraints

Site History

The Hop Exchange is a Grade II listed building, originally designed by Architect R.H Moore and constructed from 1866 to 1867. The building was known as "The Hop and Malt Exchange" or "Coopers Hop Warehouse", featuring an imposing front elevation with five tiers of arches. The structure was originally eight storeys in height, and housed a large exchange hall with surrounding offices. (Figures A1 and A2, Appendix A). The original structure included iron framing, load-bearing masonry walls, lower level jack-arch floors and traditional timber floor construction for the upper levels.

The building suffered fire damage in 1920, which was concentrated on the 'West Wing' and 'Area to the Front of the Lightwell' of the structure. Following this fire, the first floor, second floor, third floor and roof of the damaged areas were rebuilt, with the surviving intact structure below being retained (Figures A4 to A7, Appendix A). Some of the cast-iron columns in the storeys were also retained. There is a lightwell in the central area of the building, to the north-west of the Exchange Hall, where there are no storeys at second floor to roof, which it is assumed, were not rebuilt after the fire.

Historic bomb maps indicate that the west part of the site has suffered bomb damage, classed as "seriously damaged, but repairable at cost", as shown in Figure 4 below. The adjacent site, currently the Public House "The Southwark Tavern", suffered "general blast damage – not structural".

Figure 6: Bomb Damage Map (Maps 76 & 77)

The nearest sites of "total destruction" are approximately 20m to the east of the site, where Borough Market is situated, and approximately 100m to the west of the site, across the railway line on Thrale Street.

The Lost Rivers of London map is presented as Figure 7 below. This indicates that there are no lost rivers running under the site, or significantly close by. The nearest lost river shown is the Walbrook, which fed into the Thames on the north side.

The site is noted to be approximately 200m south of the River Thames. Unnamed features may have been present in the form of canals or other surface water features, providing access from the river to allow the produce to be delivered, though this is conjecture and has not been unverified.

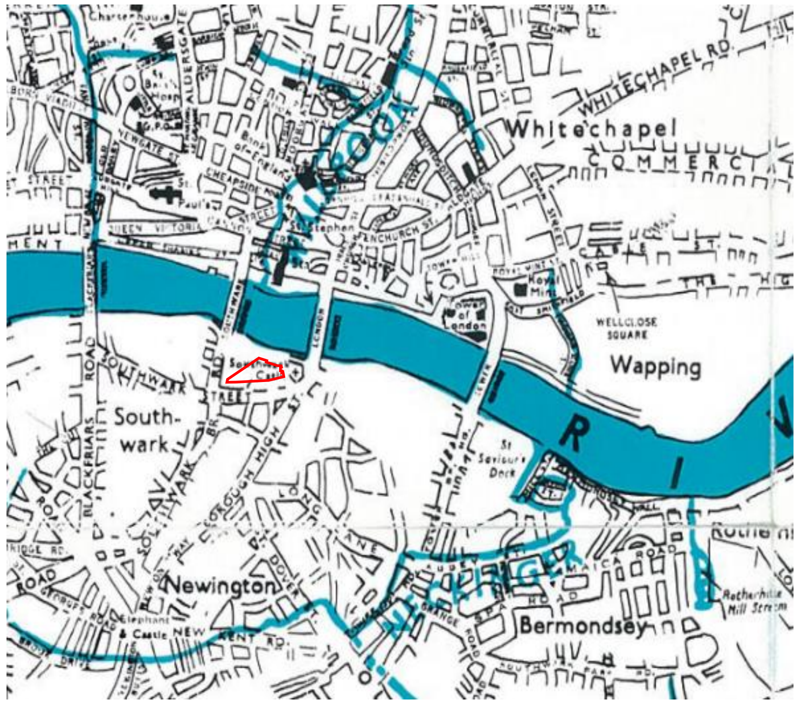


Figure 7: The Lost Rivers of London Map

2 Ground Conditions

Geology

The site (marked on Figures 8 & 9 in red) sits on “London Clay Formation – Clay, Silt and Sand” and also superficial deposits “Kempton Park Gravel Formation – Sand & Gravel”. This geology is typical for the area, although other superficial deposits, of “Alluvium – Clay, Silty, Peaty, Sandy”, are also widely found in the surrounding sub-strata.

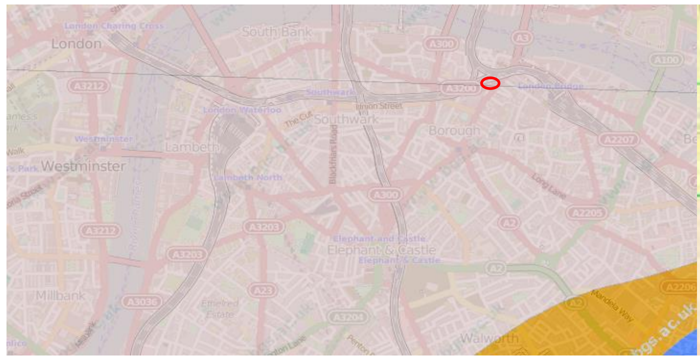


Figure 8: Bedrock surface geology

Figure 9: Superficial deposits under the site

The borehole records available from the BGS website have been reviewed in relation to the site. The location of nearest boreholes is shown below in Figure 10.

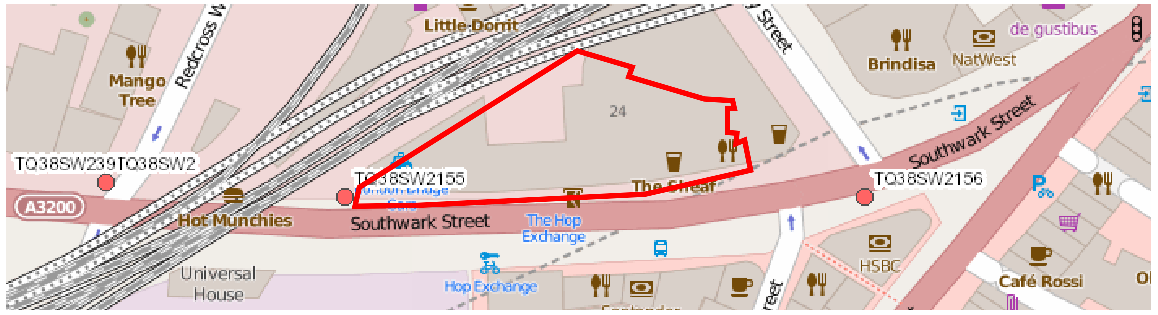


Figure 10: Public boreholes for the site

Borehole TQ38SW2155, located at the west end of the site at street level, was dug for LUL in 1990. It indicates Made Ground to 3.1m below ground level, underlain by Terrace Gravels continuing to 10.2m bgl. Beyond this is London Clay (with occasional bands of granular material) to a depth of 44.7m bgl where further granular and cohesive strata are encountered to 50.25m bgl where the borehole terminates.

Borehole TQ38SW2156, which is located towards the east side of the site, indicates Made Ground 3.8m below ground level, where a thin band of Alluvium was found to 4.2m below ground level. Terrace Gravels were found to a depth of 10.3m below ground level, over London Clay to 37m bgl, where the borehole terminates.

From this we anticipate the Jubilee Line to be set within London Clay formation. The record for both boreholes can be found in Appendix B.

A geotechnical investigation is planned to be carried as part of the Stage 2 works to help verify the ground below the site and inform the foundation design. Due to the site history this will require and archaeological watching brief as described in the following section on archaeology and the boreholes are likely to require review and approval by LUL who will be sent the borehole layout for their approval.

Groundwater

Groundwater was confirmed by the historical trial pits in Appendix C as sitting at about 600mm below basement finish level. According to the nearby borehole data this would place the water at the top of the band of 'Terrace Gravels', however it is expected that part of the building sits over a post-medieval burial ground which could indicate that the water sits within the Made Ground in some locations.

Archaeology

An 'Archaeological Desk Based Assessment' (Ref. JAC26397; dated: May 2020) and a ' Written Scheme of Investigation for Archaeological Monitoring of the Site Investigation Works' (Ref. JAC26397; dated: June 2020) have been carried out by RPS Group. Given the archaeological sensitivity of the ground below the site a watching brief will also be required for the main groundworks relating to the proposed substructure.

Below is the Executive Summary from the desk based assessment:

''The site of the Hop Exchange, 22-24 Southwark Street, London SE1, has been reviewed for its below ground archaeological potential.

In terms of relevant, nationally significant designated heritage assets, no World Heritage Sites, Historic Wrecks or Historic Battlefields lie within the study site or its immediate vicinity.

In terms of designated nationally significant Scheduled Monuments, the site of Winchester Palace lies c.145m from the northern boundary of the study site. The site of a designated Scheduled Monument comprising a Romano-British bathhouse and Medieval remains at 11-15 Borough High Street lies c.140m from the study site's eastern boundary.

In addition, the Hope Exchange occupying the study site comprises a nationally significant Grade II Listed building.

In terms of relevant local designations, the study site lies within the Tier 1 North Southwark and Roman Roads Archaeological Priority Area, as defined by the London Borough of Southwark and their in house archaeological planning advisor.

The study site is considered likely to have an archaeological potential for the prehistoric, Roman, Medieval, Post Medieval and Modern periods. Previous trial pit evaluation within the basement at the study site revealed Post Medieval artefacts, together with human remains interpreted as relating to a former burial ground.

Past post-depositional impacts within the study site are considered likely to have had a negative archaeological
impact.
Proposals comprise an enlargement of part of the western end of the Hop Exchange. Impacts beyond the existing building envelope are understood to principally comprise foundations for the structure above.

Further archaeological fieldwork mitigation measures are anticipated to be required in association with redevelopment impacts.

There is no perceived intervisibility or relationship between the Hop Exchange buildings and the Scheduled Monument designations to the north and east. ''

The foundation scheme will be developed with the archaeologist, once the results from the geotechnical investigation (GI) are received.

3 Existing Structure

The existing structural arrangement of the building has been discerned through undertaking limited visual inspections and opening up works.

Functional Framing

- Front Façade

The existing structure features a decorative front elevation facing Southwark Street. The main entrance is flanked by Portland stone pillars, approximately 27ft high, and a portico roof. Portland stone pedestals form the base of cast-iron columns, which exist for the entire length of the elevation.

- Exchange Hall

The exchange room, 80ft long by 50ft wide, was originally 75ft in height, to the cornice. From here sprang an iron and glass curved roof structure, with a maximum ridge height of 115ft achieved. The existing roof is smaller than the original, and consists of 2 triangular cross-section glass roofs. The roof is surrounded by cast iron ornamental walkways and offices/showrooms, with access via stone staircases. The support brackets include hops and seed in the intricate design, carved by Frampton and Williamson.

The superstructure consists of a combination of cast-iron framing and load-bearing masonry walls, providing vertical and lateral stability. Masonry jack-arches feature extensively on the lower floors, with the upper storeys built in traditional timber joisted construction.

The existing foundations details have not been confirmed. From the age of the building and visible corbelling in the basement, the foundations are assumed to comprise shallow strip footings under the load-bearing walls and pad footings underneath the columns. It is noted that the original foundations will have experienced load from the original height of the building.

Trial pits undertaken in 1999 by previous advising engineers, Bowden Sillett & Partners (BSP), under the load-bearing walls of the atrium, show the foundations here to be traditional brick corbels projecting up to 700mm from the face of the approx 700mm thick existing brick walls. Refer to Appendix C for a record of the findings. As the original structure at basement level appears to have been retained throughout the building and the thickness of the existing load-bearing walls at this level appears to be consistent with visible corbelling throughout, the foundations under the lightwell are assumed to be similar to what was found in the BSP trial pits. Water was encountered at approximately 500mm below basement finished floor level within the trial pits.

- West Wing

As part of earlier strengthening works to allow for a roof extension over the West Wing, intrusive exploratory work was carried out by Price & Myers on this part of the building, to discern the existing structural arrangement, and it was found that there had been significant alterations to the original structure. This is thought to be the result of both the fire damage of 1920 and bomb damage incurred during the Second World War.

These works confirmed that the roof, third, second and first floors have been rebuilt. A lightweight metal deck was used for the roof, timber joists for the third floor, RC hollow pot floor for the second floor and beam & block floor was used for the first floor. The upper and lower ground floors were generally still the original masonry jack arch vaults spanning between cast iron beams. There were solid brick walls throughout and the original cast iron columns still in place up to the underside of 2nd floor level. On the upper ground and first floor, newer mild steel columns were in place in the east half of the West Wing, dating back to the early 20th century. On the second and third floors modern steel UKCs were used.

The strengthening work was carried out by P&M in 2015 to allow for a roof extension to the West Wing. This work included strengthening to the existing central steel UKCs using bolted flange plates and extending cast iron columns from 2nd floor to existing roof level using new steel columns. Steel stub columns were installed, which project above the roof level to allow for the connection of a new structure over at a future date.

Drawings and calculations detailing these strengthening works are contained in the following Price and Myers documents: 'The Hop Exchange-West Wing-Strengthening Works Structural Calculations' dated 23rd December 2015 and 'The Hop Exchange - Structural Feasibility Report -RIBA Stage 1' dated 2nd of September 2015. Refer also to Appendix E for typical strengthening details

- Area to front of Lightwell

Opening up to this part of the building has not been carried out due to it being tenanted. Whilst for the purpose of this report and initial concepts it has been assumed that that the structural arrangement of this area is similar to the West Wing, further exploratory work will be necessary, to discern and assess the existing structure. Existing survey drawings and visual inspections have given some indication of the position of the framing elements and this has been used to inform the initial schemes.

Note: From historic photographs it appears the fire extended part way into this area of the building, indicating that the floors would have re-been built in a similar way to the West Wing. Part of the floor appeared to remain intact, perhaps due to existing brickwork spine walls, helping to prevent further spread of the fire. If this is the case then it's possible the floors could be the original timber joist construction from upper ground floor.

- Lightwell

In the central area of the building, to the north-west of the exchange hall under the footprint of the proposed infill works, there is a three storey lightwell which provides light to the surrounding cellular offices.

A visual inspection was undertaken by P&M on the 13th of July 2017, to view the structure under and immediately around the lightwell. The existing first floor level roof under the footprint of the lightwell appeared to be solid concrete slab over or between steel beams, suggesting that this floor is likely to be non-original and perhaps re-built after the fire. The upper ground and lower ground floors beneath appeared to be either the original jack-arch vaults or again solid concrete slab construction spanning between cast iron and concrete encased steel beams respectively, suggesting that these floors were partially rebuilt or are infilled lightwells.

The surrounding load-bearing walls enclosing the infill area appeared to be solid brickwork of varying thicknesses; typically, 700mm thick in the basement thinning to 330mm/440mm thick at first floor level. It is assumed that these wall thicknesses are typical for corresponding storeys throughout the building where there is original structure, depending on the loads carrying requirements of each wall. The upper ground floor central spine wall under the new infill was 215mm thick indicating this is non-original.

External rendered markings on the walls around the lightwell perimeter indicate that there was once a three-storey building infilling the lightwell.

The approximate existing structural arrangement and vertical load transfer is shown in Figure 11.

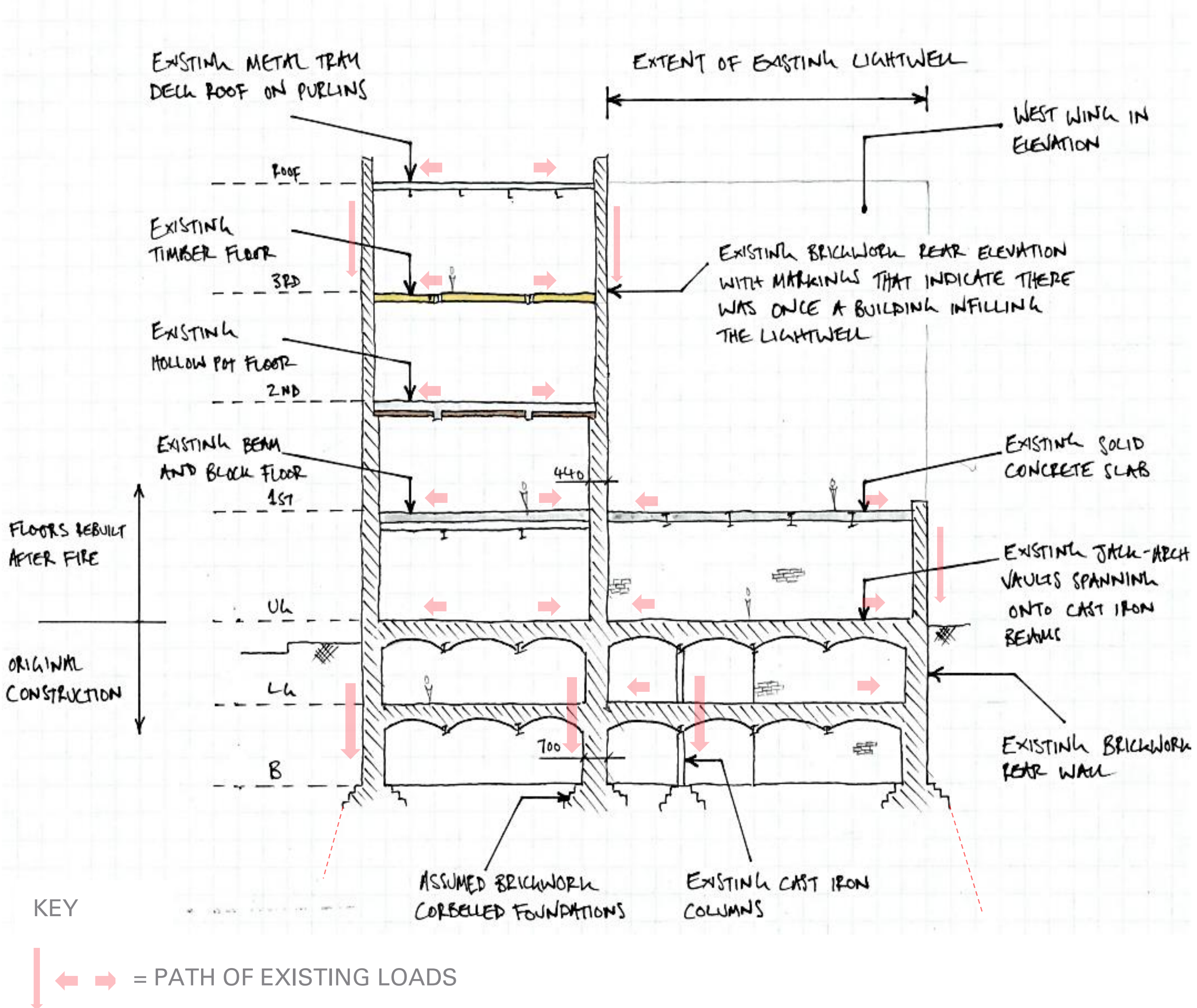


Figure 11: Existing Structure and Vertical Load Path of the Hop Exchange beneath and adjacent to the Lightwell

Horizontal Load Transfer

Lateral wind loads are applied to the external façade, which spans between the floor plates and return cross-walls, where the form of the structure is cellular around the perimeter. The solid masonry cross-walls transfer loads to the foundations. It is noted that a cross-wall has previously been removed in the West Wing reducing the shear load transfer capacity.

The approximate horizontal load transfer for the West Wing is shown in Figure 11a. The principle for the area to the front of the west wing and lightwell is similar, relying on floor diaphragms and cross-walls to transfer the load to the foundations.

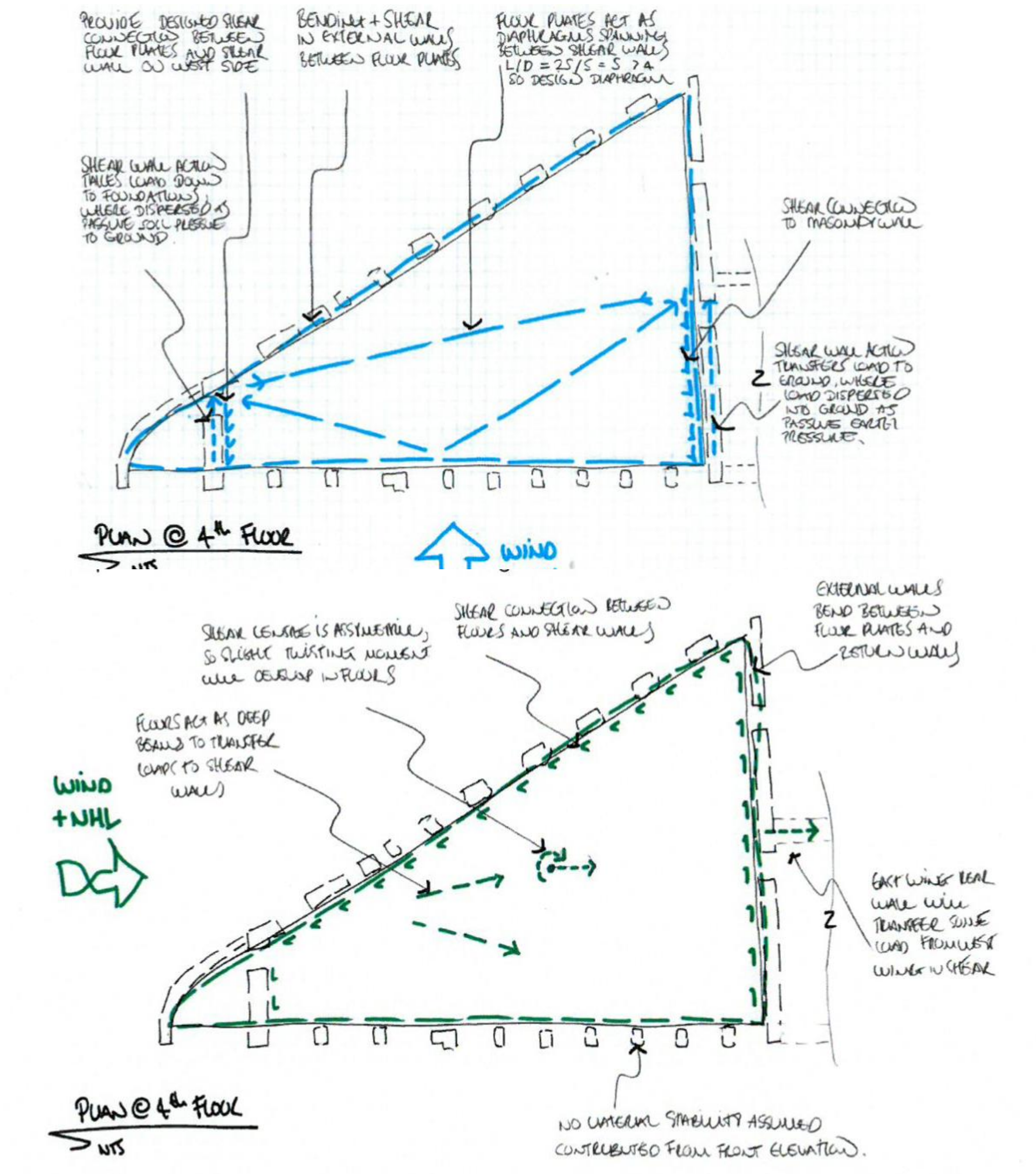


Figure 11a: Horizontal Load Path of the Hop Exchange in north-south and east-west directions of the West Wing

Should the design be taken past RIBA Stage 2, further visual and intrusive surveys will be required, most pertinently to the Area to the front of the Lightwell, for the existing horizontal and vertical load paths to be more accurately discerned.

4 Capacity of the West Wing Existing Structures

As part of the strengthening works to the West Wing carried out by Price & Myers in 2015 the capacity of the existing structure was assessed to determine whether it could withstand additional storeys. These will add vertical load, lateral load and introduce the requirement to assess the existing structure against modern accidental load cases (Disproportionate Collapse). Lateral and accidental load cases would not have been considered when the structure was originally designed, however when modifying existing buildings, they must be upgraded to meet modern standards.

Material Testing

To assess any weakening to the structure that may have occurred due to the fire and to allow for less conservative assumptions in the calculations, material testing was carried out.

Samples of brick and mortar were taken from the front facing external wall on the upper ground, first, second and third floors, and from internal walls at lower ground and basement. This was to help determine the masonry unit strength to enable accurate calculation of the capacity of the existing masonry walls.

A steel sample was also taken from a steel transfer beam under the upper ground floor to check for fire damage.

The results from the material testing are contained in Appendix D, along with the plan with references for areas of opening up works.

Additional Vertical Load

Previous calculations have been carried out by P&M that check the critical elements in the West Wing. The calculations provide details of the allowable loads that the new roof extension can exert on the existing stub columns.

It concluded that the strengthening works would allow for a 2-storey lightweight roof extension over the West Wing. The strengthening drawings are contained in Appendix E with the assumed roof extension loading and connection design loads highlighted,

Approval for any load reduction or increase imposed on the tunnels will be required from LUL, to prove there is no significant effect.

Additional Lateral Load

The original pre-fire 8 storey 1860's structure is assumed to have adequate lateral stability, having been in service for approximately 50 years with this arrangement. However, it is noted to be unlikely that any wind analysis or lateral stability checks were performed to justify this.

If the original shear wall arrangement up to 4th floor still existed, the lateral stability of the structure could be justified up to the original height of the structure. However, a cross-wall in the west wing is noted to have been removed during the service life of the structure, which would have contributed to the original stability. Therefore, load analysis and element checks were carried out to justify any additional height.

The 'West Wing-Strengthening Works Structural Calculations' allow for a two-storey lightweight roof extension over the West Wing assuming that the load path for resisting lateral loads for the new storeys is provided by new structural plywood diaphragms at each additional level spanning between steel cross-bracing built off the eastern and western sides of the west wing with loads resisted by in-plane shear and overturning capacities of the existing perimeter brick masonry walls.

Disproportionate Collapse

To comply with current Building Regulations, all modern buildings must be designed to ensure that in the event of an accidental load case (e.g. gas blast) the building will not suffer collapse to an extent disproportionate to the cause. This condition applies when refurbishing or extending existing structures, and hence is relevant to the proposals.

The Hop Exchange, like many historic structures, does not meet current regulations for disproportionate collapse. The proposals are likely to comprise an upward double-storey extension over the existing six-storey structure.

The building is currently occupied by retail units and offices, with public houses at low level. It is likely to retain similar occupancy in the proposed condition. Hence, the building would be classified as Class 2B under current Building Regulations, Part A3.

"Requirements relating to building work
4. – *(1) Subject to paragraph (2) building work shall be carried out so that –*
(a) it complies with the applicable requirements contained in Schedule 1; and
(b) in complying with any such requirement there is no failure to comply with any other such requirement.
(2) Where –
(a) building work is of a kind described in regulation 3(1)(g), (h) or (i); and
(b) the carrying out of that work does not constitute a material alteration, that work need only comply with the applicable requirements of Part L of Schedule 1.
(3) Building work shall be carried out so that, after it has been completed –
(a) any building which is extended or to which a material alteration is made; or
(b) any building in, or in connection with, which a controlled service or fitting is provided, extended or materially altered; or
(c) any controlled service or fitting,
complies with the applicable requirements of Schedule 1 or, where it did not comply with any such requirement, is no more unsatisfactory in relation to that requirement than before the work was carried out.".

In accordance with the above legislation with respect to disproportionate collapse, the proposed additional storeys to the Hop Exchange should make the existing structure no more unsatisfactory than it was before the work was carried out.

In cases of upward extensions over existing structures, it is generally recognised that interpretation of "no more unsatisfactory" can give rise to copious strengthening requirements throughout existing structures, even though they are robust. As this would introduce significant intrusive works, disturbance to users and cost, the structural strategy for disproportionate collapse is agreed on a case-by-case basis for developments of this kind.

Three scheme options were prepared during the 2015 feasibility works and discussed in principle with the Building Control Authority. The chosen structural strategy to achieve Class 2B is a "Strong Floor" bearing onto the existing structure, as shown indicatively in figure 12 below. This solution takes support from the existing structure, while designing the lowest new floor plate to have the ability to support the load of all the above storeys, should they all collapse.

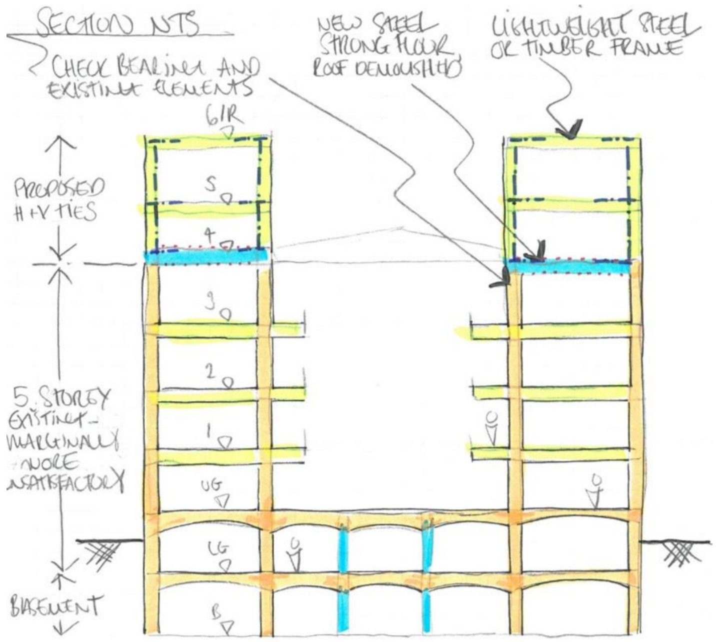


Figure 12: Existing Structure and Vertical Load Path of the Hop Exchange beneath and adjacent to the Lightwell

As detailed in "Practical Guide for Disproportionate Collapse" – IStructE 2010 "if a strong floor can be designed to withstand collapse of the structure above, it clearly protects the occupants below". In this way, the existing structure is only marginally more unsatisfactory than before.

A 'strong floor' is a floor with sufficient capacity to support the dynamic impact loading of the weight of the additional structure were it to collapse while protecting the occupants in the existing structure below. It is noted that this option would exert additional load on the existing structure however the expected amount of load compared with the current weight of the structure is relatively minor.

This option is recommended, as the works would entail far less intrusive works than the alternative options, offering the feasibility of executing the works while the commercial storeys below continue in service.

The load factors for use in the derivation of the collapse load case are summarised in Section 6 and are based on the Camden Ruling approach for the design of 'Strong Floors'.

It's important to note that this was agreed in principle with AIS (Approved Inspector Services) at the time and there is now a different approved inspector in place to oversee these works, who has been asked to provide an updated AIP for the strategy,

5 Capacity of the Existing Structures below the Lightwell

Additional Vertical Load

The '2017 Lightwell Infill Feasibility Study 'can be referred to for further details on the vertical capacity of the existing structure, however it is understood that the intention is to remove the existing superstructure and foundations, so it is not discussed in detail here. The existing walls and their foundations surrounding the lightwell once supported additional 4 storeys which will be considered in the calculations.

A geotechnical investigation is planned to be carried out which will assess the capacity of the ground in and around the lightwell.

Approval for any load reduction or increase imposed on the tunnels will be required from LUL, to prove there is no significant effect.

Additional Lateral Load

The existing brickwork retaining wall will become superfluous once the new RC box structure is installed. It will need to be propped in the temporary case to allow for removal of the Lower Ground Floor as indicated in Figure 15.

The crosswalls of the 'West Wing' and 'Area to the Front of the Lightwell' are considered suitable to resist lateral forces from the Lightwell infill.

Disproportionate Collapse

Framed members are effectively tied at each level using end plates and bolted connections to resist minimum integrity forces. Columns are to be effectively restrained in two directions at each level
The connections will be designed to meet the requirements of disproportionate collapse class 2b. These will also increase temporary erection stability. The floors are tied back to the existing brick shear walls in places where columns are not feasible within the architectural proposals

6 Design Criteria

Ground Conditions

Note: a GI is planned to be carried out at the end of RIBA Stage 2.

-It has been assumed that the ground directly below the lightwell contains archaeological remains and is not suitable to support high loads and shallow depths. It could be that spread foundations work at formation levels below the archaeological remains, but at this stage a piled solution has been assumed.

-Piles are shown indicatively at this stage until the results from the GI are received along with site specific information showing the location of the existing tunnels.

Existing foundations

-The foundations under the basement walls are generally taken as 2.1m wide corbelling strip foundations, as Appendix C

-As a general rule anything greater than a 10% increase in the overall loading on the existing foundations requires further assessment of the capacity of the existing foundations, which may include further geotechnical investigations.

LUL Tunnels

-The density of the Kempton Park Gravels and London Clay acting over the tunnels has been taken as 20kN/m^3

-A 2:1 Load spread under the foundations is assumed for the existing and new loads.

Existing Brick Walls

-A bearing capacity of 0.63N/mm^2 is used for existing brickwork, against unfactored loads.

Loadings

-Refer to Appendix G for a schedule of the new and existing loads.

-The proposed loads is assessed using a live load of 3.50 kN/m^2 to cover office use with lightweight partitions.

-The dynamic wind load for the proposed extension is taken as 0.8kN/m^2

-The load factors for use in the derivation of the collapse load case are summarised as follows and are based on the Camden Ruling approach for the design of Strong Floors:

Dead Loads

Floor plates above Strong Floor	– 3.00
Floor plate of Strong Floor	– 1.00
Floor plates below Strong Floor	– 1.00

Imposed Loads

Floor plates above Strong Floor – 1.00
Floor plate of Strong Floor – 1.00
Floor plates below Strong Floor – 1.00

External Wall Loads

Walls above Strong Floor – 2.00
Walls below Strong Floor – 1.00

Design Fire Periods

Replacing the existing brickwork walls with a steel frames will create a much larger fire compartment and increase the escape route distances.

It is likely the current fire strategy can be re-adjusted without significant alterations to the existing building, but this would need to be assessed and designed by a Fire Engineer consultant.

The building is approximately 24m above ground level. The assumed minimum periods of fire resistance are highlighted below (extract from Building Regs Part B).

B PERFORMANCE OF MATERIALS, PRODUCTS AND STRUCTURES

Table A2 **Minimum periods of fire resistance**

Purpose group of building	Minimum periods of fire resistance (minutes) in a:					
	Basement storey (6) including floor over		Ground or upper storey			
	Depth (m) of a lowest basement		Height (m) of top floor above ground, in a building or separated part of a building			
	More than 10	Not more than 10	Not more than 5	Not more than 18	Not more than 30	More than 30
1. Residential:						
a. Block of flats						
– not sprinklered	90	60	30*	60**†	90**	Not permitted
– sprinklered	90	60	30*	60**†	90**	120**
b. Institutional	90	60	30*	60	90	120#
c. Other residential	90	60	30*	60	90	120#
2. Office:						
– not sprinklered	90	60	30*	60	90	Not permitted
– sprinklered (2)	60	60	30*	30*	60	120#
3. Shop and commercial:						
– not sprinklered	90	60	60	60	90	Not permitted
– sprinklered (2)	60	60	30*	60	60	120#

It is assumed that either fireboarding or intumescent paint will be provided to the new steel frame. Any timber elements such as CLT or timber joists should also be provided with suitable fire protection or designed for charring in accordance with the latest requirements.

This information is just a guide-The architect's and fire consultant's information should be referred to for the fire strategy.

Codes and Standards

Loading	BS EN 1991-1	Part 1 Part 3 (1997) Part 4 (1988)
Concrete	BS EN 1992 & BS 8500.	
Foundations	BS EN 1997	
Steelwork	BS EN 1993	
Masonry	BS EN 1996	
Timber	BS EN 1995	

Design Life

60 years

7 Construction of Proposed Storeys

Architectural Proposals

Refer to the architect's RIBA Stage 3 Report for the architectural proposals. The architect's CGI image is presented below in Figure 13

Figure 13: Architectural CGI image (Forge Architects Image)

The following outline of works are proposed:

- Lightwell

The existing structure below the 'lightwell' is to be removed and replaced with a new 7 storey infill structure, with glazed external walls the following uses:

Basement - back of house and WCs (A3/A4);
Ground and 5th floor - restaurants and/or cafes (A3/A4);
1st to 5th Floor - Offices (B1);
Roof - A fully accessible roof terrace servicing the A3/A4 spaces with a band of extensive green roof to the perimeter, as well as an area for lift, plant and pvc cells.

- Area to the front of the lightwell

To be reconfigured, with the existing floors, walls, vaults and front façade retained where feasible and practicable, with the addition of a 2 storey roof extension, with the following uses:

Basement - to remain as storage;
Ground floor - restaurants and cafes (A3/A4);
1st floor to 5th Floor - Offices (B1) ;
4th floor to Roof -terraced areas created where the front façade of the new roof extension is set back and over a portion of the upper main roof, with a band of green roof to the perimeter and some areas for M&E plant.

The current roof design is based on Forge's design, however it is noted that the landscape architects have indicated some areas of *intensive* green roof which will be incorporated in the next stages.

- West Wing

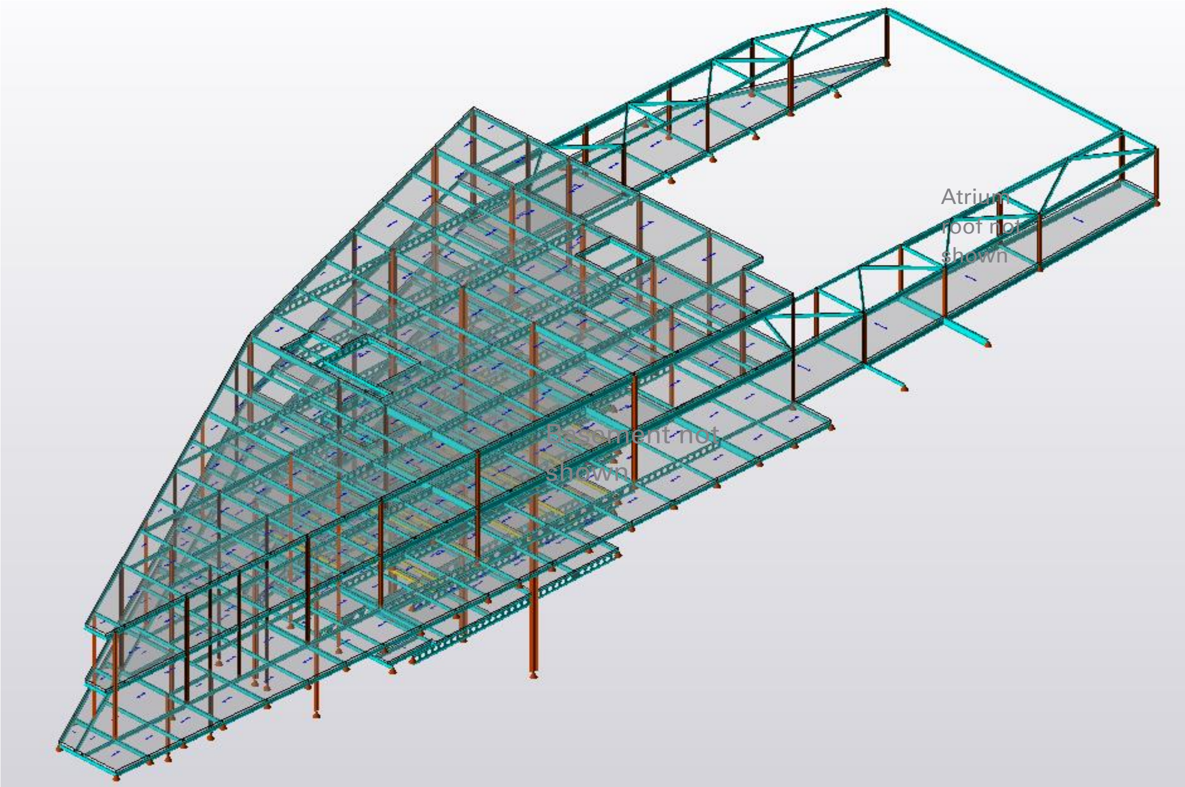
To be increased in height by 2 storeys, with the existing storeys use as current and the new roof extension as described for the 'Area to the Front of the Lightwell'

- Atrium Roof

The existing steel roof is to be replaced with a new curved roof supported off the atrium perimeter wall at 5th floor.

Structural Proposals

Refer Appendix F for structural scheme including member sizes and the below 3d view of the steel frame from TEKLA SD.



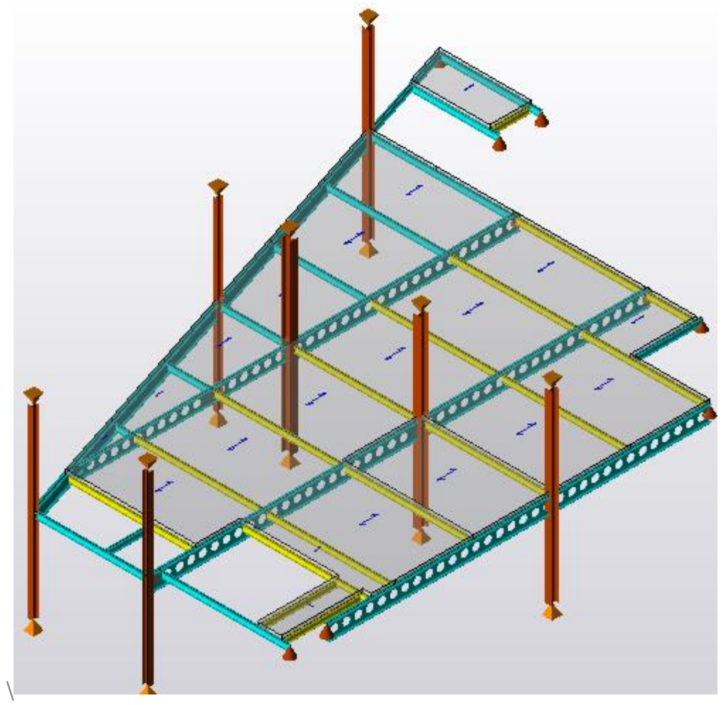
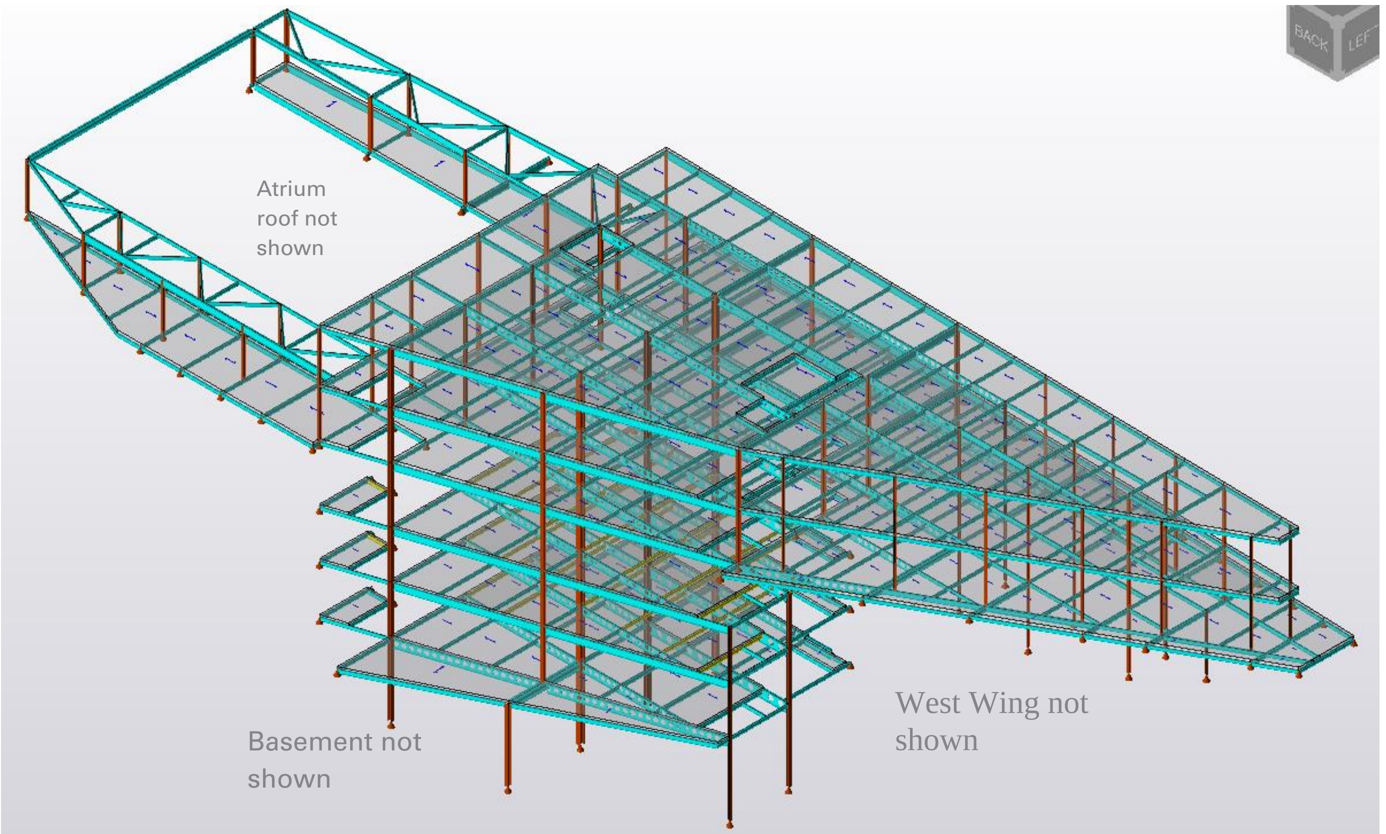


Figure 14c: Tekla Structural Designer 3rd floor sub-model of steel frame.



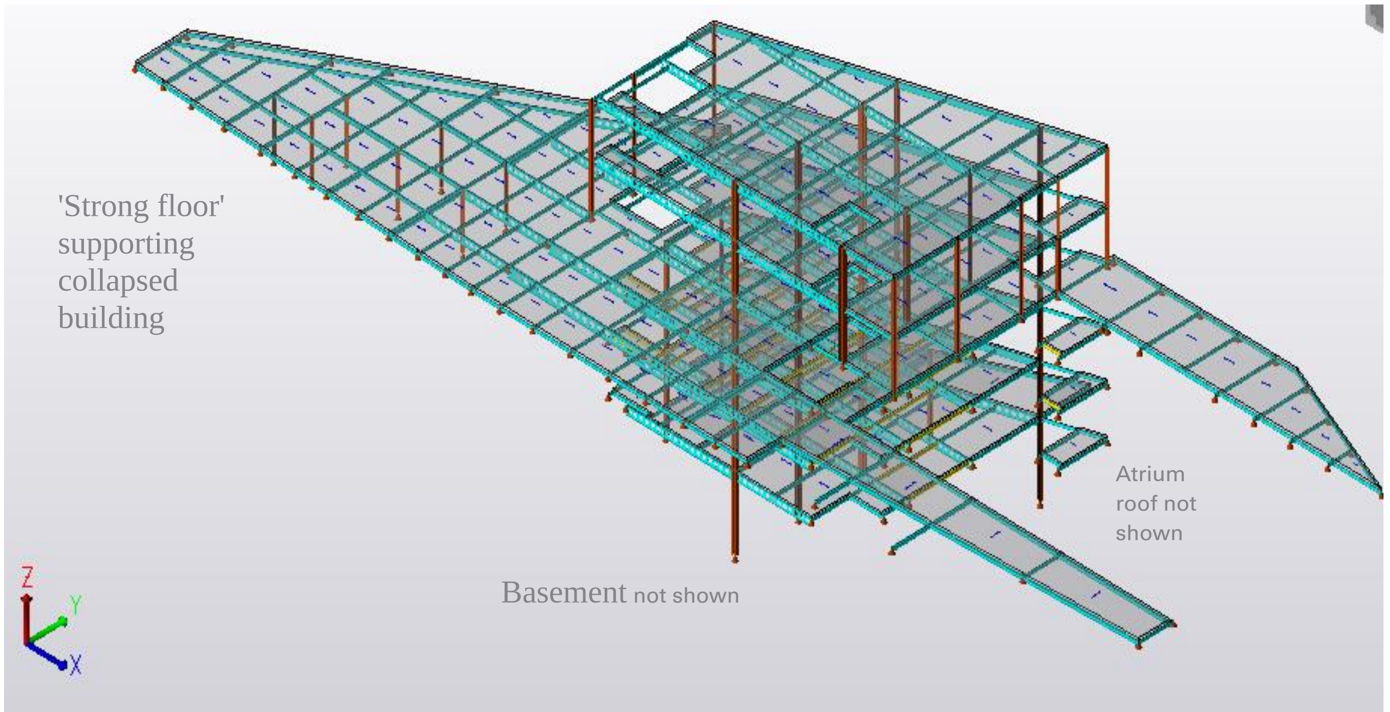


Figure 14d: Tekla Structural Designer showing building in Accidental state with 'strong floor' at 4th floor supporting load of collapsed building over in accordance with the Camden Rule.

Figure 14a and 14b: Tekla Structural Designer models of steel frame. Basement and atrium roof not shown.

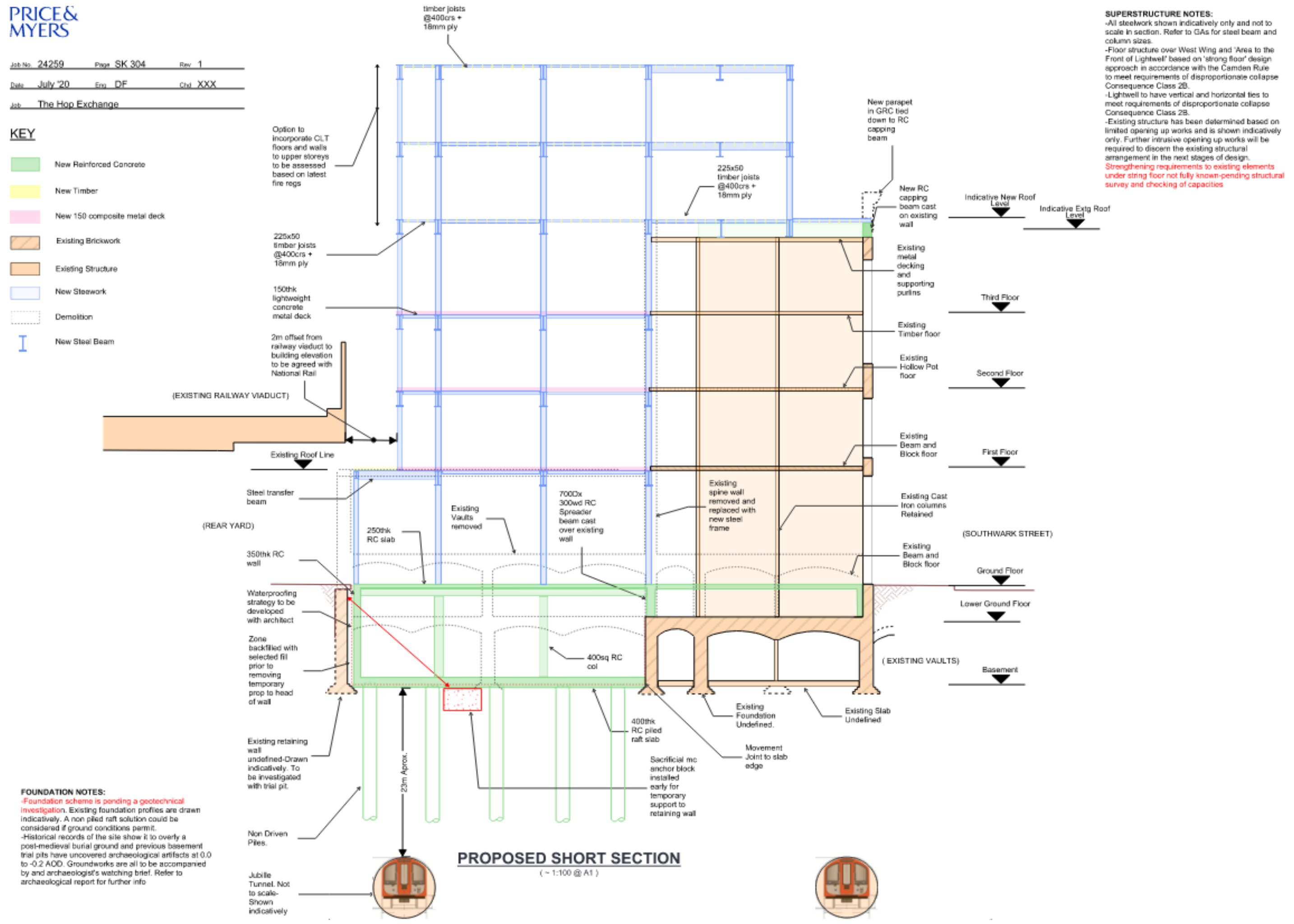


Figure 15: Section through 'Lightwell' and 'Area to Front of Lightwell' showing proposed structural works

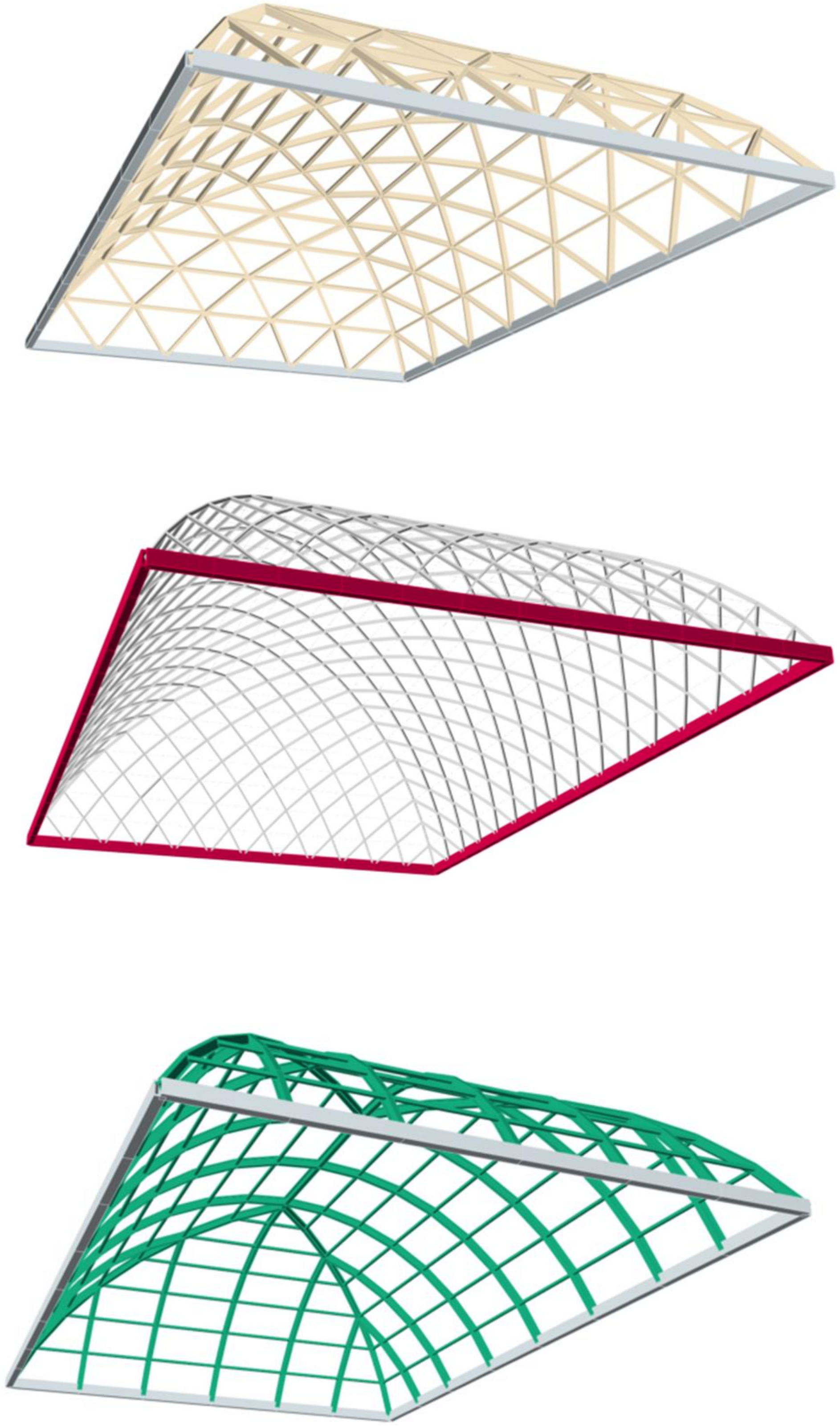


Figure 16: GSA models of atrium roof

- Lightwell

The roof and upper floors are built in timber joists (4th to Roof) or 150 lightweight composite metal deck (1st to 3rd) spanning onto secondary steel beams (approx 250 deep) at regular centres which span onto primary cellular Westok beams (approx 600 deep) which are supported off steel columns. The secondary steel beams are designed as composite where this is achievable. The floors are tied back to the surrounding brick walls and portalised frames for stability and robustness.

The timber floors are sheathed in 18mm ply and the metal deck will have continuity reinforcement to enable both floor plates to work as diaphragms. They will be tied back to portalised frames and the existing brick walls

At 1st floor there is a 400 deep steel transfer beam to support a 1st floor column where the façade steps back to make way for the railway viaduct, allowing the building's rear facade line to be offset at ground floor.

The steel columns are supported off the RC frame at ground floor.

The basement is formed from an RC 'box'. The rear RC retaining wall is propped by the ground floor slab and supports the retained ground with the existing brickwork retaining wall left in place and rendered structurally obsolete. The ground floor is a 250thk RC slab spanning between downstanding RC beams which are supported off RC columns and walls.

The lift cores are built in 200thk RC concrete.

The basement floor is formed from a 400thk piled raft slab between bored or cfa piles. The substructure design is in abeyance pending results from the GI, surveys of the LUL tunnels and archaeologist review.

- Area to front of Lightwell and West Wing Roof Extension

The roof and floors are built in timber joists with ply sheathing supported off a steel frame. At 4th floor level the floors are supported off 'strong floor' steel grillage (approx 400 deep) erected over the existing lightweight metal deck roof.

The new frame is partly built off the existing steel stub columns that were installed as part of the earlier P+M strengthening works to the West Wing. The stubs transfer the loads into the columns at 3rd floor and below, which may need to be strengthened depending on the final roof extension loading and structural configuration.

This floor is designed to support the load from the collapsed building above in accordance with the 'Camden Rule' to meet requirements for disproportionate collapse as discussed in Section 6 and 7 . An RC ring beam is cast over the existing brickwork walls where they support the 'strong floor' to help dissipate the loads and tie the frame together.

Note: The existing roof is retained to facilitate construction providing a platform to aid erection of the new storeys, for weatherproofing and to minimise disruption to the tenanted areas.

The existing rear elevation wall to the front of the 'lightwell' is removed down to ground floor and replaced with a new steel frame and brickwork shear wall to provide lateral stability and support to the existing floors. The frame is built off an RC spreader beam at ground floor that allows the load to be spread across the retained basement brick wall.

The existing cast iron columns and beams are generally retained to facilitate retention of the existing floors and because of their heritage significance.

- Atrium Roof

We have explored three distinctively different structural options for the Atrium roof. All three options follow cylindrical shape that was selected to meet the massing requirements.

The first option is a steel gridshell structure formed by steel flat plates and welded together on site. Thediagrid forms diamond shape openings which would be covered by solid roof or glazing. In order to minimise the site fixing, the shell could be modularised into transportable pre-assembled panels.

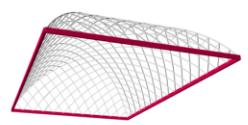
The second option is a timber gridshell which uses saw cut straight timber members and steel fabricated nodes. The triangular units are larger than the steel shell option an as a result the rooflight would become larger also.

The third option is a steel three pin arch system that is perhaps closest to the original roof and uses a combination of curved and straight hot rolled sections. The geometry of the arches result in rectangular glass panels with the exception of the panels adjacent to the hips of the roof.

All three options are supported by a steel perimeter ring beam/truss that is forming the base for the shell and arch members and provides the interface between the atrium roof and the new/existing superstructure; providing resistance to lateral forces from wind and horizontal thrust from the atrium roof.

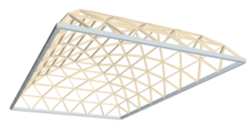
Hop Exchange - Atrium Roof Options

Tonnages/sizes shown are approximate and should provide guidance only at this Stage



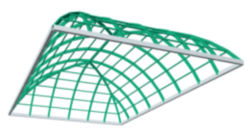
Steel gridshell

Members	Material	Notes	Notes on roof panels	Section				Section area [mm2]	avarage member length [m]	no	total length [m]	tonnage [t]
				depth	width	top/bot th	sides thk					
diagonals	steel	Laser cut flats using 2x15thk where modules joined, joints welded within modules	Panels to be broken down to triangles to fit onto diamond shape grid. Typical panel size 1.6x1.2x1.2m sides, area: 0.8m2. Total roof area: 560m2 - 768 triangle panels	80	25			2000	1.2	768	936	16.9
perimeter ring beam	steel	fabricated box section		350	200	20	10	18000			84	13.1



Timber gridshell

Members	Material	Notes	Notes on roof panels	Section				Section area [mm2]	avarage member length [m]	no	total length [m]	tonnage [t]
				depth	width	top/bot th	sides thk					
diagonals	timber	twin saw cut or solid glulam, joints fabricated steel nodes with bolted/bearing connection to timber	Triangular panels . Typical panel size 3.3x2.3x2.3m sides, area: 3.0m2. Total roof area: 560m2 - 192 triangle panels Nodes fabricated from laser cut flats and CHS sections	200	100				2.5	192	468	
horizontals	timber	twin saw cut or solid glulam - nodes as		150	100				3.3	82	268	
perimeter ring beam	steel	fabricated box section		350	200	20	10	18000			84	13.1



Steel arch

Members	Material	Notes	Notes on roof panels	Section				Section area [mm2]	avarage member length [m]	no	total length [m]	tonnage [t]
				depth	width	top/bot th	sides thk					
Arches	steel	254x146x43UB rolled to curve	Rectangular panels with triangular/trapezoid panels at hips. Typical rectangular panel size 3.4x1.5m sides, area: 5.0m2. Total roof area: 560m2 - 148 panels (92 rectangular, 56 triangular/trapezoidal)	254	146			5480	10.5	24	243	11.55
Horizontals	steel	100x100x5SHS		100	100	5	5	1870	3.4	120	323	5.5
perimeter ring beam	steel	fabricated box section		250	200	20	10	14000			84	10.2

8 Below Ground Drainage

Existing

Thames Water Asset Location Plans (Figure 17) shows that there is a 1143x762mm combined trunk foul water sewer running to the south of the site along Southwark Street from east to west within a tunnel. There is also a 1143x762mm combined water public sewer running to the east of the site along Stoney Street.

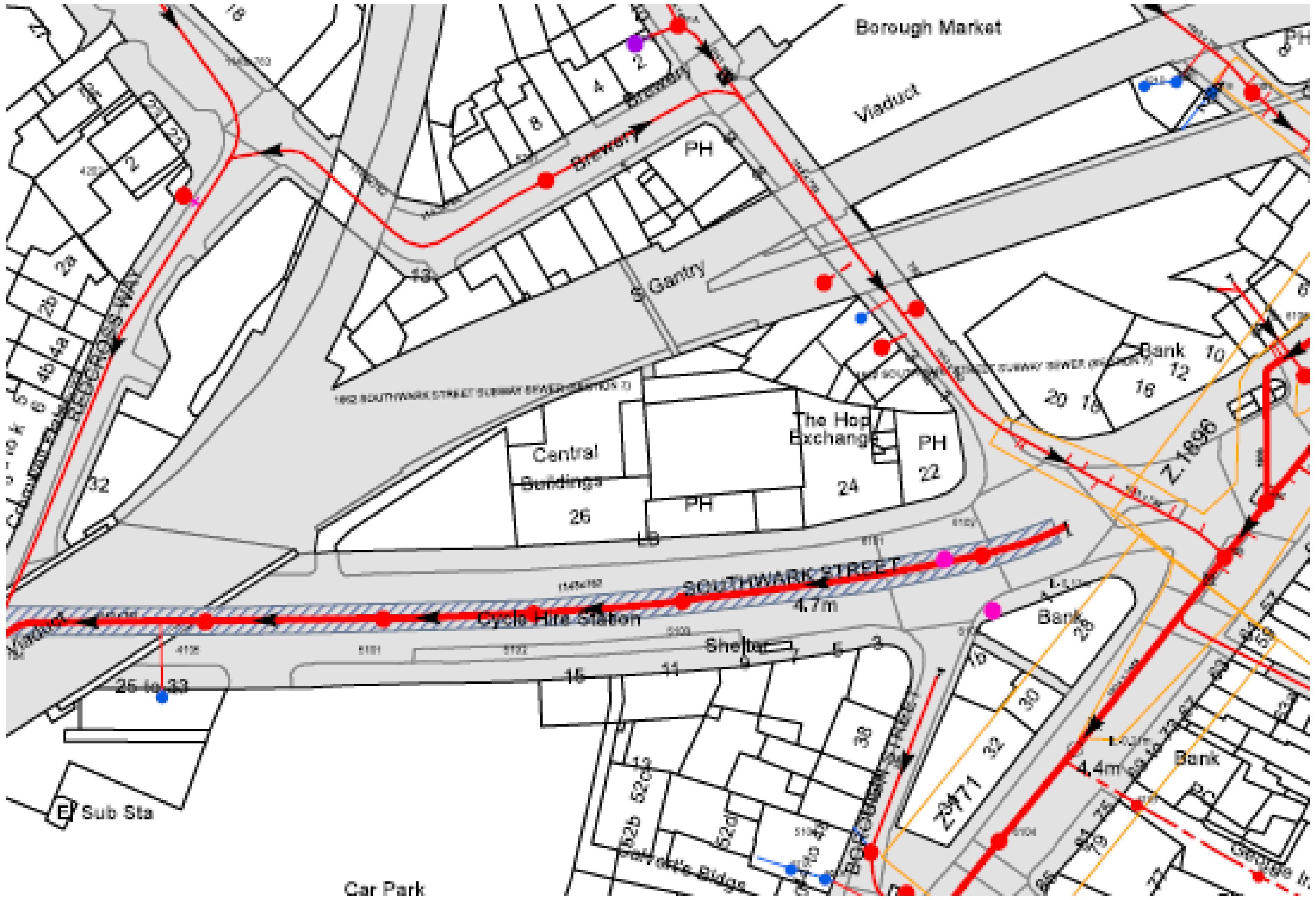


Figure 17: Thames Water Asset Location Plan

A number of site investigations have taken place and information relating to the existing drainage has been recorded. A drainage CCTV survey undertaken by UKDN (Ref: UKSN386441, April 2015) found a combined water network serving the site along the north of the building running from east to west, which is assumed to be a public sewer as it has upstream connections from offsite. This then discharges south through the western corner of the site where it is assumed to discharge into the combined water trunk sewer in Southwark Street. There were also two other combined networks identified to the south of the building which have separate connections to the combined trunk sewer in Southwark Street.

A separate 150mm diameter surface water drainage run in the rear yard was identified running from east to west. The rear yard is under a separate ownership and it is believed that the surface water run is a public sewer as it has upstream connections coming from beyond the site boundary.

The survey found that most of the runs surveyed were in a reasonable condition, with only some runs requiring repairs. The repairs include patch liners, excavation and replacement of pipe and jetting. It was not known whether these remedial works, in accordance with UKDN recommendations, were undertaken following the survey.

An underground utility trace was undertaken by Murphy Surveys (Ref: MSL 33085, December 2019). This included the Rear Yard and the land between the Hop Exchange and the Rear Yard. This further confirmed some of the routes identified by UKDN in 2015. This did not include a camera survey of the drainage pipes; therefore, it could not be ascertained as to whether the condition of the pipes had further deteriorated or if the survey works were undertaken previously.

As a result, to confirm if these remedial works had taken place and to confirm all routes on site an additional CCTV survey of the entire drainage network was commissioned. Kenclean attended the site in August 2020 (Ref: A988HPEX). This survey confirmed the four different networks previously identified.

This survey provided additional information on the combined drainage runs located at the front of the property in a narrow passageway in the basement beneath the pavement of Southwark Street. Both of these networks are shallow with a 640mm deep 225mm diameter connection in the south west and a 710mm deep 150mm diameter connection in the south east to the public sewer in Southwark Street. A number of the connections into these runs appear to be redundant and should be sealed with cement if no longer required.

The survey also confirmed the combined water assumed public sewer in the rear walkway, which turns to the south in the west of the site, running underneath the basement and discharging into the public sewer in Southwark Street via a 150mm diameter pipe. The depth of this discharge point is unknown as the internal manholes were not accessible within the basement. There is an additional foul water run in this walkway which discharges into this public sewer prior to it running underneath the basement. It is suffering from a number of fractures; however, these are assumed to be redundant. If no longer required then connections should be capped, but if live then structural repairs are required.

Parts of the drainage network are suffering from contamination which could cause blockages in the future. Therefore, any drainage runs proposed to be re-used should be high pressure jetted. There were also a number of fractures identified, which is proposed to be re-used would need to be repaired. The Kenclean report sets out the proposed remedial works for the drainage network.

Proposed

The drainage will be designed in accordance with the following documents:

- Building Regulations – Approved Document Part H;
- BS EN 12056: Parts 1-5: Gravity Drainage Systems Inside Buildings;
- Design and Construction Guidance, March 2020;
- BS 8000-14: Workmanship on Building Sites: Code of Practice for Below Ground Drainage;
- National Planning Policy Framework (NPPF) 2012 and subsequent addendums;

- The SuDS Manual C753 CIRIA
- DEFRA's Non-statutory technical standards for SUDS

Much of the façade of the building is remaining and the external layout is largely unchanged therefore it is proposed to re-use as much of the existing below ground drainage as possible. In addition, there are archaeological remains beneath the basement therefore excavation in this area should be limited. This impacts on the amount of new below ground drainage and opportunities for below ground attenuation tanks. As a result, it will not be possible to restrict the discharge from the site to the Greenfield run-off rate. Where possible above ground features will be utilised to restrict flow rates where feasible.

This is in accordance with Southwark's "Developers Guide for Surface Water Management" which states that "In general, drainage strategies are not required for any development where no changes are to be made to the external layout of the site (primarily change of use applications). However, Southwark Council expects all developments to take advantage of any suitable opportunities to reduce surface water runoff, e.g. installation of water butts."

It is proposed that the rooftop terrace (approx. 250m^2) could utilise a blue roof for temporary storage with flow restrictions on the rainwater pipes, reducing the peak surface water discharge rate from the site. A blue roof specialist would need to confirm the depth and discharge rate. Existing rainwater pipes within the building would need to be extended up to the new roof level and connections made. Refer to SK600 for the above ground SuDS strategy in Appendix J.

Areas of brown and green roof are also proposed; these will not be designed to provide surface water attenuation; however they will provide ecological and water treatment benefits and naturally reduce surface water peak discharge rates.

The internal alterations will require drainage and where possible existing connections will be utilised. The M&E engineer will need to confirm where the existing foul water appliances drain and therefore which ones will need to remain or can be re-used for new connections.

Where possible the drainage from the lower ground floor and above should drain by gravity and will need to run at high level in the basement. This above ground drainage will connect into the existing manholes at ground floor at both the front and rear of the property. The connection points will depend on the location of these above ground connections and will be developed during the next stages.

In the basement the new kitchens, WCs, showers and bike stores will require new drainage and an indicative layout can be seen in SK601 (Appendix J). The kitchen drainage will need to run through a grease trap, it is advised that this is provided above ground in each kitchen, however an allowance should be made for a below ground grease trap. The drainage from the basement will need to connect into a below ground foul water pumping station and will be pumped up to an existing manhole at ground floor. Basement areas which are unchanged will drain as existing and these routes will need to be confirmed.

As mentioned in the existing drainage section the combined water sewer to the north of the existing building appears to be a public sewer as there are upstream connections from another property. As a result, a build over application to TW will be required for the structural works to the basement as these are within 3m of the sewer.

The surface water drainage design for the Rear Yard will need to be developed during the next stage when landscape proposals are available. If possible, SuDS will be utilised however this area is under Network Road ownership therefore it is unlikely that below ground surface water attenuation will be possible and in addition the manholes are shallow providing limiting depth for below ground storage. The area of hard landscaping will not increase therefore there will be no increase in surface water run-off rates to the public sewer. The hard landscaping will re-use existing gullies, or new gullies which utilise existing connections to the surface water drain/sewer. Planting and potential loading on the sewer must be considered however the current proposal utilises moveable planters for trees, therefore this should be acceptable to TW.

Any existing drainage which is proposed to remain or be re-used will need to be high pressure jetted and remedial works undertaken in accordance with the Kenclean CCTV drainage survey report findings.

A S106 agreement with TW will be required for re-using existing connections or any new connections to the public sewers.

BREEAM- Pol 03

In accordance with the BREEAM UK New Construction, Non-domestic Buildings, Technical Manual, (SD5076: 2.0 – 2014)), there are elements in Pol 03 "Flood and Surface Water Management" that must be considered.

The site is located in Flood Zone 3, therefore is not able to achieve 2 credits for flood resilience. The ground floor level of the building is not changing therefore it is not possible to set it 600mm above the design flood level of the flood zone. No credits are achievable.

The impermeable area draining to the watercourse (natural or municipal) remains unchanged post development, therefore the peak volume and rate of run-off requirements for the surface water run-off credits will be met by default and two credits are achievable for surface water run-off.

The site is not appropriate for infiltration therefore it is not possible for the first 5mm of rainfall to be prevented from leaving the site completely. In line with CN17 if this is not achievable and all other criteria has been achieved then one credit can be awarded for minimising watercourse pollution. The rest of the area is to be drained is surface water from roofs, therefore the risk of pollution is low, and one credit is possible.

9 Construction Sequence/Logistics

The context of the site will constrain the design and construction of the proposals. The level of edge protection required at high level to ensure the works do not affect the service of the railway, Borough Market, and Southwark Street will be stringent and could preclude any forms of construction which require significant over sailing lengths.

The key issues influencing sequencing and logistics are shown below in Figure 18 and discussed overleaf.

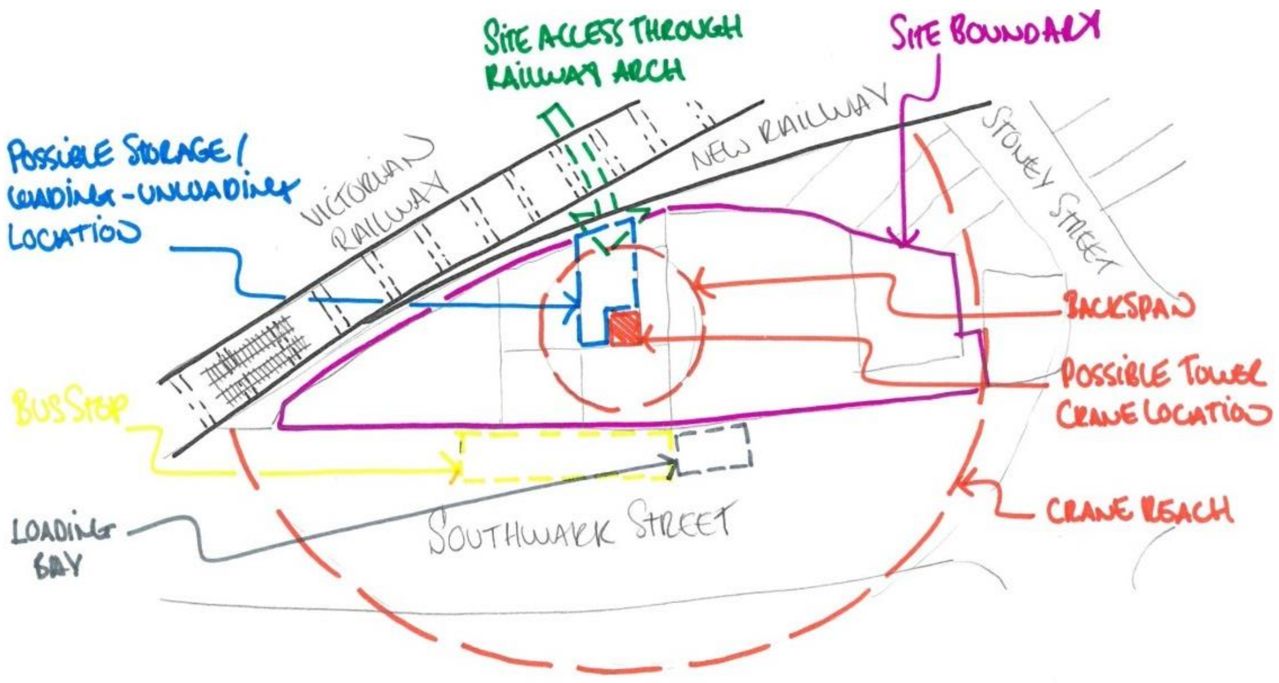


Figure 18: Key Logistics Scheme

Access

A key design constraint is access to the site. The site is tightly bounded on all sides, which will affect how materials could be delivered and stored. Currently, goods are delivered via access along a narrow passageway through an existing railway arch running to the rear of the site. This is expected to be the primary site access route during construction and could limit the size of elements used and the size of vehicles that can access the site. Stick-form construction could be an option, as this would require very little storage on site. Conversely, prefabricated construction could be favourable if a craned solution is viable.

The area accessed by this arch, the 'lightwell' would be essential for loading and possibly storage; however, this may clash with being the most viable location for a crane, and the proposed structure when completed.

Alternative to this is using Southwark Street, a busy road with several bus routes. Therefore, road closures would are likely to be contentious and may have to be done on weekends. If possible, arrangements should be made with Southwark Council to use Southwark Street for parking and access.

Occupancy

The occupancy of the West Wing needs be considered in terms of phasing and sequencing; existing tenants are currently occupying this part of the building, and as the 'strong floor' solution involves intrusive work to the top storey, it's likely the relevant commercial tenants will be disturbed. The current scheme assumes that the existing 4th floor roof will remain in place and the new 'strong floor' will be built above. If this is too restrictive for floor to ceiling heights, and it is decided the existing roof is to be removed, then this clearly will have implications for the top floor tenants.

The works to the 'Area to the front of the lightwell' are too disruptive for this area of the building to be tenanted during the works.

Drainage and all incoming services must be kept live throughout, to keep the existing businesses running.

Storage

The site has a lack of storage area, which will be a key issue and influence the sequence and logistics. A possible storage location is the area to the rear of site above the 'Lightwell', that will later be infilled as part of these works. This area will also be required for access, loading/unloading, and possibly craneage.

Craneage and working platforms

If a tower crane is used, consideration should be given to its reach and back span. It is likely to require a limiter, to prevent oversailing over the railway, and liaison would be necessary with Network Rail to ensure the relevant approvals were given for the construction methods. A tower crane would need to be located in the 'Lightwell' as shown in Figure 18. The dismantling of the crane will need to be carefully planned and sequenced with the erection of the surrounding structure. The existing foundations will need to be surveyed to check that they do not clash with the crane base.

Alternatively, a mobile crane could be used, although this has a shorter reach and is larger, so would need to be located in Southwark Street. As this is a busy main road, road closures would be required and may only realistically be done on weekends.
A scaffold tower supporting a light platform will be required in the atrium to support the atrium roof, which will be supported of the jack arch floor at upper ground level. It's likely that the jack arches will need to be back propped down to foundation level.

10 Further Investigations and Approvals.

Further assessment of the capacity of the existing foundations and ground conditions is planned at the end of RIBA Stage 2 which includes a geotechnical investigation and around 10 trial pits. A suggested trial pit and borehole location plan is included in Appendix I. The final plan will need to be sent to LUL, Network Rail and the archaeologist for review,

The preliminary calculations discussed in Appendix H that were carried out to assess the likely change in stresses on the LUL tunnels, induced from a 2-storey extension over the 6 storey existing building and a 7 storey building over the cleared lightwell indicated there will be a percentage increase in stress in the soil at the level of the tunnel’s crown in the order of 1.6% and 1.5% respectively. This information has been sent to LUL for comment, and advice on their approval process.

This loading is considered negligible; however, the calculation should be re-run for a piled solution if that is the preferred option once the results from the GI are received. In any case, approval for any load increase imposed on the tunnels will be required from LUL, to prove there is no significant effect. Although the applied loads are minor, the proposals are still likely to necessitate a high-level of settlement analysis by the geotechnical consultants, and the approval should be factored into the project program.

The foundation scheme should be sent to the archaeologist for review, once the foundation scheme is further developed pending receipt of the GI,

Where the existing structure is being retained and built over at 4th floor using a 'strong floor' approach in accordance with the Camden Rule, approval of this method has be sought from the current AIS,

11 Design Drawings

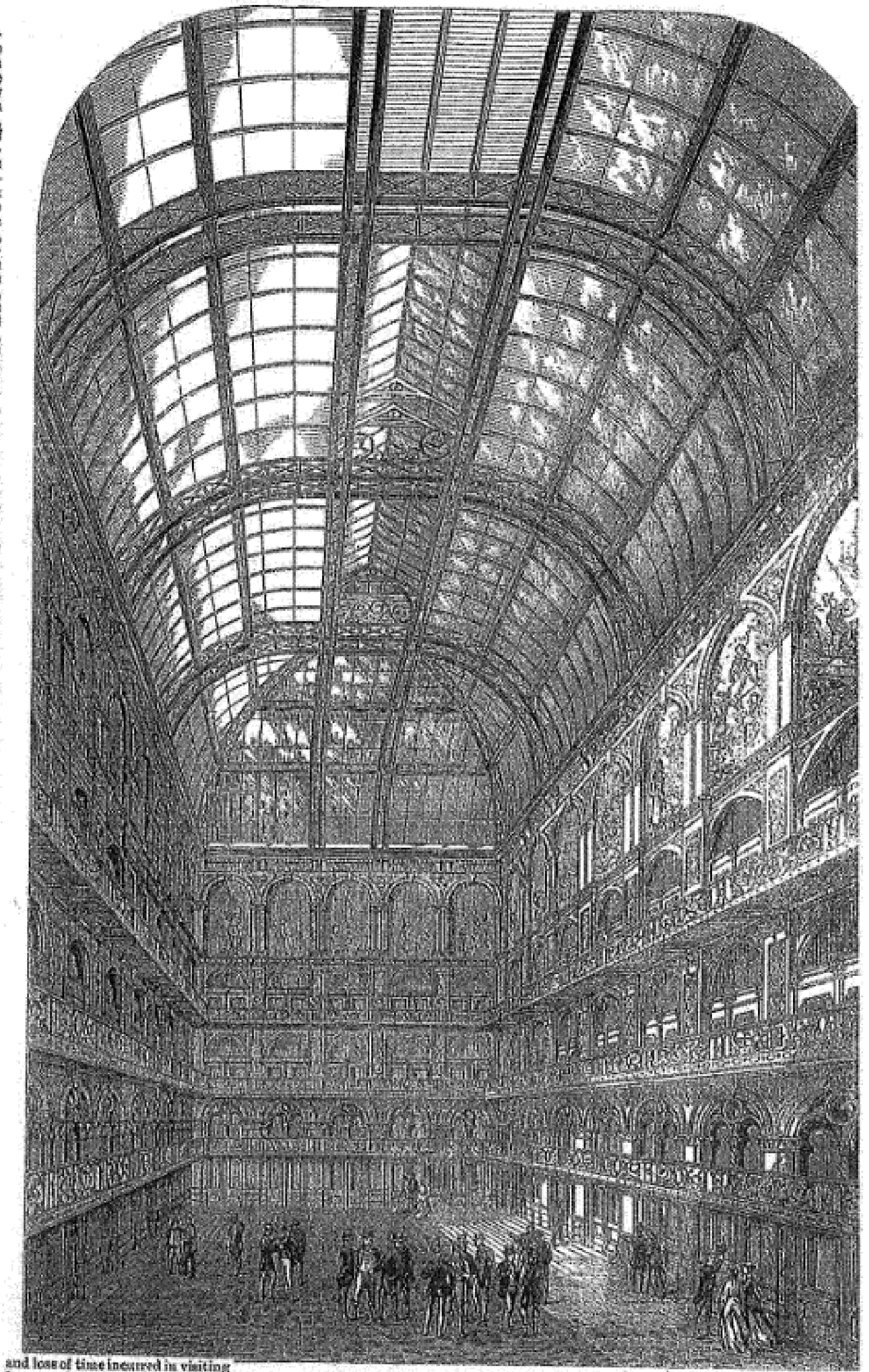
Refer to Appendix F

Appendix A
Historic Documents Recovered

THE HOP AND MALT EXCHANGE.

The new building in Southwark-street, Borough designed for a Hop and Malt Exchange, has just been opened for the business of the trade. It has been constructed by a limited liability company, with an original capital of £120,000, the architect, Mr. R. H. Moore, of Walbrook, being one of the shareholders. It is situated near the London Bridge end of Southwark-street, opposite the Alliance Bank and the premises of the Hop Planters' Association. It has a frontage of 810 ft. in that street, and a 75-ft. frontage in Red Cross-street, the site comprising more than an acre of ground. In the front, Portland-stone pedestals, about 4 ft. 6 in. high, forming the base of cast-iron ornamental columns, extend the entire length, except at the ends and principal entrance. The entrance is flanked with pillars of Portland stone, in all about 27 ft. high. The building consists of an Exchange-room, 80 ft. long by 50 ft. wide, and 75 ft. high to the cornice, from which springs an iron roof of 25 ft. radius, with a lantern-light surmounting it, and arrangements for ample ventilation. From the ridge of this lantern to the floor the height is 115 ft. The floor is laid with encaustic tiles. Around the Exchange are four stories of offices and show-rooms. The three upper floors are approached from ornamental cast-iron galleries running all round. The stone staircases at the opposite angles of the Exchange, and one at the principal entrance, lead up to the galleries, giving access to each office. The floors of the galleries, partly set with small squares of plate glass, are carried on brackets of appropriate design, in which, as well as the balcony railing, the hop leaf and seed have been introduced. The carvers are Frampton and Williamson. A refreshment-room (first and second class) is provided; and a subscription-room, 40 ft. by 35 ft. and 24 ft. high, having a rich ceiling, with six glass star-lights. A fireproof gallery is carried along one end of this room, affording access to a set of offices fronting the street. The remaining portion of the building, yet unfinished, which will be built to its full height in about three months, will consist of warehouses and offices in the front, the height of four stories. There will be in all above one hundred offices, fifty show-rooms, sixty stands, besides basement offices for wine merchants and others, with warehouse-room for 50,000 bales of hops and other produce, and cellarage for about 3000 barrels of ale or other goods. The area of the warehouse-room for the storage of hop and other produce will exceed 220,000 superficial feet.

The cost of the entire building up to the present date is £40,000, and it is estimated that the part unfinished will cost about £10,000. It is anticipated that the rents will be not less than £3000 per annum. By the erection of this exchange, the hop growers, merchants, dealers, and buyers will have all the advantages of a complete and well-attended market close to the termini of all the railways which pass through the hop-growing districts of Kent, Surrey, and Sussex, and will thus be enabled to avoid the trouble, expense, and loss of time incurred in visiting hop merchants' counting-houses in various parts of the Borough.



THE NEW HOP AND MALT EXCHANGE.

Illus. London News. 26-10-

Figure A1 – 1868 – Depiction of Original Exchange Room and Roof

Figure A2 – 1868 – Depiction of original Exchange Room

FAULTY GIRDERS.

During the construction of the New Hop Exchange, in Southwark-street, the foreman noticed that a portion of the building was sinking at a very unusual rate. The attention of Mr. Moore, the architect, was called to the fact; and the sinking part having been shored up, the supporting girder was taken out, sent to Kirkaldy's testing works, tested, and found faulty. Mr. Moore thereupon very properly cancelled his order on the firm who had supplied it; and, ordering the rest of his ironwork from another house, took care to use none of it until it had been thoroughly tested. A little less careful observation on the part of the foreman, and a little less caution on that of the architect, or, if the girder had stood firm until a subsequent period, when a great mass of the building had been completed, and the consequence would have been certainly a large destruction of property, and probably a coroner's inquest. Upon whom would then have rested the responsibility? Upon the builder, with the questionable remedy of an action against the iron founder, for defective work in the material supplied. Under such circumstances, the only method of attaining protection is by rigorously testing every girder before it is fixed. Not a single exception should be made, and no ironwork should be allowed about a building until a guarantee has been given that it has been successfully tested. The introduction of iron, as a material for construction, has rendered increased engineering knowledge necessary to architects. Builders, however, should by no means take for granted the correctness of architects' instructions, with regard to girders. Testing must be rigorously applied, or complete safety will never be obtained.

BUILDING NEWS 8-11-1867

Figure A3 – 1867 – Building News article concerning construction

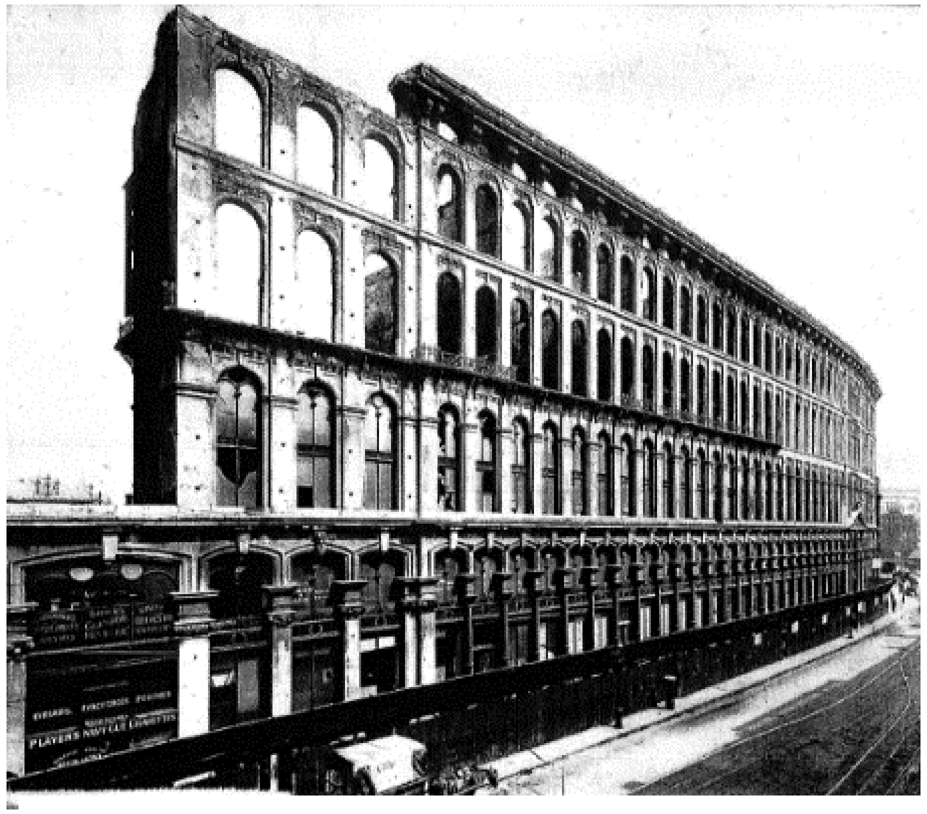


Figure A4 – 1921 – Front elevation following fire damage of 20th October 1920

Figure A6 – no date – Elevation reduced to three arch tiers on east side of structure

Figure A5 – 1931 –Elevation reduced to two arch tiers on west side of structure

Figure A7 – no date – Elevation reduced to two arch tiers across full front elevation

Appendix B
Nearby Borehole Logs

Soil Mechanics — BOREHOLE No.305T

Sheet 1 of 7

Equipment & Methods Cable percussive boring in 200mm diameter to 11.45m,(cased to 11.00m) then rotary drilling, using polymer mud flush and SK6L wireline equipment (100mm core) to 50.25m.	**Location No.** 7663 **Location** JUBILEE LINE EXTENSION TQ 38 SW 2155
Carried out for London Underground Limited (JLE 011)	**Ground Level** 4.27 m.O.D. **Coordinates** 532505.32m E 180148.54m N **Date** 10.09.90 to 21.09.90

Description	Reduced Level	Depth (Thick)	Samples/Tests Depth	Sample Type	Sample No.	Test	Field Records
TARMAC	4.27 4.17	(0.10) 0.10					
CONCRETE	4.07	(0.10) 0.20					
Rubble fill, brick (Driller's description)	3.07	(1.00) 1.20					
Soft silty pinkish brown sand with occasional gravel (Driller's description) (MADE GROUND?)	1.97	(1.10) 2.30	2.30	D	1		
Brown slightly clayey (fine to coarse) sandy subangular to rounded, fine to medium, occasional coarse flint gravel (MADE GROUND?)	1.17	(0.80) 3.10	3.10	D	2		
Brown fine to coarse SAND with occasional rounded fine to medium flint gravel (TERRACE GRAVELS)	-1.73	(2.90) 6.00					
Dense SAND with flint gravels. (Driller's description) (TERRACE GRAVELS)	-4.73	(3.00) 9.00	9.00	W	3		
SAND and flint GRAVEL (Driller's description) (TERRACE GRAVELS)		(1.20)					

Remarks

Hand dug inspection pit to 1.20m

Logged by DMH — Scale 1:50 — Fig. 7

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.91/18.10 (Ver 4.1.20)

Soil Mechanics — BOREHOLE No.305T

Sheet 2 of 7

Equipment & Methods As sheet 1	**Location No.** 7663 **Location** JUBILEE LINE EXTENSION TQ 38 SW 2155
Carried out for London Underground Limited (JLE 011)	**Ground Level / Coordinates / Date** As sheet 1

Description	Reduced Level	Depth (Thick)	Samples/Tests Depth	Sample Type	Sample No.	Test	Field Records
(TERRACE GRAVELS) (As sheet1)	-5.93	(1.20) 10.20	10.25	D	4		
Firm very closely fissured brown and grey mottled CLAY. Below 10.30m, brown in colour. (WEATHERED LONDON CLAY)			10.30 - 10.70	B	5		
	-7.18	(1.25) 11.45	10.70 - 11.45	B	6		
NO RECOVERY	-7.49	(0.31) 11.76					

Description	Reduced Level	Depth (Thick)	Depth	W	TCR	SCR	RQD	If	Field Records
Stiff thinly laminated extremely to very closely fissured grey-brown CLAY. Fissures subvertical and vertical, occasionally randomly orientated, locally slightly to moderately polished, planar, smooth (LONDON CLAY)			11.45 - 13.10	10	81	-	-		Assessed core loss 11.45-11.76 coring time 1 hour
12.70-12.72 brown (fine) sandy silt parting									
13.75-13.93 subvertical fissure slightly polished			13.10 - 14.70	10	100	-	-		Coring time 1 hour Assessed core loss 14.70-14.91 coring time 55 minutes
15.73-15.80 fissure subvertical moderately polished		(7.95)	14.70 - 16.25	25	86	-	-		Assessed core loss 16.25-16.35 coring time 55 minutes
17.11-17.16 light brown highly weathered CLAYSTONE, weak. 17.68-17.79 grey slightly weathered CLAYSTONE, strong, with a vertical clean joint			16.25 - 17.75	70	93	-	-		Core sample S10 17.68m - 17.79m Assessed core loss 17.75-17.84 coring time 50 minutes
			17.75 - 19.10	100	100	-	-		
19.77-19.86m fissure smooth, subvertical	-15.44	19.71	19.10 - 20.70	100	100	-	-		Coring time 55 minutes
(LONDON CLAY) (As sheet 3)									

Remarks

Logged by DMH — Scale 1:50 — Fig. 7

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 28.01.91/14.04 (Ver 4.1.22)

Soil Mechanics — BOREHOLE No. 305T — Sheet 3 of 7

TQ38SW 2155

Equipment & Methods: As sheet 1
Location No.: 7663
Location: JUBILEE LINE EXTENSION
Carried out for: London Underground Limited (JLE 011)
Ground Level: | **Coordinates:** As sheet 1 | **Date:**

Description	Reduced Level	Depth (Thick)
Very stiff thinly laminated very closely fissured, grey brown lightly sandy (fine) CLAY. Fissures subvertical and vertical smooth, planar, locally slightly to moderately polished (LONDON CLAY). 20.06-20.26 fissure subvertical, slightly polished; 20.85-21.06 fissure curved; 21.11-21.23 fissure subvertical, planar smooth; 21.98-22.10 fissure subvertical, smooth; 24.01-24.44 fissure subvertical, smooth, slightly polished	-21.14	(5.70) 25.41
Very stiff thinly laminated, very closely to closely fissured grey (fine) sandy CLAY with much bioturbation. Fissures subvertical to vertical smooth, planar with black mottling on fissure surfaces. Occasional fissures horizontal, tight and (LONDON CLAY). 25.81-25.82m brown silty fine sand parting; 26.25-26.27 grey fine sand parting; 27.47-27.57 fissure subvertical, rough; 29.74-29.57 pyrite infilled burrow, (<10mm) thick		(6.38)

Drilling Records Depth	W	TCR	SCR	RQD	If	Field Records and Test Results
19.10 - 20.70	100	100	-	-		Coring time 55 minutes
20.70 - 22.30	100	100	-	-		
22.30 - 23.90	100	100	-	-		Coring time 55 minutes Core sample S1 23.48m-23.88m
23.90 - 25.50	100	100	-	-		Coring time 30 minutes Core sample S2 24.81m-25.21m
25.50 - 27.10	100	98	-	-		Coring time 50 minutes Assessed core loss 25.50-25.52 Core sample S4 26.43m-26.83m
27.10 - 28.70	100	96	-	-		Coring time 60 minutes Assessed core loss 27.10-27.16
28.70 - 30.20	100	100	-	-		Coring time 50 minutes Core sample S5 29.97m-30.37m

Remarks

Logged by DMH
Scale 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.91/18.10 (Ver 4.1.28)

Fig. 7

Soil Mechanics — BOREHOLE No. 305T — Sheet 4 of 7

TQ38SW 2155

Equipment & Methods: As sheet 1
Location No.: 7663
Location: JUBILEE LINE EXTENSION
Carried out for: London Underground Limited (JLE 011)
Ground Level: | **Coordinates:** As sheet 1 | **Date:**

Description	Reduced Level	Depth (Thick)
(LONDON CLAY) (As sheet 3). 30.37-30.61 very thinly bedded with partings (<1 mm) of grey silt	-27.52	(6.38) 31.79
Grey subrounded medium flint gravel. (BLACKHEATH BEDS)	-27.57	(0.05) 31.84
Very stiff extremely closely fissured brown and grey mottled CLAY. Fissures subvertical, planar, smooth, locally striated and polished (WOOLWICH AND READING BEDS) (UPPER MOTTLED CLAY)	-28.02	(0.45) 32.29
Very stiff very closely fissured brown and grey mottled sandy (fine) CLAY. Fissures subvertical, planar, smooth (WOOLWICH AND READING BEDS) (UPPER MOTTLED CLAY)	-29.07	(1.05) 33.34
Very stiff extremely closely fissured brown sandy (fine) CLAY. Fissures subvertical, planar, smooth (WOOLWICH AND READING BEDS) (UPPER MOTTLED CLAY). 36.63-36.84 fissure subvertical, slightly polished; 37.68-37.83 fissure subvertical, smooth	-33.73	(4.66) 38.00
Very stiff grey very silty CLAY. (WOOLWICH AND READING BEDS) (LAMINATED SANDS AND SILTS)		(2.01)

Drilling Records Depth	W	TCR	SCR	RQD	If	Field Records and Test Results
28.70 - 30.20	100	100	-	-		Coring time 50 minutes Core sample S5 29.97m-30.37m
30.20 - 31.75	100	100	-	-		Coring time 50 minutes
31.75 - 33.25	100	95	-	-		Coring time 55 minutes Assessed core loss 31.75-31.81 Core sample S6 32.39m-32.79m
33.25 - 34.85	100	100	-	-		Coring time 55 minutes Core sample S7 34.28m-34.68m
34.85 - 36.35	100	100	-	-		Coring time 50 minutes
36.35 - 37.85	100	100	-	-		Coring time 50 minutes Core sample S8 37.18m-37.58m
37.85 - 39.35	100	100				Coring time 60 minutes S9 38.31m-38.71m
39.35 - 40.90	100	98	-	-		Coring time 1 hr 5 mins Assessed

Remarks

Logged by DMH
Scale 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.91/18.10 (Ver 4.1.28)

Fig. 7

Soil Mechanics — BOREHOLE No.305T

Sheet 5 of 7

Equipment & Methods	Location No. 7663
As sheet 1	Location: JUBILEE LINE EXTENSION — TQ38SW 2155
Carried out for: London Underground Limited (JLE 011)	Ground Level / Coordinates: As sheet 1 / Date

Description	Reduced Level	Depth (Thick)	Drilling Records Depth	W	TCR	SCR	RQD	If	Field Records and Test Results
(WRB)(As sheet 4) (LAMINATED SANDS AND SILTS); 40.06-40.09 fragments of oyster shells	-35.74	(2.01) 40.01							
		(0.60)	39.35 - 40.90	100	98	-	-		Coring time 1 hr 5 mins Assessed core loss 39.95-39.98
	-36.34	40.61							
Very stiff thinly to thickly laminated grey CLAY with thinly to thickly laminated with partings (<6mm) of grey silt (WRB) (LSS)		(0.38)							
	-36.72	40.99							
41.69-41.77 subvertical fissure, tight; 41.90-41.96 subvertical fissure, tight			40.90 - 42.40	100	96	-	-		Coring time 1 hr 35 min Assessed core loss 40.90-40.96
Very stiff thinly bedded black CLAY with many shell fragments (<6mm) often in bands (<10mm) (WRB)(LOWER SHELLY CLAY)		(2.91)							
Very stiff closely fissured grey and brown mottled CLAY (WRB) (LOWER MOTTLED CLAY); 43.47-43.55 subvertical fissure, tight; 43.62-43.68 subvertical fissure			42.40 - 43.90	100	87	-			Coring time 1 hr 30 min Assessed core loss 42.40-42.60
	-39.63	43.90	43.90 - 44.12	100	0	-	-		Coring time 1 hour
			44.12 - 44.17	100					Coring time 35 minutes
(A) Grey and brown slightly sandy (fine to coarse) subangular to rounded, fine to coarse flint GRAVEL (WOOLWICH AND READING BEDS) (PEBBLE BED)		(1.92)	44.17 - 44.71	100	100	-	-		Coring time 40 minutes
			44.71 - 46.25	100	98	-	-		Coring time 90 minutes Assessed core loss 44.71-44.74
	-41.55	45.82							
Firm brown slightly sandy (fine to coarse) CLAY with much rounded to subrounded fine to medium flint gravel (WRB)(GLAUCONITIC SAND); 45.96-46.16 glauconitic zone; 46.42-46.99 glauconitic zone		(1.22)	46.25 - 47.65	100	97	-	-		Coring time 1 hour Assessed core loss 46.25-46.29 Core sample B11 47.15m-47.65m
	-42.77	47.04							
Green glauconitic clayey silty very sandy (generally) (fine to medium) subangular to rounded, fine to medium flint GRAVEL (WRB)(GLAUCONITIC SAND)		(1.50)	47.65 - 48.85	100	82	-	-		Coring time 1 hour Assessed core loss 47.65-47.87
	-44.27	48.54							
Grey and brown mottled clayey very silty fine to coarse SAND with occasional fine to medium rounded flint gravel (WRB)(GLAUCONITIC SAND)		(1.17)	48.85 - 50.25	100	100	-	-		Coring time 1 hour Core sample B12 48.85m-49.35m Core sample
(WRB) (As sheet 6) (THANET BEDS)	-45.44	49.71							

Remarks

3. Disturbed samples taken in tubs at 44.17m, 44.71m, 47.65m and 48.85m
4. WRB = WOOLWICH AND READING BEDS

Logged by: DMH — Scale: 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.91/18.10 (Ver 4.1.28)

Fig. 7

Soil Mechanics — BOREHOLE No.305T

Sheet 6 of 7

Equipment & Methods	Location No. 7663
As sheet 1	Location: JUBILEE LINE EXTENSION — TQ38SW 2155
Carried out for: London Underground Limited (JLE 011)	Ground Level / Coordinates: As sheet 1 / Date

Description	Reduced Level	Depth (Thick)	Drilling Records Depth	W	TCR	SCR	RQD	If	Field Records and Test Results
Grey fine SAND (THANET BEDS)	-45.98	(0.39p) 50.25	48.85 - 50.25	100	100	-	-		Coring time 1 hour Core sample B12 48.85m-49.35m Core sample B13 49.75m-50.25m

BOREHOLE ENDS AT 50.25 m.

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1990					
10.09	1800	3.10	3.10	-	End of shift
11.09	0800	3.10	3.10	DRY	Start of shift
11.09	-	9.00	-	9.00	Seepage
11.09	-	9.00	-	6.00	After 20 mins
11.09	1800	11.45	11.00	-	End of prebore
14.09	0700	11.45	11.00	-	Start of shift 200mm casing reduced to 146mm SK6L wireline
14.09	1700	17.75	17.75	0.00	End of shift
17.09	0700	17.75	17.75	1.20	Start of shift
17.09	1900	31.75	31.75	-	End of shift
18.09	0700	31.75	31.75	1.30	Start of shift
18.09	1900	43.90	43.90	0.00	End of shift
19.09	0700	43.90	43.90	1.20	Start of shift
19.09	1900	44.12	-	-	End of shift
20.09	0700	44.12	-	0.90	Start of shift Pulled out wireline string to change bit
20.09	1900	50.25	50.25	0.95	End of Borehole

Remarks

On completion of drilling the borehole was geologged to 44.10m and then double piezometers were installed (see sheet 7)

Logged by: DMH — Scale: 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 10.01.91/18.10 (Ver 4.1.28)

Fig. 7

Soil Mechanics — BOREHOLE No. 306

Sheet 1 of 6

TQ 38 SW 2156

Equipment & Methods	Location No. 7663
Hand dug inspection pit to 1.50m, then cable percussive boring in 200mm to 24.40m (cased to 11.00m) then 150mm to 36.95m (cased to 22.50m).	Location: JUBILEE LINE EXTENSION

Carried out for	Ground Level	Coordinates	Date
London Underground Limited (JLE011)	4.61 m O.D.	532624.17m E 180151.06m N	11.09.90 to 02.10.90

Description	Reduced Level	Depth (Thick)
TARMAC	4.61 4.51	(0.10) 0.10
Rubble (Driller's Description)	4.31	(0.20) 0.30
Loose light grey-brown angular to subrounded fine to coarse gravel to cobble sized brick, concrete, ash and flint fragments with much matrix of slightly clayey fine to coarse sand. (MADE GROUND)	2.81	(1.50) 1.80
Soft grey sandy (fine to coarse) clay with many angular to subrounded fine to coarse gravel sized brick and concrete fragments. (MADE GROUND)	0.81	(2.00) 3.80
Medium dense green-brown clayey fine to coarse SAND with some subangular to rounded fine to medium flint and quartzite gravel. (ALLUVIUM)	0.41	(0.40) 4.20
Orange-brown fine to coarse SAND with much subangular to rounded fine to medium flint and chalk gravel. Occasional bands of brown silty clay. (TERRACE GRAVELS)	-1.39	(1.80) 6.00
Medium dense to dense orange-brown sandy to very sandy (generally medium and coarse) subangular to rounded fine to coarse flint GRAVEL with occasional flint cobbles. (TERRACE GRAVELS)		(4.30)

Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
1.50 - 1.95			C N=9	2,4/3,2,2,2.
2.20 - 2.70	B	2		
3.80 - 4.25	B	3	C N=21	3,4/5,5,5,6
4.20 - 4.70	B	4		
5.00	W	6		
6.50 - 6.95	B	5	C N=41	4,7/8,10,11,12
7.00 - 7.50	B	7		
8.00 - 8.50	B	8		
9.50 - 9.95	B	9	C N=27	4,4/6,6,7,8

Remarks: Chiselling from 8.50m to 9.20m for 1 hour.

Logged by: MAC
Scale: 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 07.01.91/06.18 (Ver 4.1.28)

Fig. 8

Soil Mechanics — BOREHOLE No. 306

Sheet 2 of 6

TQ 38 SW 2156

Equipment & Methods	Location No. 7663
As sheet 1	Location: JUBILEE LINE EXTENSION

Carried out for	Ground Level	Coordinates	Date
London Underground Limited (JLE011)	As sheet 1		

Description	Reduced Level	Depth (Thick)
(TERRACE GRAVELS) (As sheet 1)	-5.69	(4.30) 10.30
Firm extremely closely fissured, grey-brown mottled yellow-brown CLAY with occasional lenses (40x5mm) of yellow-brown fine to medium sand, occasional rounded fine to medium flint gravel. Fissures randomly orientated elliptical clean irregular stained red-brown. (REWORKED LONDON CLAY?)	-5.89	(0.20) 10.50
Stiff becoming very stiff below 13.50m thinly laminated extremely closely fissured grey-brown CLAY with occasional bioturbation, rare to occasional partings (<2mm) of light grey-brown silty fine sand and occasional pockets (<2mm) of light grey silt. Fissures randomly orientated clean planar to undulose. (LONDON CLAY)	-13.39	(7.50) 18.00
(LONDON CLAY) (As sheet 3)		(8.00)

Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
10.30 - 10.50	D	10		
10.50 - 10.95	U	11		31 blows 350mm recovery
10.90	D	12		
10.90 - 11.35	D	13	S N=24	4,4/5,5,6,8
11.50	D	14		
13.50 - 13.95	U	15		41 blows 450mm recovery
14.00	D	16		
14.00 - 14.45	D	17	S N=29	3,5/5,7,8,9
15.50	D	18		
16.50 - 16.95	U	19		70 blows 400mm recovery
16.95	D	20		
16.95 - 17.40	D	21	S N=31	4,5/7,7,8,9
18.00	D	22		
19.50 - 19.90	U	23		150 blows 350mm recovery
19.90	D	24		
19.90 - 20.35	D	25	S N=44	

Remarks:

Logged by: MAC
Scale: 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 07.01.91/06.18 (Ver 4.1.28)

Fig. 8

Soil Mechanics — BOREHOLE No. 306

Sheet 3 of 4

Equipment & Methods: As sheet 1	Location No. 7663 / Location: JUBILEE LINE EXTENSION — TQ 38 SW 2156
Carried out for: London Underground Limited (JLE011)	Ground Level: — / Coordinates: As sheet 1 / Date: —

Description	Reduced Level	Depth (Thick)
Very stiff thinly laminated very closely fissured grey-brown locally slightly sandy to sandy (fine) CLAY with many pockets (<10mm) of light grey silt and generally very thinly bedded with partings (<1mm locally 20mm) of brown silty fine sand. Occasional bioturbation. Fissures randomly orientated generally clean undulose to planar with occasional black mottling. (LONDON CLAY) — fissures absent	-21.39	(8.00) 26.00
Very stiff thinly laminated very closely fissured grey-brown CLAY with occasional partings (<2mm) and pockets (<4mm) of light grey silty fine sand and occasional bioturbation. Fissures randomly orientated clean planar undulose, smooth. (LONDON CLAY)	-23.39	(2.00) 28.00
Very stiff indistinctly thinly laminated very closely fissured grey-brown very silty CLAY, with occasional pockets (<4mm) and partings (<1mm locally up to 15mm) of light brown and grey-brown silty fine sand and occasional to some partly pyritised bioturbation. Fissures randomly orientated clean occasionally lightly dusted, planar undulose. (LONDON CLAY)		(2.60)

Depth	Sample Type	Sample No.	Test	Field Records
19.90 - 20.35	D	25	S N-44	6,8/8,11,10,15
22.00 - 22.45	U	-		No recovery
22.00 - 22.50	B	26		
22.50 - 22.95	D	27	S N-52	6,11/12,11,13,16
23.00 - 23.45	U	28		150 blows 450mm recovery
23.50	D	29		
23.50 - 23.95	D	30	S N-47	8,8/9,12,12,14
24.00 - 24.40	U	-		No recovery
24.00 - 24.40	B	31		
24.50 - 24.95	U	32		41 blows 450mm recovery
25.00	D	33		
25.00 - 25.45	D	34	S N-49	8,8/10,11,13,15
25.50 - 25.95	U	35		57 blows 450mm recovery
26.00	D	36		
26.00 - 26.45	D	37	S N-49	6,8/10,12,12,15
26.50 - 26.95	U	38		54 blows 350mm recovery
26.90	D	39		
26.90 - 27.35	D	40	S N-63	9,11/13,15,17,18
27.50 - 27.95	U	41		74 blows 450mm recovery
28.00	D	42		
28.00 - 28.45	D	43	S N-64	9,11/13,15,18,18
28.50 - 28.95	U	44		80 blows 400mm recovery
28.95	D	45		
28.95 - 29.40	D	46	S N-63	8,11/15,16,15,17
29.50 - 29.95	U	47		85 blows 300mm recovery
29.85	D	48		
29.85 - 30.30	D	49	S N-70	

Remarks:

Logged by: MAC — Scale: 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 29.01.91/09.41 (Ver 4.1.22)

Fig. 8

Soil Mechanics — BOREHOLE No. 306

Sheet 4 of 4

Equipment & Methods: As sheet 1	Location No. 7663 / Location: JUBILEE LINE EXTENSION — TQ 38 SW 2156
Carried out for: London Underground Limited (JLE011)	Ground Level: — / Coordinates: As sheet 1 / Date: —

Description	Reduced Level	Depth (Thick)
(LONDON CLAY) (As sheet 3)	-25.99	(2.60) 30.60
Very stiff friable light blue-grey and red-brown sandy (fine) CLAY. (WOOLWICH AND READING BEDS) (UPPER MOTTLED CLAY)	-27.39	(1.40) 32.00
Very stiff friable extremely closely fissured orange-brown and light blue-grey locally very silty CLAY. Fissures randomly orientated, clean, occasionally slightly polished irregular, with occasional striations. (WOOLWICH AND READING BEDS) (UPPER MOTTLED CLAY) Below 34.50m mottled red and fissuring absent	-31.39	(4.00) 36.00
Very stiff extremely closely fissured orange-brown, light brown and light blue-grey CLAY. Fissures randomly orientated clean irregular occasionally moderately polished and striated. (WOOLWICH AND READING BEDS) (UPPER MOTTLED CLAY)	-32.34	(0.00p) 36.95
BOREHOLE ENDS AT 36.95 m.		

Depth	Sample Type	Sample No.	Test	Field Records
29.85 - 30.30	D	49	S N-70	9,10/15,17,18,20
30.50 - 30.95	U	50		110 blows 300mm recovery
30.85	D	51		
30.85 - 31.30	D	52	S N-102	11,17/18,20,32,32
31.50 - 31.95	U	53		150 blows 350mm recovery
31.90	D	54		
32.50 - 32.95	D	55	S N-75	9,12/14,18,18,25
33.00 - 33.45	U	-		No recovery
33.00 - 33.45	B	56		
33.50 - 33.95	D	57	S N-103	12,15/18,22,29,34
34.00 - 34.45	D	58	S N-120	10,18/24,29,29,38
34.50 - 34.95	D	59	S N-130	20,24/29,30,34,37
35.00 - 35.45	D	60	S N-155	18,18/31,36,42,46
35.50 - 35.95	D	61	S N-112	10,12/17,29,34,32
36.00 - 36.45	D	62	S N-111	9,17/18,26,32,35
36.50 - 36.95	D	63	S N-99	11,16/19,20,25,35

Remarks:
Hard strata from 32.00m to 37.00m, intermittant chiselling for 12 hours 30 minutes.
3. A piezometer was installed in an adjacent borehole (number 306A).

Logged by: MAC — Scale: 1:50

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 07.01.91/06.18 (Ver 4.1.28)

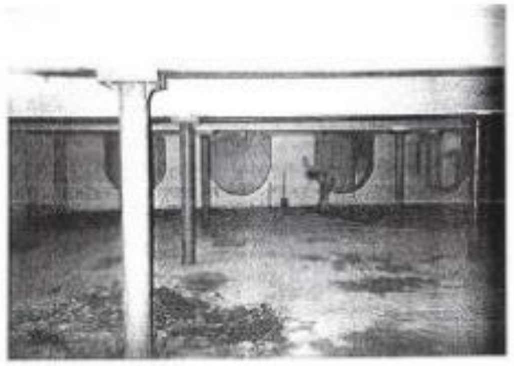
Fig. 8

Appendix C
Historical Trial Pits

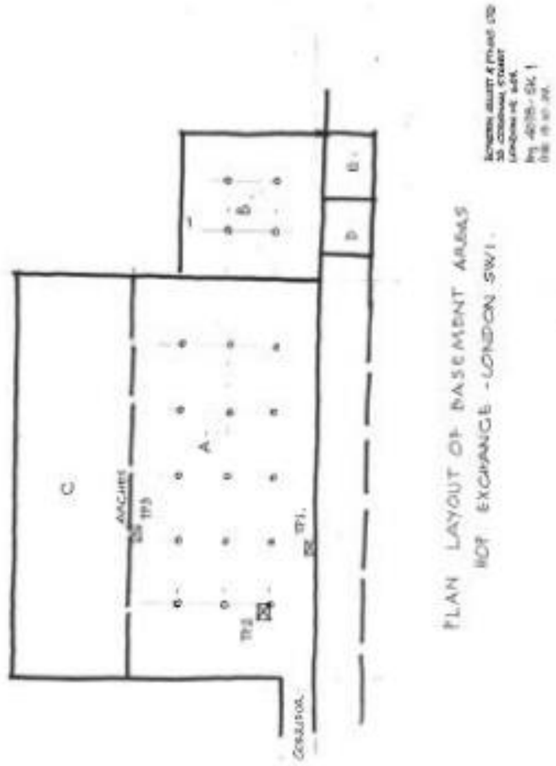
TRIAL PIT Nº 1

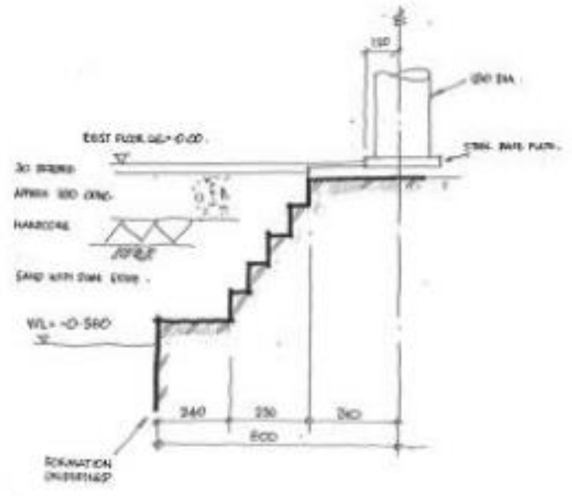
TRIAL PIT Nº 2

TRIAL PIT Nº 3

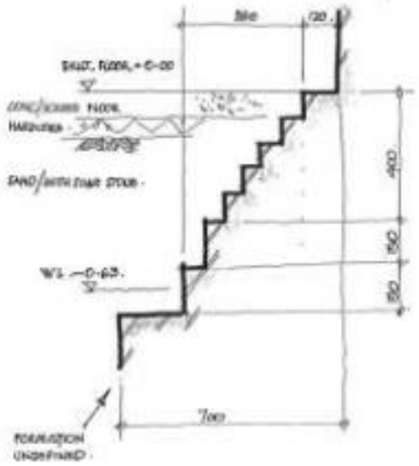


GENERAL VIEW

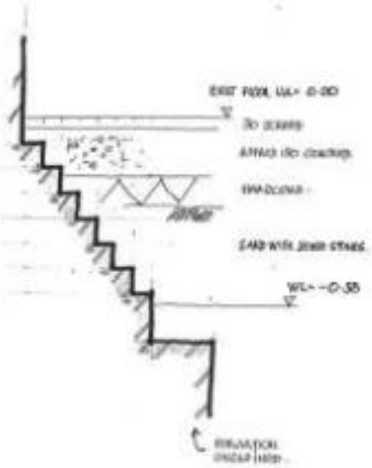




TRIAL PIT Nº 2



TRIAL PIT Nº 1

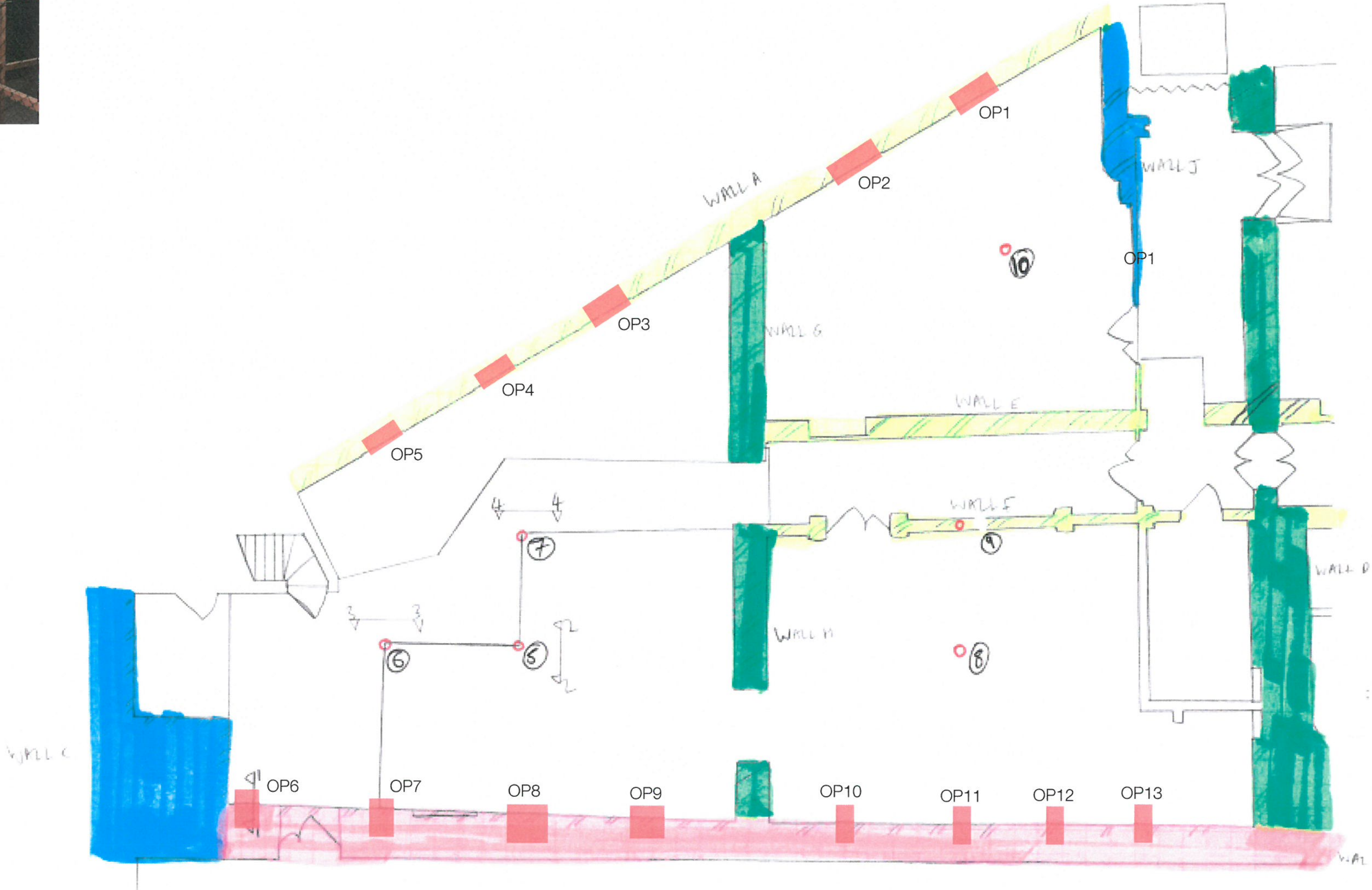


TRIAL PIT Nº 3

Appendix D
Material Testing

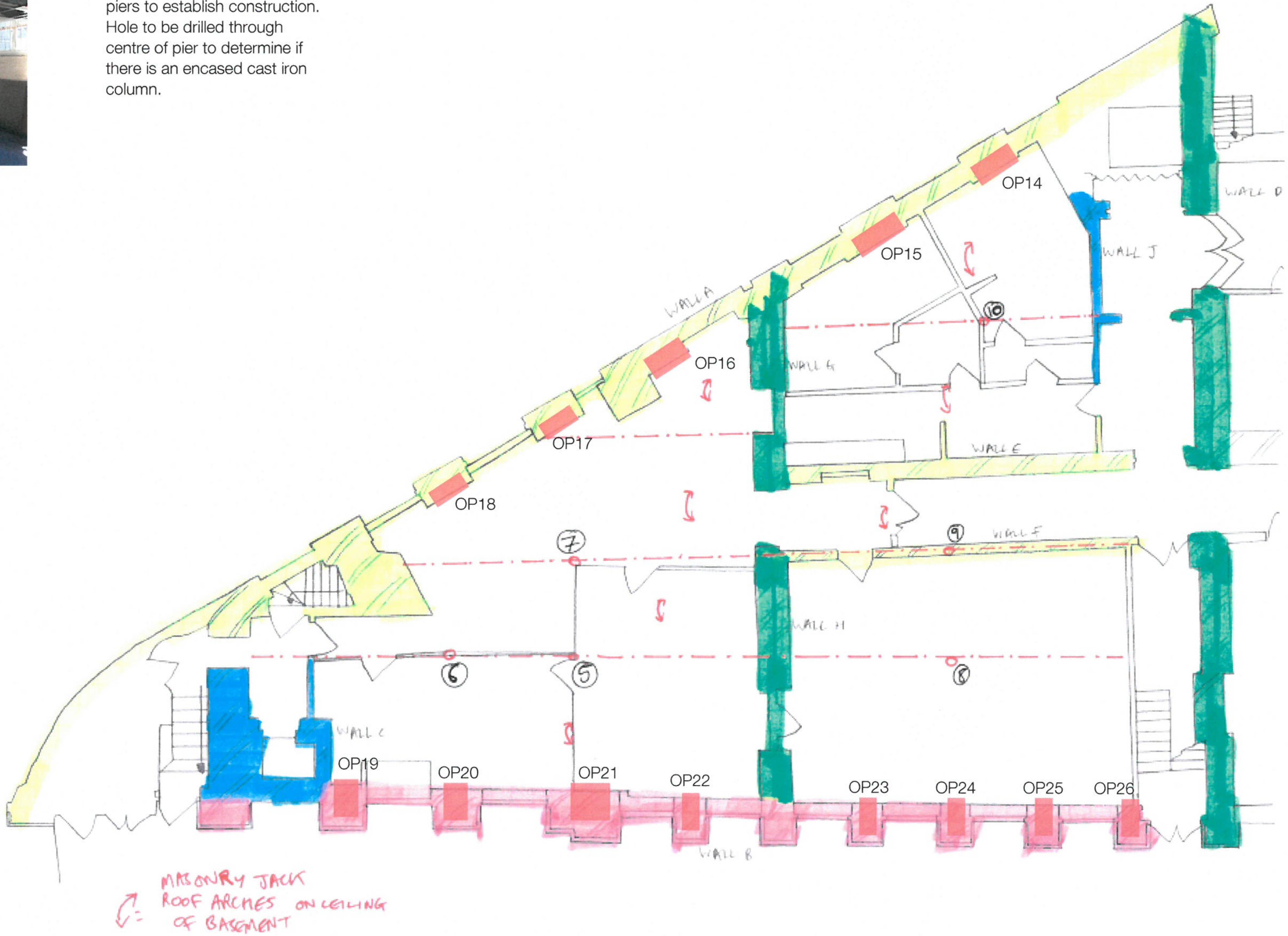
BASEMENT PLAN

OP1-13. Finishes to be removed from piers to establish construction. Hole to be drilled through centre of pier to determine if there is an encased cast iron column.



LOWER GROUND FLOOR PLAN

OP14-26. Finishes to be removed from piers to establish construction. Hole to be drilled through centre of pier to determine if there is an encased cast iron column.



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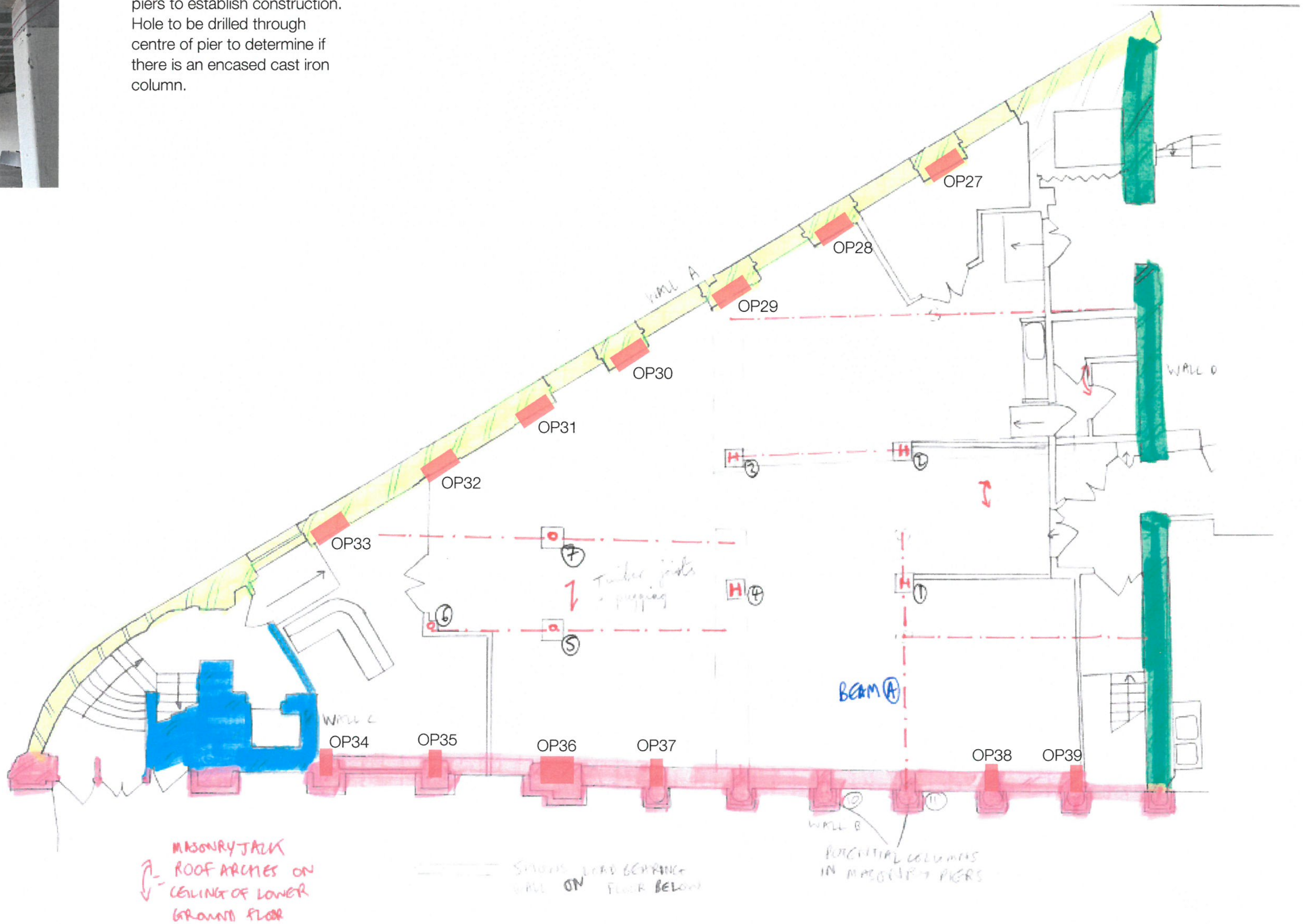
Consulting Engineers
30 Newman Street London W1T 1LT T 020 7631 5128

Job No 24259 Page OP9 Rev 1
Date 17.08.15 Eng VW Chd
Job HOP EXCHANGE

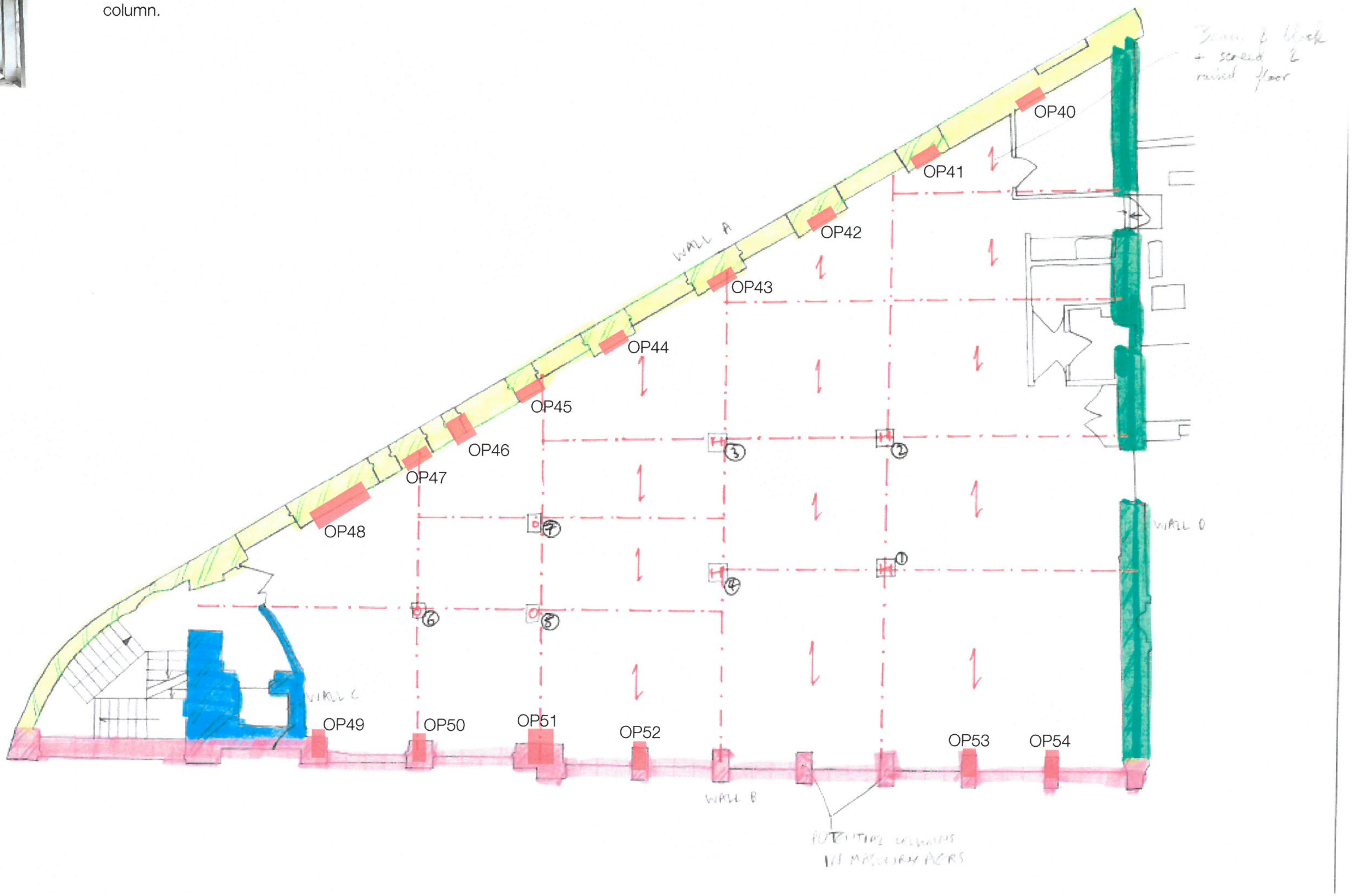
UPPER GROUND FLOOR PLAN

OP27-39. Finishes to be removed from piers to establish construction. Hole to be drilled through centre of pier to determine if there is an encased cast iron column.



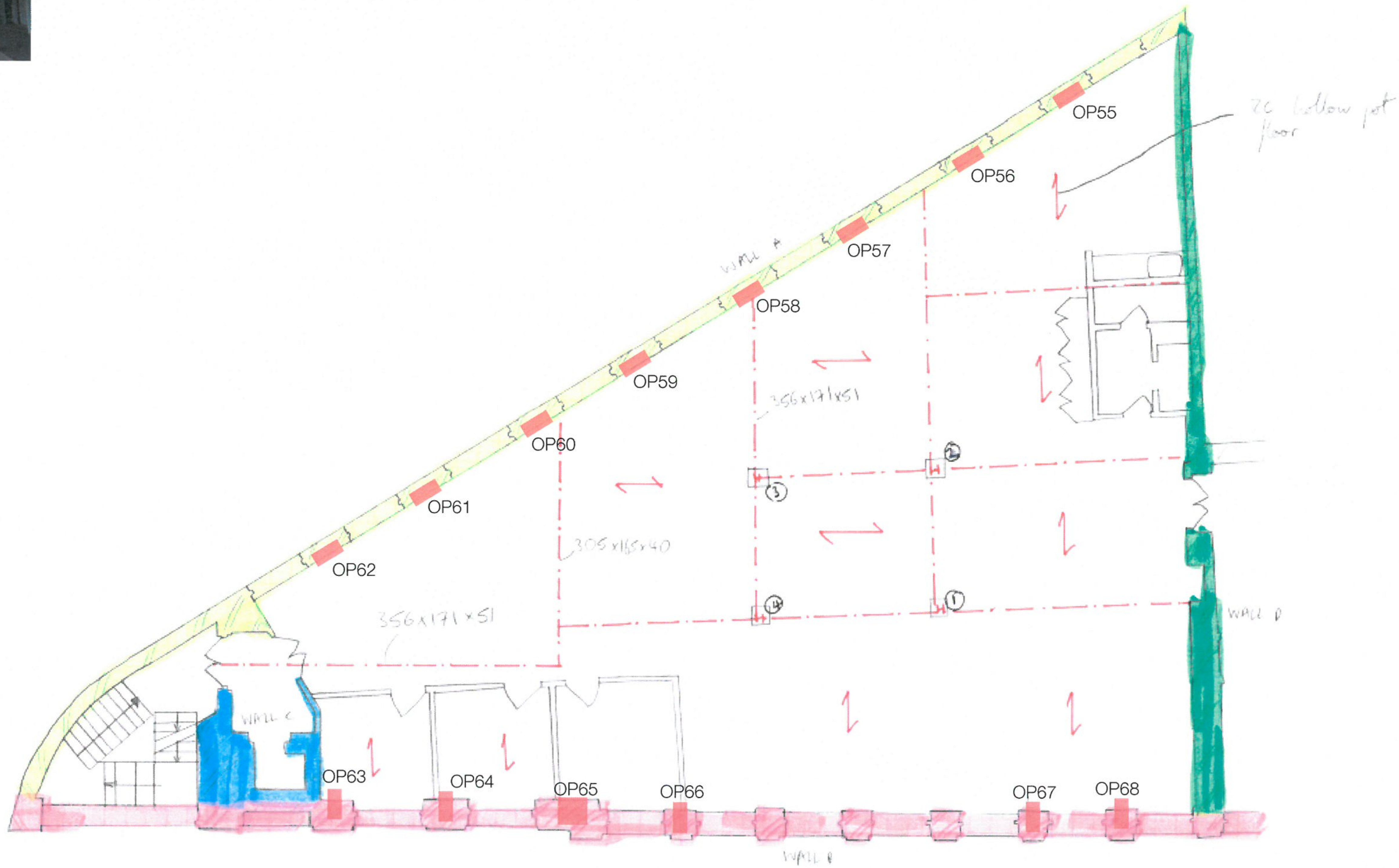
FIRST FLOOR PLAN

OP40-54. Finishes to be removed from piers to establish construction. Hole to be drilled through centre of pier to determine if there is an encased cast iron column.



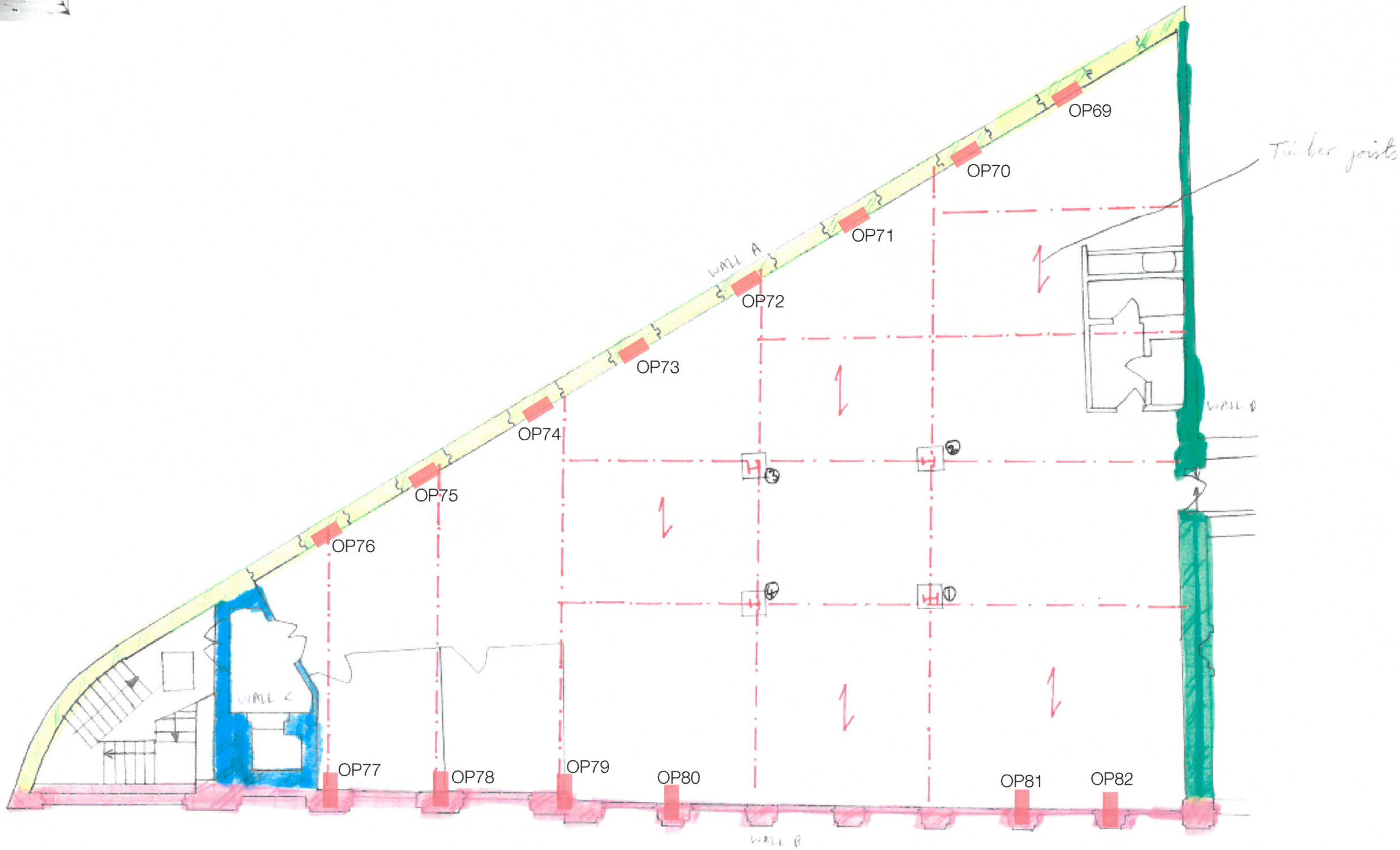
SECOND FLOOR PLAN

OP55-68. Finishes to be removed from piers to establish construction. Hole to be drilled through centre of pier to determine if there is an encased cast iron column.



THIRD FLOOR PLAN

OP69-82. Finishes to be removed from piers to establish construction. Hole to be drilled through centre of pier to determine if there is an encased cast iron column.



SANDBERG
CONSULTING ENGINEERS
INVESTIGATION INSPECTION
MATERIALS TESTING

UKAS TESTING 0262

TENSILE TEST CERTIFICATE
BS EN ISO 6892-1:2009

Sandberg LLP
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London SW1W 0EB
Tel: 020 7565 7000
Fax: 020 7565 7100
email: ho@sandberg.co.uk
web: www.sandberg.co.uk

Certificate:	55072/M/1	**Order Ref:**	55072/F
Samples Received:	27 August 2015	**Tested By:**	AT/ NAF
Test Date:	03 September 2015	**Test Procedure:**	M10/3/1
Client Details:	Price & Myers - Hop Exchange		

Specimen Reference		Area mm^2	0.2% Proof		Ultimate Tensile		Elongation %
Met lab Ref	Sample Ref		Load kN	Stress N/mm^2	Load kN	Stress N/mm^2	
MV 417	F86971 OP26 Steel Cut From Beam - Lower Grd Floor	28.46	7.82	275	13.20	464	30.0
Specification: BS EN 10025-2:2004 Grade S235 Grade S275 Grade S355				235 min 275 min 355 min		340-470 410-560 470-630	26 min 23 min 22 min

Comments: The tensile properties for sample MV 417 conformed to the structural steel grade S275.

For Sandberg LLP [signature] Date: 3 September 2015

Neale Fetter - Assistant Manager Metallurgy Department

Materials, samples and test specimens are retained for a period of 2 months from the issue of the final report.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

SANDBERG

UKAS TESTING 0262

55072/F
Table 1
Date of Test 2/9/2015

BRICK TEST RESULTS
COMPRESSIVE STRENGTH
BS 3921:1985, Appendix D(s/s)[1]

Sandberg Sample Reference	F86960-F86964
Client Sample Reference	OP5, OP6, OP35, OP36 & OP37
Type:	Used Single Clay Frog
Mean strength of mortar used to fill frogs at test, days, N/mm^2	HAC Used

Sandberg Specimen Reference	Client Specimen Reference	Surface Area mm^2	Maximum Failing Load kN	Compressive Strength[2] N/mm^2
7241	OP5	21630	342	15.8
7242	OP5	24624	310	12.6
7243	OP5	17220	238	13.8
7244	OP6	20910	406	19.4
7245	OP6	22880	525	22.9
7256	OP6	22790	319	14.0
7247	OP35	21624	269	12.4
7248	OP36	22644	321	14.2
7249	OP37	15228	233	15.3

[1] **BS 3921:1985 has been withdrawn and replaced by parts of BS EN 771 and BS EN 772 series. However for the purposes of testing reclaimed bricks we have continued to use BS 3921 methods.**
[2] **To the nearest 0.1 N/mm^2**

Brk 202/1 Type

Appendix E
Existing Strengthening Works to West Wing

`

Appendix F
Structural Drawings

Appendix G
Load Schedule

New Floor Loads:

Metal Deck Floor (1st to 3rd Floor Offics)

Selfweight	150 Comflor 60 Slab	=	*2.57*	
		=	0.00	
Insualtion ceiling and services		=	0.30	
Finishes	20 mm tile	=	0.48	
			3.35	kN/m^2

Offices (1st to 5th Floor)
- **Imposed**

	=	2.50	
Partitions	=	1.00	
		3.50	kN/m^2

Timber Floor (4th-5th Floor)

Selfweight	225 mm dp joists	=	*0.30*	
Ply	18mm		0.12	
Insulation ceiling and services		=	0.20	
Finishes	20 mm tile	=	0.48	
			1.10	kN/m^2

Restaurant/Café (B, G, 5th Floor)
- **Imposed**

	=	4.00	
LW Partitions	=	0.00	TBC
		4.00	kN/m^2

Basement Floor

Selfweight	400 mm slab	=	*10.00*	
Screed	50 mm	=	1.20	
Insulation		=	0.20	
Finishes	20 mm tile	=	0.48	
			11.88	kN/m^2

Basement Floor (Back of House/ Kitchen) - Imposed

	=	4.00	
Partitions	=		
		4.00	kN/m^2

Ground Floor

Selfweight	400 mm slab	=	*10.00*	
Screed	50 mm	=	1.20	
Insulation		=	0.20	
Finishes	20 mm tile	=	0.48	
			11.88	kN/m^2

Basement Floor (Restaurant/Cafe) - Imposed

	=	4.00	
Partitions	=		
		4.00	kN/m^2

Upper Roof Plant - Imposed

=	4.00	tbc
	4.00	kN/m^2

Roof Terrace

Selfweight	225 Joists	=	*0.30*	
Insualtion and services		=	0.30	
Finishes	40 mm paver	=	0.96	TBC
		=	**1.56**	kN/m^2

Green Roof

Selfweight	225 Joists	=	*0.30*	
Insualtion and services		=	0.30	
100 soil		=	1.80	TBC
		=	**2.40**	kN/m^2

Upper Roof Terrace - Imposed

=	4.00	tbc
	4.00	kN/m^2 TBC

4th FloorTerrace

Selfweight	225 Joists	=	*0.30*	
Insualtion and services		=	0.30	
Finishes	40 mm paver	=	0.96	TBC
		=	**1.56**	kN/m^2

4th Floor Terrace-Imposed

=	2.50	tbc
	2.50	kN/m^2

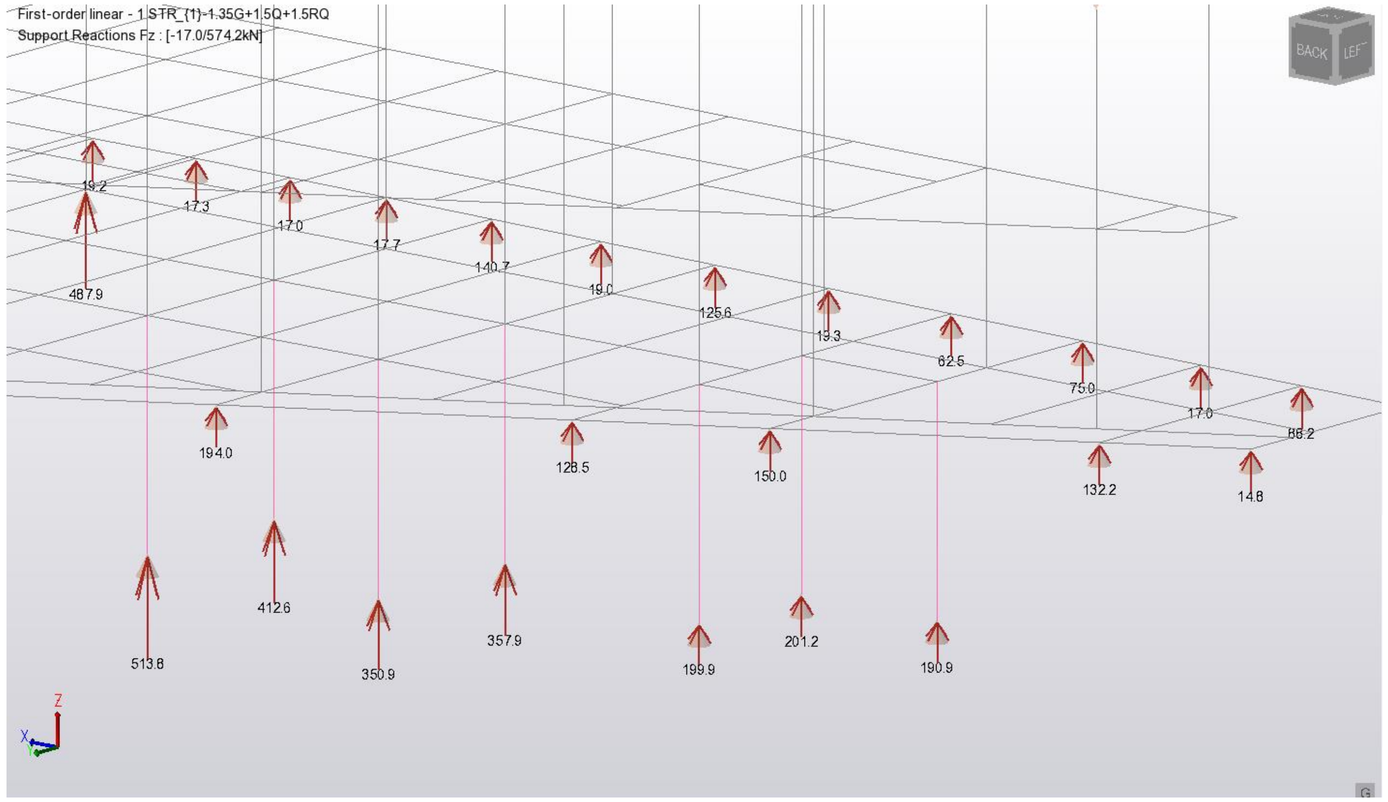
Cladding Loads:

Brick single skin Walls

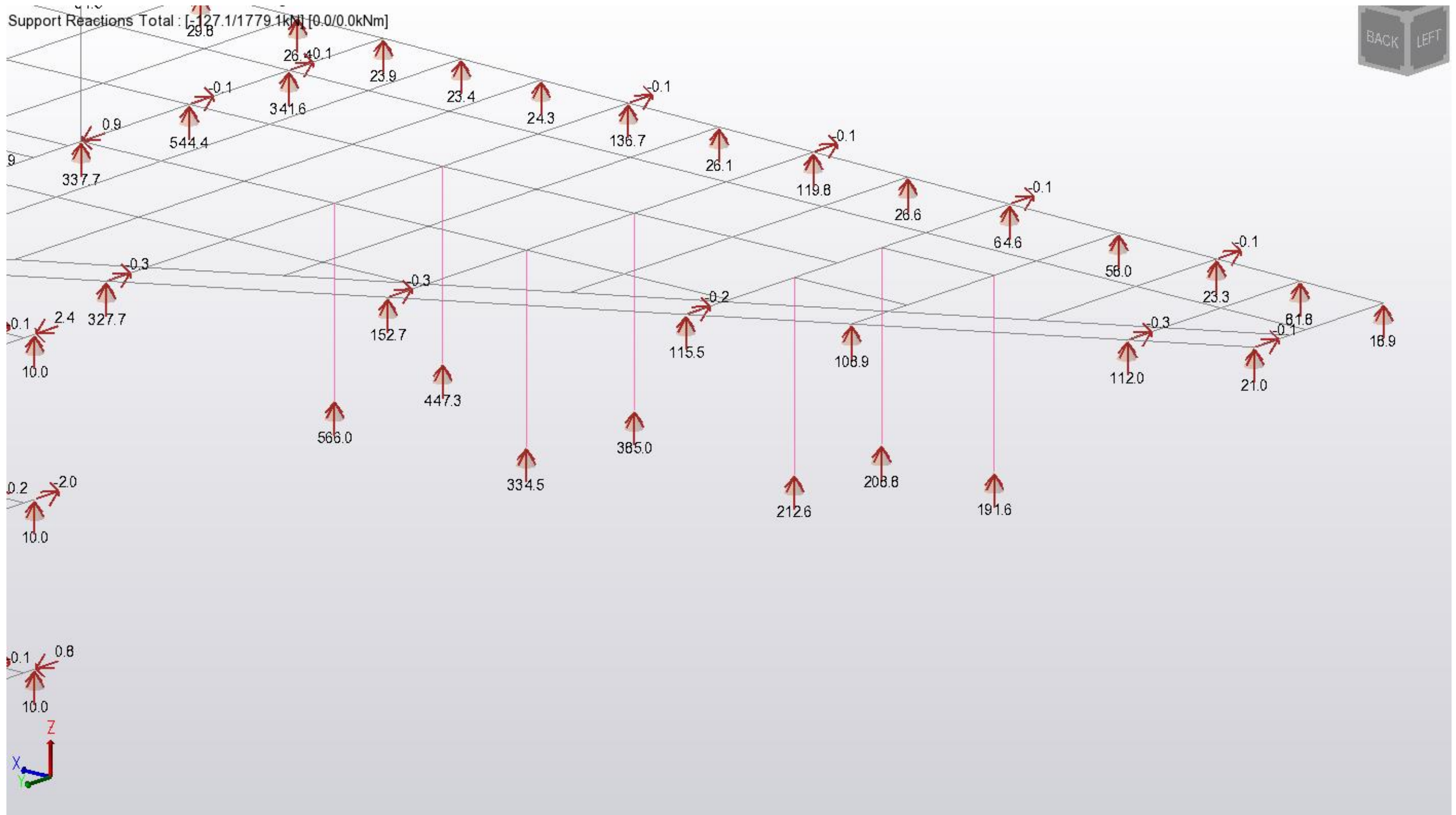
Selfweight	102 mm brickwork	=	2.04	
Fixtures and Fittings		=	0.10	
			2.14	kN/m^2

Brick+Timber stud Cladding TBC

Selfweight	102 mm brickwork	=	2.04	
Selfweight	100 x50 timber stud	=	0.40	
Fixtures and Fittings		=	0.10	
Insulation		=	0.20	
			2.74	kN/m^2



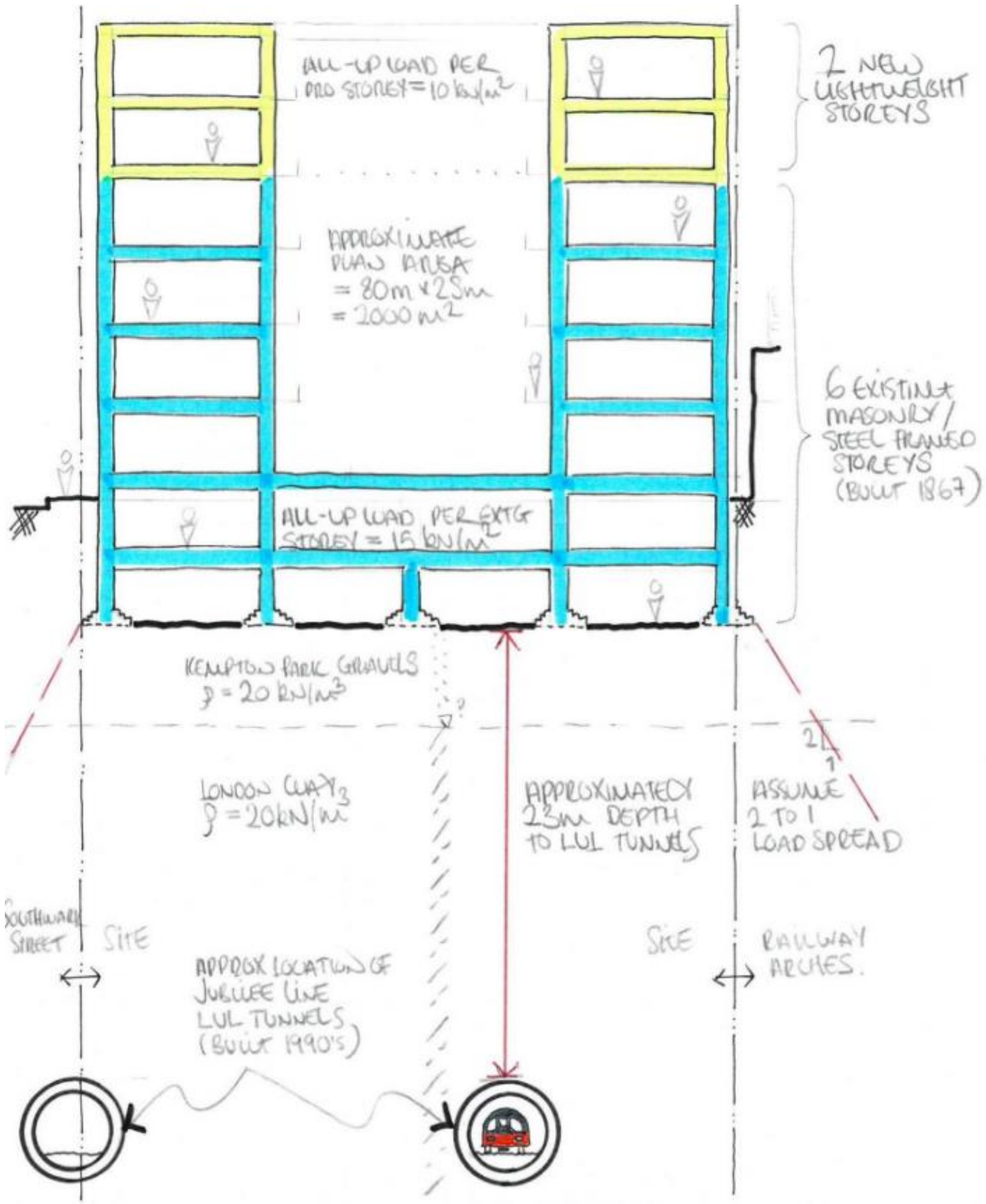
SLS Reactions over West Wing



SLS Reactions over West Wing from collapsed building

Appendix H
Calculations

Load increase felt by tunnels under 2 storey roof extension



Existing Stress in Soil at Tunnel Crown Level

$\sigma_{exist} = \sigma_{soil} + \sigma_{exist\ bldg}$

$= 20\ kN/m^3 \times 23m + [15\ kN/m^2 \times 6 \times 2000\ m^2 \div (80 + 23) \times (25 + 23)\ m^2]$

$= 460 + 36$

$= 496\ kN/m^2$

Proposed Stress in Soil at Tunnel Crown Level

$\sigma_{pro} = \sigma_{soil} + \sigma_{exist\ bldg} + \sigma_{pro\ storeys}$

$= 460 + 36 + [10\ kN/m^2 \times 2 \times 2000\ m^2 \div (80+23) \times (25+23)\ m^2]$

$= 460 + 36 + 8$

$= 504\ kN/m^2$

Change in Stress in Soil at Tunnel Crown Level

$\%\ inc = [(504 - 496) / 496] \times 100$

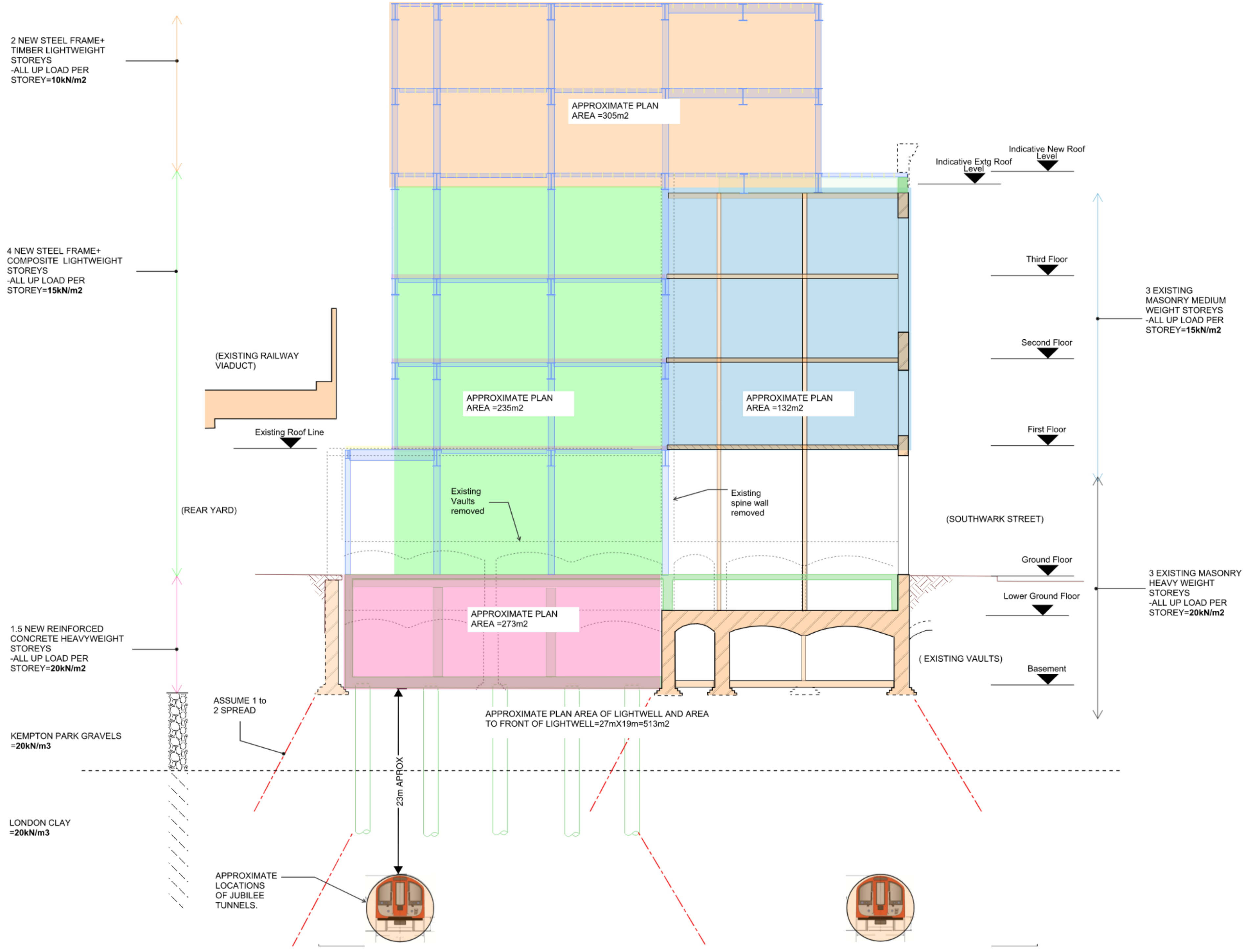
$= 1.6\ \%$ INCREASE.

Summary

- VERY SMALL CHANGE IN STRESS FELT BY TUNNEL (& CONSERVATIVE)
- ANTICIPATE NEGLIGIBLE EFFECTS ON TUNNEL
- MUST OBTAIN RELEVENT APPROVALS FROM TFL
- LIKELY TO REQUIRE COMPREHENSIVE LOAD/SETTLEMENT ANALYSIS
- ALLOW TIME IN PROJECT PROGRAM FOR ANALYSIS AND APPROVALS.

SECTION SHOWING EXISTING AND NEW LOADS OVER LIGHTWELL AND LUL TUNNELS

(~ 1:100 @ A1)



EXISTING STRESS IN SOIL AT TUNNEL CROWN LEVEL

$\sigma_{EXIST} = \sigma_{SOIL} + \sigma_{EXIST\ B'DING\ REMAINING} + \sigma_{EXIST\ B'DING\ DEM.}$

$= 20\,kN/m^3 \times 23m + [20kN/m^2 \times 3 \times 513\,m^2 + 15kN/m^2 \times 3 \times 132 \div (27+23) \times (19+23)\,m^2]$

$= 460 + \frac{30780 + 5940}{2100}$

$= 477\,kN/m^2$

PROPOSED STRESS IN SOIL AT TUNNEL CROWN LEVEL

$\sigma_{PRO} = \sigma_{SOIL} + \sigma_{EXIST\ B'DING} - \sigma_{EXIST\ B'DING\ DEM} + \sigma_{PRO\ STOREYS}$

$= 460 + \frac{30780 + 5940 - 3 \times 275 \times 20kN/m^2}{2100}$

$+ [10kN/m^2 \times 305m^2 \times 2 + 15kN/m^2 \times 235 \times 4 + 20kN/m^2 \times 273 \times 1.5 \div (27+23) + (19+23)]$

$= 460 + 1.07 + \frac{6100 + 14100 + 8190}{2100}$

$= 484\,kN/m^2$

CHANGE IN STRESS IN SOIL AT TUNNEL CROWN LEVEL

$\%\ INCR = [(484 - 477)/477] \times 100$

$= 1.5\%$ INCREASE

SUMMARY

VERY SMALL CHANGE IN STRESS FELT BY TUNNEL (AND CONSERVATIVE) -> ANTICIPATE NEGLIGIBLE EFFECTS ON TUNNEL, BUT MUST OBTAIN APPROVAL FROM LUL

NOTE:
- THIS CALC IGNORES THE LOAD SPREAD OF THE EXTG EXCHANGE HALL AND WEST WING SO IS CONSERVATIVE IN THAT RESPECT.
- THIS CALC IS ESSENTIALLY BASED ON A RAFT SOLUTION. IT SHOULD BE RE-RUN FOR A PILED SOLUTION IN THE NEXT STAGE IF THAT IS THE PREFERRED OPTION WHICH IS LIKELY TO GIVE MORE OPTIMAL RESULTS DEPENDING ON THE DEPTH OF THE PILES

Appendix I

Preliminary Borehole and Trial Pit plan

PRICE& MYERS

Job No	24259	Page	SK 201	Rev	2
Date	June '20	Eng	DF	Chd	LMN
Job	The Hop Exchange				

ALL SUGGESTED LOCATIONS TO BE AGREED ON SITE.

ALL BOREHOLES TO BE APPROVED BY LONDON UNDERGROUND LTD

ACCESSIBLE AREAS TO BE CONFIRMED BY CLIENT

Location of existing statutory services to be confirmed and overlaid to inform possible borehole locations

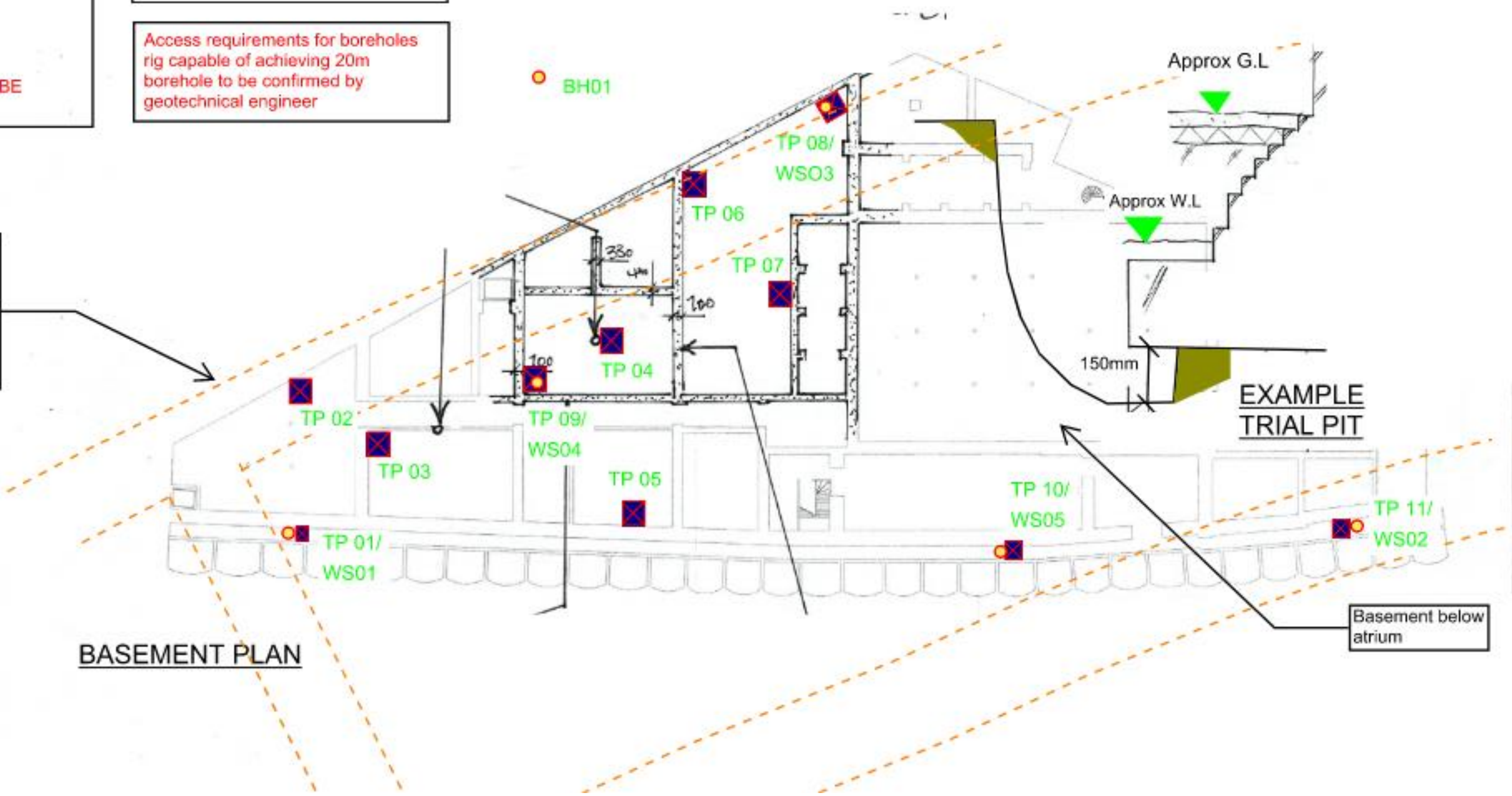
Access requirements for boreholes rig capable of achieving 20m borehole to be confirmed by geotechnical engineer

KEY

Suggested Trial Pit location, approx. 900mm sq to reveal superficial make-up of ground and exising underground structure. To be dug to a depth 150mm lower than the existing foundations.

Suggested borehole (Depth advised by Geo Engineer and to be approved by LUL) or window sample location (minimum 5m deep),to record ground conditions and ground water levels (Allow for monitoring of levels).

Approx location of Jubilee tunnels. Require min 5m exclusion zone to any boreholes. (tunnels are 22m below basement)

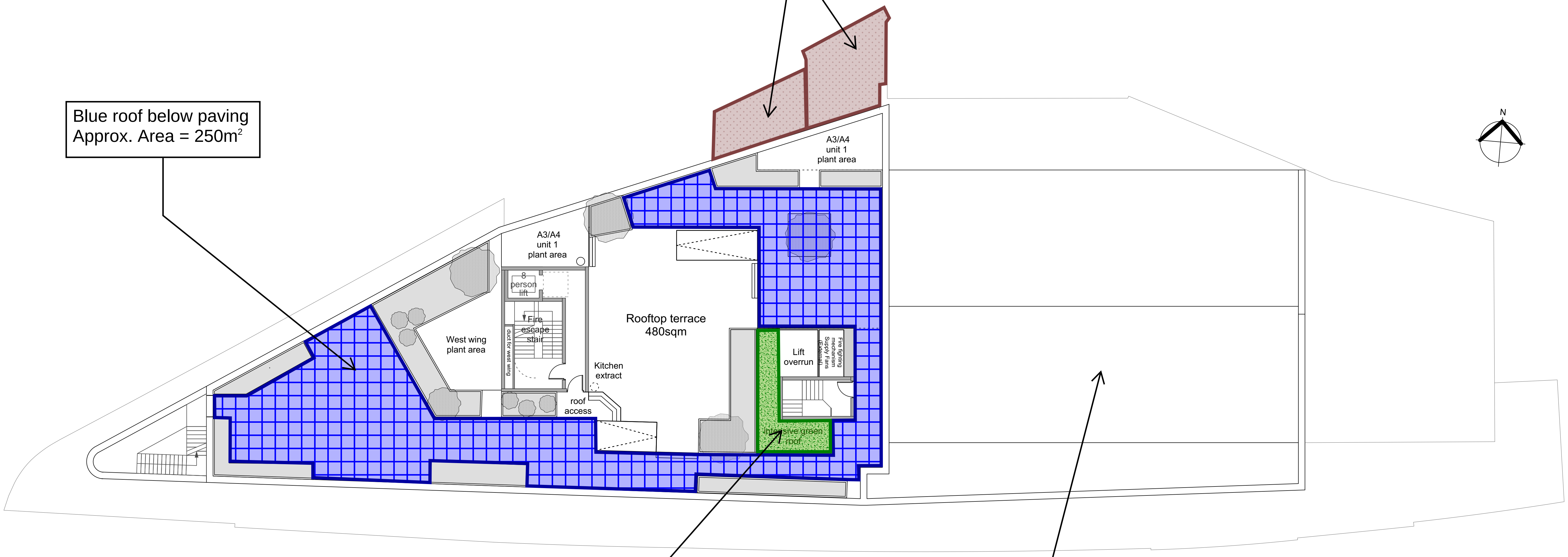


Appendix J
Civil Engineering Sketches

Above Ground SuDS Strategy

Brown roof at 1st floor to provide ecological benefits.

Blue roof below paving
Approx. Area = 250m^2



Green roof to provide ecological benefits. No attenuation allowed for within green roof.

Due to design it is not possible to utilise blue/green roofs for the atrium roof. Area to drain to RWP as existing.

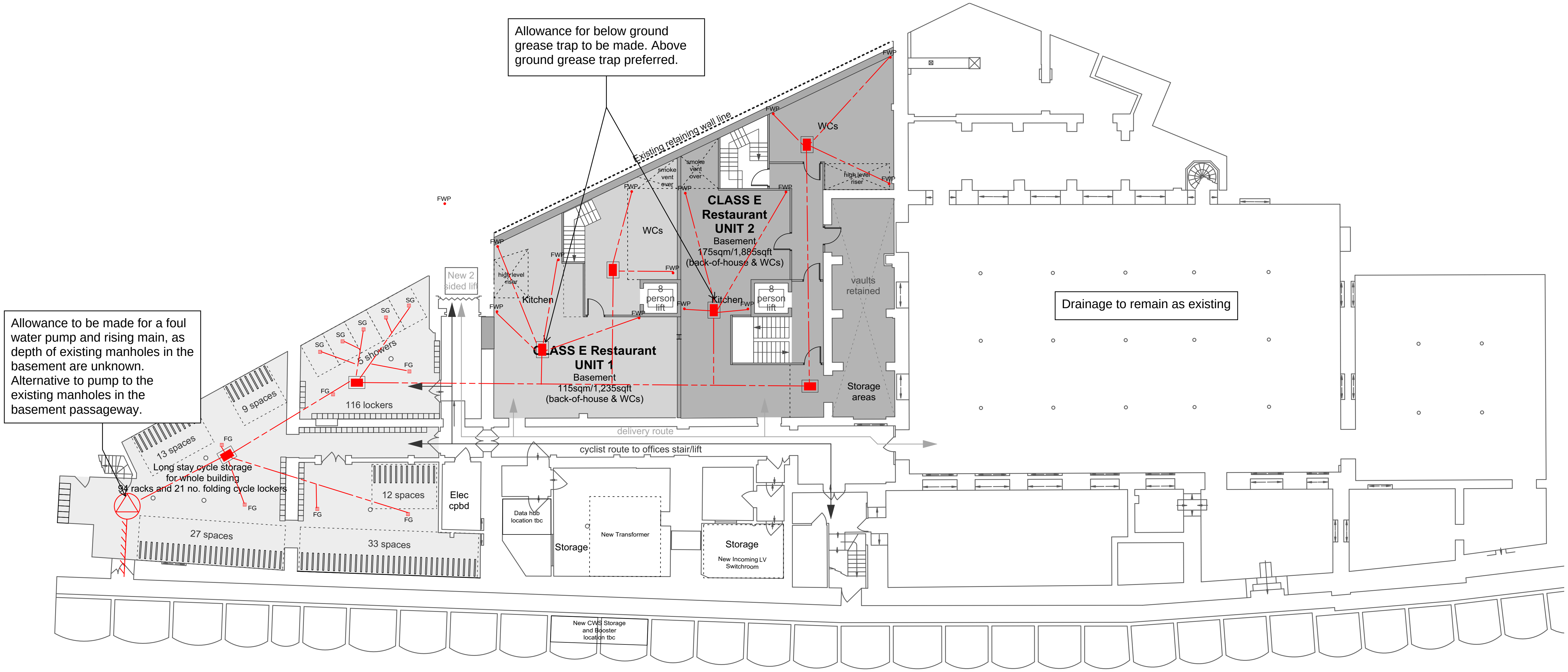
Key

- Brown Roof
- Blue Roof
- Green Roof

PRICE&
MYERS

Job No.	24259	Page	SK 600	Rev	2
Date	21/01/2021	Eng	KB	Chd	DLin
Job	The Hop Exchange				

Proposed Basement Drainage



Notes:
- All proposed drainage points are indicative and to be set out by the Architect and/or M&E Engineer.
- Existing drainage on site TBC
- Above ground grease traps to be utilised for the kitchen where possible.

Key

	Proposed Foul Water Drain
	Proposed Pumping Station
	Proposed Foul Water Rising Main
FG/SG	Proposed Foul/Shower Gully
FWP	Proposed Foul Water Point

PRICE & MYERS

Job No. 24259 Page SK 601 Rev 2

Date 20/01/2021 Eng KB Chd DLin

Job The Hop Exchange