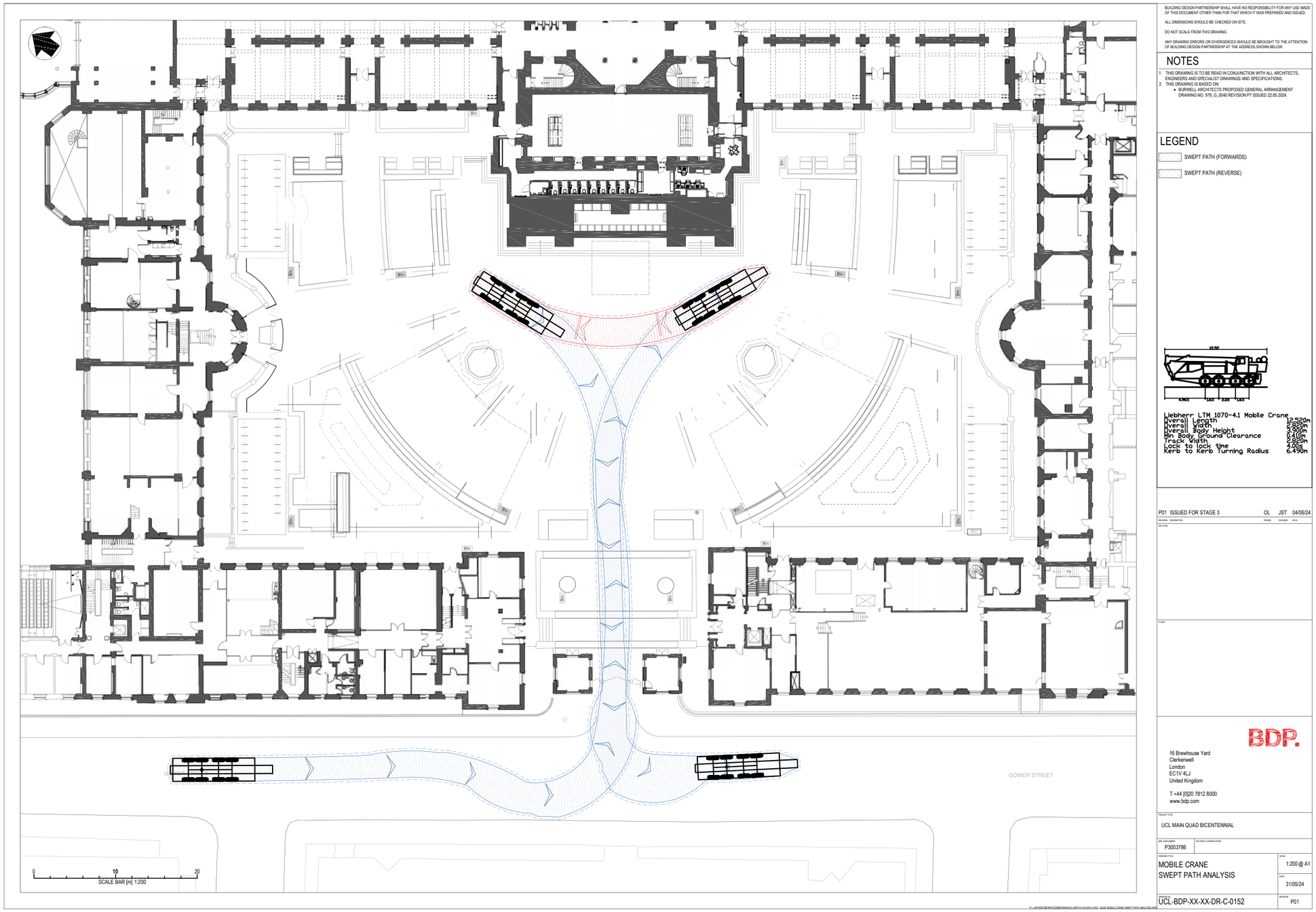
8. Civil Engineering Proposals
Main Quad



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NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ARCHITECTS, ENGINEERS AND SPECIALIST DRAWINGS AND SPECIFICATIONS.
2. THIS DRAWING IS BASED ON:
   - BURWELL ARCHITECTS PROPOSED GENERAL ARRANGEMENT DRAWING NO. 979_G_0040 REVISION P7 ISSUED 22.05.2024.

LEGEND

SWEPT PATH (FORWARDS)

SWEPT PATH (REVERSE)

Liebherr LTM 1070-4.1 Mobile Crane

Overall Length	12.520m
Overall Width	2.990m
Overall Body Height	3.910m
Min Body Ground Clearance	0.410m
Track Width	2.500m
Lock to lock time	7.40s
Kerb to Kerb Turning Radius	6.490m

P01	ISSUED FOR STAGE 3	OL	JST	04/06/24
REVISION	DESCRIPTION	DRAWN	CHECKED	DATE

KEY PLAN

CLIENT

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PROJECT TITLE

UCL MAIN QUAD BICENTENNIAL

BDP JOB NUMBER: P3003786

BIG STEP CLASSIFICATION

DRAWING TITLE

MOBILE CRANE
SWEPT PATH ANALYSIS

SCALE: 1:200 @ A1

DATE: 31/05/24

DRAWING NO.: UCL-BDP-XX-XX-DR-C-0152

REVISION: P01

9. Design Criteria

Project Description

Refer to BDP Structural Engineer's and Architect's Planning Reports

Purpose

This document provides the Basis of Design for the project with regards to structural engineering. The report sets out the codes, standards and reference documents by which the structure is designed. It includes an outline of the assumptions for structural materials, design loads and performance criteria.

Design Life and Building Condition

Table 2.1 in BS EN 1990:2002 states that a minimum design life of 50 years should be for Category 4 buildings (Building Structures and other common Structures). Normal practice in the UK is to try and achieve a design life of 60 years. At this stage the proposal is therefore to achieve a minimum design life of 60 years.

The condition of the existing building where works are taking place has not been reviewed at this stage. Best practice to improve the durability and longevity of existing structures is to continuously review and record the condition of structural elements as more of the building is opened up. An allowance for repair of elements should be made at the design phase as it is likely that defects will be uncovered during the construction phase.

Any planned improvements to the building thermal envelope and waterproofing may be beneficial to the longevity of the structure.

It is difficult to guarantee the design life for existing structural elements.

Codes and Standards

The building will be designed to Building Regulations Part A and the current Eurocodes and National Annexes, including those listed below:

Code Reference	Title
BS EN 1990:2002	Basis of Structural Design
BS EN 1991-1-1:2002	Actions on Structures - General Actions – Densities, self-weight, imposed loads for buildings
BS EN 1991-1-2:2002	Actions on Structures - General Actions – Actions on structures exposed to fire
BS EN 1991-1-3:2003	Actions on Structures - General Actions – Snow loads
BS EN 1991-1-4:2005	Actions on Structures - General Actions – Wind loads
BS EN 1991-1-7:2006	Actions on Structures - General Actions – Accidental actions
BS EN 1992-1-1:2004	Design of Concrete Structures – General rules and rules for buildings
BS EN 1993-1-1:2005	Design of Steel Structures – General rules and rules for buildings
BS EN 1994-1-1:2004	Design of composite steel and concrete structures – Part 1-1: General rules and rules for buildings
BS EN 1995-1-1:2004	Design of Timber Structures - Common rules and rules for buildings
BS EN 1995-1-1:2004	Design of Masonry Structures - Common rules and rules for buildings
BS EN 1997-1:2004	Geotechnical design – General rules
BS EN 1997-2:2007	Geotechnical design – Ground investigation and testing
CP111: 1970	Structural recommendations for load bearing walls
BS449	Use of Structural Steel in Buildings

Table of codes used in Planning design

Loadings

Existing Loads

Existing loads have been calculated using archive drawings available, where archive information is lacking assumptions have been made. Results from the Site investigation are required to confirm assumptions.

Loadings assumed at this design stage are given below:

Dead Loads	
4 1/2" Concrete Slab	3.0kN/m²
5" Concrete Slab	3.3kN/m²
5 1/2" Concrete Slab	3.5kN/m²
6 1/2" Concrete Slab	4.2kN/m²
7 1/2" Concrete Slab	5.0kN/m²
8 1/2" Concrete Slab	5.5kN/m²
9 1/2" Concrete Slab	6.3kN/m²
Superimposed Dead Loads	
1/4" Lino & 1 1/4" Monolithic Screed	1.0kN/m²
Ceiling & Services	0.3kN/m²
Note: Superimposed Dead Loads are TBC by site investigation.	
Imposed Loads (Historical)	
Roof - No Access	0.5kN/m² (10lbs/sq. ft)
Roof - Access	1.5kN/m² (30lbs/sq. ft)
Roof - Plant	4.8kN/m² (100lbs/sq.ft)
Library Sorting Room	5.8kN/m² (120lbs/sq. ft)
Reading/Lecture Rooms	3.8kN/m² (80lbs/sq. ft)
Circulation	2.9kN/m² (60lbs/sq. ft)
Storage	7.2kN/m² (150lbs/sq. ft)

Table of existing loads (Dead loads derived from 1950s archive drawings, imposed loads derived from BSCA historical steelwork handbook)

9. Design Criteria

Proposed Loads

Dead Loads	
150mm Composite Deck	3.5kN/m²
Superimposed Dead Loads	
50mm Stone (TBC by Architects)	1.3kN/m²
Ceiling & Services	0.3kN/m²
Imposed Loads (Eurocodes)	
Plant (E213)	7.5kN/m²
Library Sorting Room (B1)	2.5kN/m²
Reading/Lecture Rooms (C13)	3.0kN/m²
Circulation (C31)	3.0kN/m²
Storage (E14)	5.0kN/m²

Table of proposed loads used in design

Robustness & Disproportionate Collapse

The Wilkins building, like many historic structures, is unlikely to meet current regulations for disproportionate collapse.

The building is an educational building and between 1-15 storeys and will retain similar occupancy and no. of storeys in the proposed condition. Hence, the proposed building would be classified as Class 2B under current Building Regulations, Part A3.

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 explosion) the building will not suffer collapse to an extent disproportionate to the cause. This condition applies when refurbishing existing structures, and hence is relevant to the proposals.

However the original construction pre-dates such requirements. In line with the Institution of Structural Engineer's "Practical Guide to Structural Robustness and Disproportionate Collapse in Buildings", where alterations to an existing building are being carried out, if the building is no more unsatisfactory than before the work was carried out with regard to disproportionate collapse then the building does not need to comply with modern requirements, in accordance with the below legislation:

uirements relating to building work
(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.".

The works include the removal of non original floors and stairs and replaced with new floors which will replace the restraint condition of the wall. All of the works being carried out can be considered to make the building as 'no more unsatisfactory than before'.

Notwithstanding, new structure will be designed to meet the requirements of 2B. This will be achieved by the following:

- Provision of horizontal tying to each floor level in two directions;
- Horizontal tying of edge columns
- Vertical tying of columns;

Fire

The building is approximately 15m above ground level. The assumed minimum periods of fire resistance are highlighted in the below extract from Building Regulations Part B).

Existing concrete encasement to steelwork may need to be assessed by the fire consultant to confirm it meets modern requirements.

It is assumed that either fire boarding or intumescent paint will be provided to the new steel frame. Any timber elements such as 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. According to the Building Regulations Approved document B, the recommended fire period is 60 minutes.

Table B4 Minimum periods of fire resistance

Purpose group of building	Minimum periods of fire resistance[1] (minutes) in a:						
	Basement storey* including floor over		Ground or upper storey				
	Depth (m) of the lowest basement		Height (m) of top floor above ground, in a building or separated part of a building				
	More than 10	Up to 10	Up to 5	Up to 11	Up to 18	Up to 30	More than 30
1. Residential:							
a. Block of flats							
– without sprinkler system	90 min	60 min	30 min[7]	60 min*[5]	Not permitted[2]	Not permitted[2]	Not permitted[2]
– with sprinkler system[3]	90 min	60 min	30 min[7]	60 min*[5]	60 min*[5]	90 min*	120 min*
b. and c. Dwellinghouse	Not applicable[4]	30 min*[7]	30 min[7]	60 min[5]	60 min[5]	Not applicable[4]	Not applicable[4]
2. Residential							
a. Institutional	90 min	60 min	30 min[7]	60 min	60 min	90 min	120 min‡
b. Other residential	90 min	60 min	30 min[7]	60 min	60 min	90 min	120 min‡
3. Office:							
– without sprinkler system	90 min	60 min	30 min[7]	60 min	60 min	90 min	Not permitted[6]

9. Design Criteria

Existing Masonry

Until brickwork testing has been carried out to confirm brickwork strength the permissible strength of the existing brickwork is taken as 0.42 N/mm².

Existing Concrete

The archive drawings from the 1940s refurbishment indicate a concrete mix of 1:2:4 for cement : sand : aggregate.

Existing Steelwork

The permissible stresses in steelwork are assumed to be in line with The BCSA's Historical Structural Steelwork Handbook guidance. The following values are for steels manufactured after 1927.

Allowable bending stresses:

Tension (8 tons/sq. in)	123.6 N/mm²
Compression (8 tons/sq. in)	123.6N/mm²

New Concrete

Material Properties	
Grade	RC 32/40
Unit Weight	2500 kg/m²
Coefficient of thermal expansion or contraction	1.0 x 10-5 /°C
Poisson's Ratio	0.2

Design for concrete in the ground is to be advised in the next stage when S.I information is available.

Reinforcement

All reinforcement is assumed to be ribbed grade B500B steel reinforcement at this stage.

Material Properties	
Yield Strength	500 MPa
Tensile/yield strength ratio	1.08

Structural Steel

Structural steel shall conform to the following standards, unless noted otherwise. Steel shapes and sizes are chosen from the Tata Steel Blue Book to ensure sizes proposed are readily available within the UK. All structural steel elements are currently assumed to be grade S355 hot rolled steel.

No allowance has been made for stainless or galvanised steel elements but this might be a consideration for any elements exposed to the elements, as the design develops.

Steel Material Properties	
Grade	S355
Yield Strength	355 MPa (thickness < 16mm) 345 MPa (thickness < 40mm)
Ultimate Strength	470 MPa

Deflection and Vibration Limits

Superstructure Movement

The limiting design deflections shall be in accordance with the relevant European Standards. Typical deflections shall be limited to the following:

Description	**Deflection Limit**
Deflection under live load	span/360
Deflection under dead and live	span/250
Deflections of transfers supporting brittle structure	span/500
Horizontal deflections/sway	h/300

Substructure Movement

Foundation elements will be designed to limit maximum settlements and mitigate any damage to surrounding buildings.

As a general rule anything greater than a 10% increase in the overall loading on the existing foundations is not considered acceptable without strengthening of existing foundations or an in depth analysis of potential settlement.

Vibration

Floors are to be designed to ensure vibration limits do not impact on user comfort. The following response factor limits should be adhered to;

Room Use	**Response Factor Limit**
Workshops	8
Offices	4
Operating theaters, precision laboratories	1

10. Construction Logistics

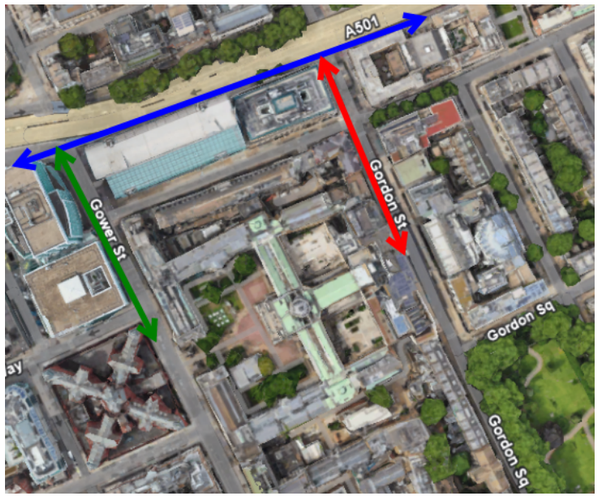
Construction Logistics

The site presents a number of constraints that the Contractor will need to consider. These have to some degree informed the design and are discussed below. As it is likely the Main Quad and Wilkins constructions will occur concurrently these have been discussed holistically.

All proposals will need agreement between the Landlord and Contractor - the below information is for indicative purposes only.

Occupancy

During works its likely that parts of the Main Quad and Wilkins building will need to be restricted to allow for safe construction activity and vehicular movement.



Assumed access routes to site

Access to Site

Main access for vehicles during construction is assumed to be provided from Gower Street or Gordon Street which can be accessed from the A501 to the North.

The route from Gordon Street to the Wilkins Building is thought to be less viable than from Gower Street via the Quad due to space and vehicular access limitations.

Storage

Its assumed that the proposed works to the Wilkins building and the Main Quad will occur concurrently and it is therefore likely that the Quad can be used for storage and a base of operation for the Contractor, as work is carried out on the Wilkins building. There are various other open areas which could be used for storage during construction. Some examples have been provided on the site logistics image on the next page.

The contractor should be made aware of the Slade and Chadwick basements so necessary precautions are made to ensure they are not overloaded. For example heavy equipment, materials or vehicles adjacent to or above the basement slab.

Mobile Crane Locations

For the proposed structural works a mobile crane has been assumed. It is likely this would be used primarily for the removal and replacement of the existing roof plant, manoeuvring bulk material and installation of precast planters.

If situated in the Quad, the crane is likely required to lift equipment over the Wilkins building. Care must be taken around the portico and dome which are a main features of the Grade I listed building.

The following image shows that a crane with 20m of reach may be required to access the back segments of the Octagon. However, if cranes are located close to the Wilkins building, the retaining walls to the light wells and the lower ground floor would need to be justified for the surcharge loads. Temporary propping may be required. A crane with a longer reach, located further the basements may be a preferred solution.

Concrete Mixer

The scale of the concrete pour may allow for on-site ‘hand’ mixing which could simplify construction logistics. However, if a mobile concrete mixer is required this is likely to be stationed in the quad as indicated on the images overleaf.

The concrete could be pumped over or through the Wilkins building to reach the ‘Level Access Zone’ where much of the ‘wet’ concrete work is occurring.

10. Construction Logistics

Access through the Building

The following image shows movement through the site to the areas where structural works are taking place.

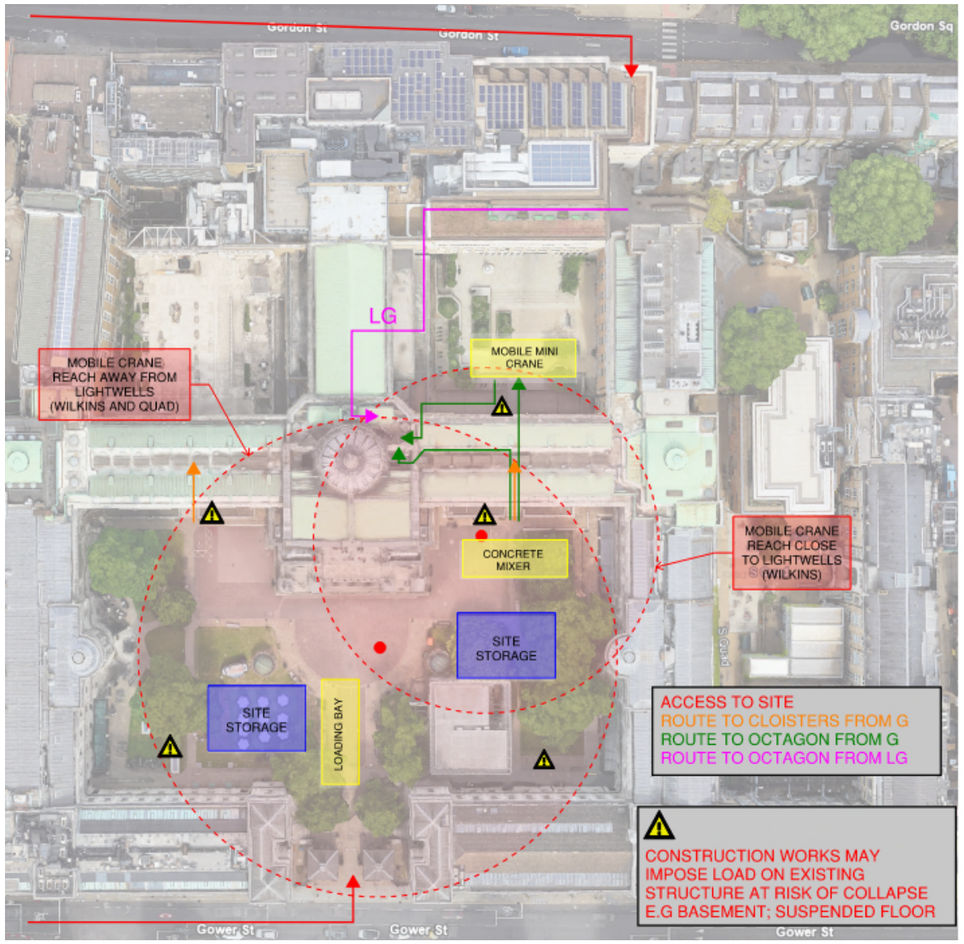
Access to the cloisters is relatively straightforward via the main entrances for each cloister possibly via a ramp.

The route to the 'level access zone' is complicated by the planned removal of the lower ground floor stairs.

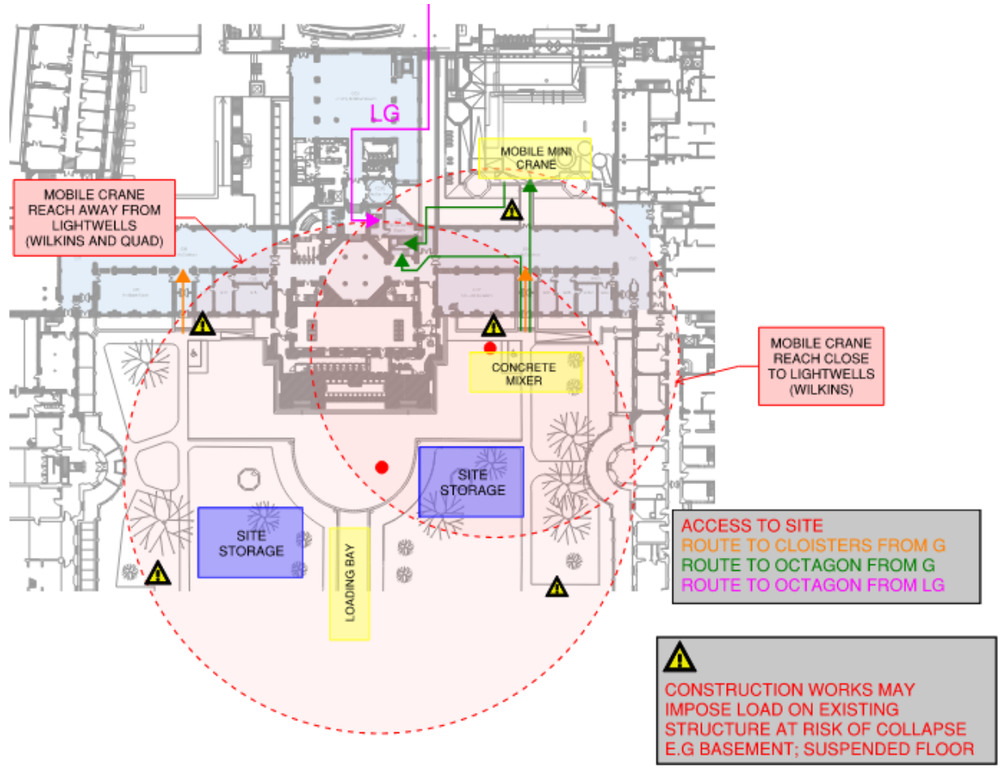
Possible routes are described below:

The green route would likely mean ground floor restrictions to the users of the Cloisters and Octagon. Necessary protections would be required to all the listed finishes. Lifting equipment would also be required to lower materials from ground floor to lower ground floor after the removal of the stairs and floors.
The green route through to the rear of the Cloisters may be less disruptive to the internal spaces. This option requires a mini crane in the South Cloister Garden to lower materials from the garden area to the external lower ground floor walkways.

The purple route may allow materials to be delivered via the rear of the site and transported to the Octagon without lifting apparatus. This route has a restricted head height and utilises the lower refectory which might cause disruption to the university users.



Assumed construction access and logistics over satellite image



Assumed construction access and logistics over existing ground floor plan

11. Next Steps and Design Risks

Next Steps Wilkins

Further Investigations

The Intrusive Site Investigation is required to be carried out in accordance with BDP scope to confirm:

- Assumed structural configurations.
- Make up of existing finishes to confirm assumed loads
- Brickwork testing to confirm compressive strength of existing brickwork.
- Trial pits to confirm existing foundations and ground conditions
- The bearing capacity and nature of the soil strata.
- Capacity of existing slabs to supports pendants using pull out tests

Piling/Geotechnical Specialist

The scheme should be sent to a geotechnical consultant for advice on the proposed raft foundations.

Information Required to Complete Design

- Lift load`s and support points from Lift Subcontractor
- Pendant Lighting loads and locations from lighting designer.
- Listed Building Consent

The design once complete should be sent to Historic England for listed building consent.

Next Steps Main Quad

Site Investigation

The intrusive site investigation is required to be carried out in accordance with BDP scope to confirm:

- Assumed ground conditions.
- Trial pits to confirm existing foundations and basement conditions within the Quad.
- Below ground services survey required for area occupied by the temporary teaching building located towards the south of the quad.
- Further survey required to identify the locations of the outlets from the existing drainage channels and the connections to the existing below ground drainage network.
- In situ CBR testing required to inform pavement design.

Piling/Geotechnical Consultant

The structural scheme, site investigation and preliminary loads should be sent to a screw pile specialist and/or geotechnical consultant for advice on the proposed foundations.

UXO

The scheme should be send to a UXO specialist for advice on whether a watching brief and/or intrusive UXO monitoring is required.

Arboriculturalist

The scheme should be sent the Arboriculturalist for review of tree root damage limitation methods.

A downstand nib element to the retaining wall may need to be incorporated post to help minimise disturbance to tree roots and help achieve the architectural scheme. This has been discussed with the architect and arboriculturalist and agreed in principle, but will be developped further.

‘Temporary’ Tensile Structures

An indication of the foundations requirements for the ‘temporary’ tensile structures are required from the specialist subcontractor. These will need to be coordinated with the below ground services, tree roots and retaining walls.

Design Risks

A project risk register is being prepared by the Project Managers Gardiner and Theobald for circulation which will highlight the design risks. The design team will provide input in to this register.