Nex—

—The British Museum

Low Level Roofs
Design & Access Statement
Rev 1

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The British Museum
Low Level Roofs
Design & Access Statement

Introduction—

Project Team
Client: British Museum
Architect: Nex
Surveyor: Ridge
Heritage Consultant: Donald Insall Associates
Planning Consultant: The Planning Lab
Structural Engineer: Civic Engineers
MEP Engineer: Hoare Lea
Principal Designer: Shore
Project Manager: Arcadis
Quantity Surveyor: Currie & Brown

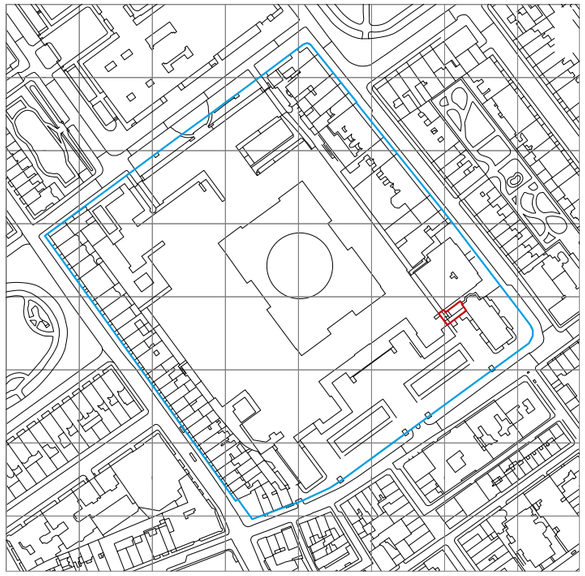
Introduction
This Design and Access Statement has been prepared by Nex on behalf of The British Museum to illustrate proposals for the proposed roof refurbishments to five small roofs at the south east of the Museum.

Project Location

The five roofs are located between the south colonnade and east residence. The area is not accessible to the public, and is used primarily by Museum security and external contractors to the Museum.

The corridor and contractor's desk space (below roofs B/3/X04 and B/3/X03 respectively) are accessed via the south forecourt, with the store (below B/2/X01) and contractor's WC (below B/2/X02) accessed via a passageway beneath the corridor, which itself is also accessed off the forecourt.

The security welfare space (below B/2/X03) can also be accessed from the external pathway to the north of the east residence.



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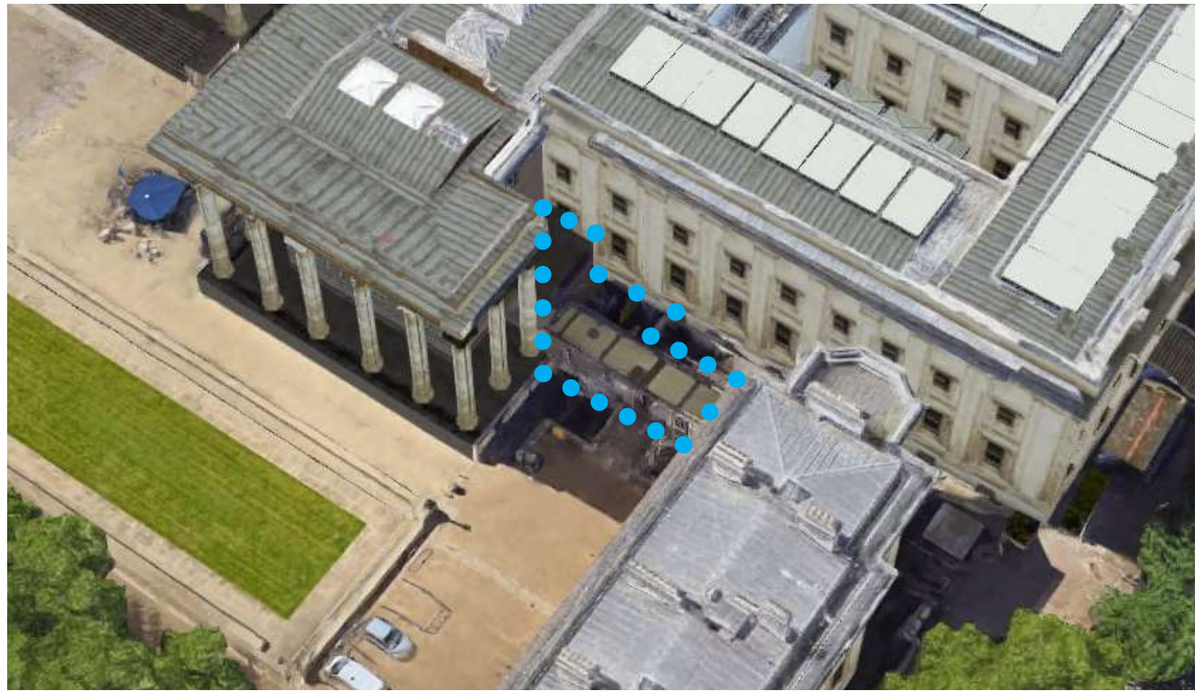

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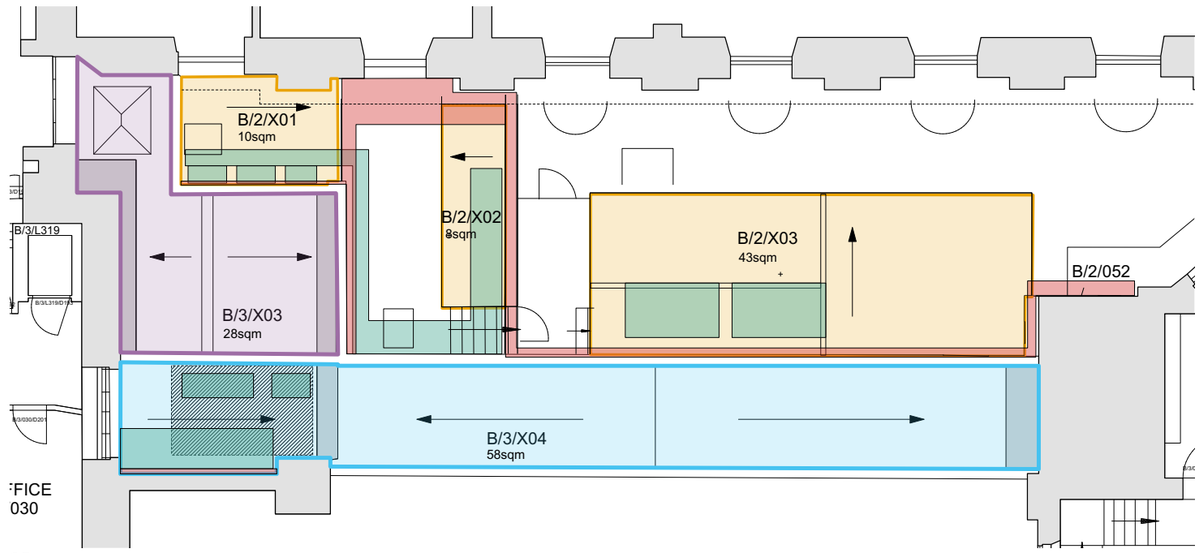
Key

- Existing patent slate roof (bituminous covering)
- Existing patent slate roof (asphalt covering)
- Existing felt roofs
- Existing gantry over roofs
- Existing mechanical plant
- Existing electric cable trays
- Roof fall direction

01. Site plan with Museum boundary in blue and project site in red
02. Aerial view of the Museum from the south east, with the project area highlighted in blue
03. Roof plan of the site, showing the existing roof coverings



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Project Context—

The five roofs were built in three different phases of the Museum's development. Two were constructed as part of Sydney Smirke's 1840's additions over the eastern connecting corridor, linking the principal colonnade of the museum with the east residence. Today, the spaces below still form the internal passageway between these two portions of the building, as well as housing the contractor's desk for contractors working at the Museum.

The remaining three were constructed to the north of the corridor in the mid to late 20th century, housing two store rooms, a WC and a welfare hut for security staff.

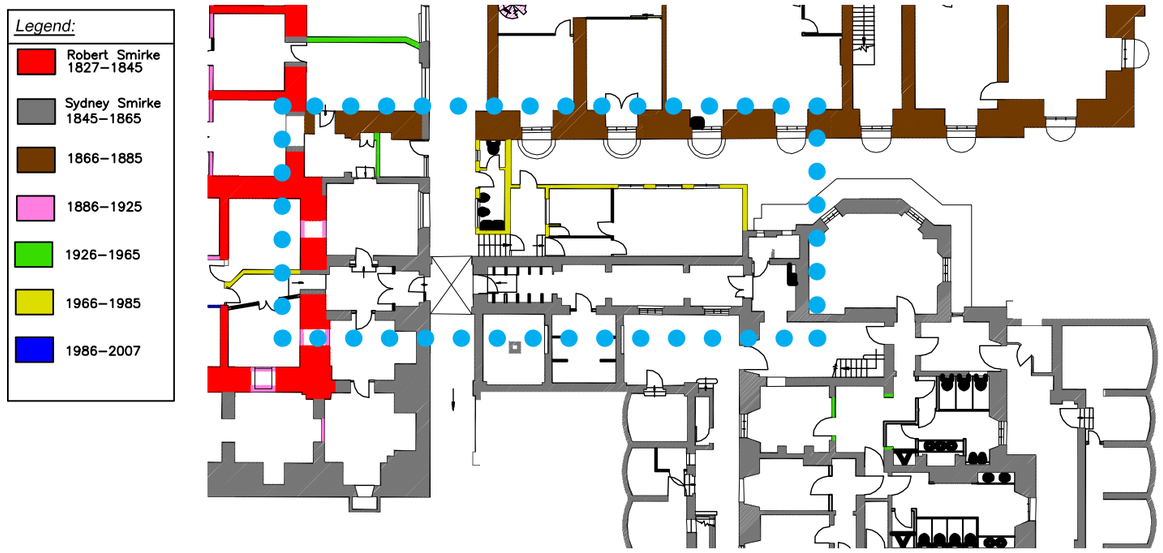
The two roofs built in the 19th century are formed from the original large format 'patent' slate tiles, and have been covered over with an array of different treatments over the years, almost certainly due to previous issues with water ingress. The roofs' structure is a mix between slate joists, cast iron beams and ad-hoc masonry piers built off the ceilings below. The roofs fall into copper gutters which connect to cast iron hoppers and downpipes.

One of these roofs currently has a bituminous covering which has badly eroded and flaked, and the other has been covered with asphalt over a layer of screed. The spaces below have a mix of slate and lath and plaster ceilings, plastered walls, some original timber joinery, and replacement modern day floor finishes and services.

Two of the three 20th century roofs are formed of timber joist and deck structures with felt coverings, with the third a concrete slab roof structure with a felt covering.

A detailed description of the building fabric and its historic significance is contained in the Heritage Report submitted as part of this application.

01. Basement plan showing dates of construction, project area highlighted in blue
02. Aerial view of the project site from the north, taken from a White Wing window
03. Ground floor plan showing dates of construction, project area highlighted in blue



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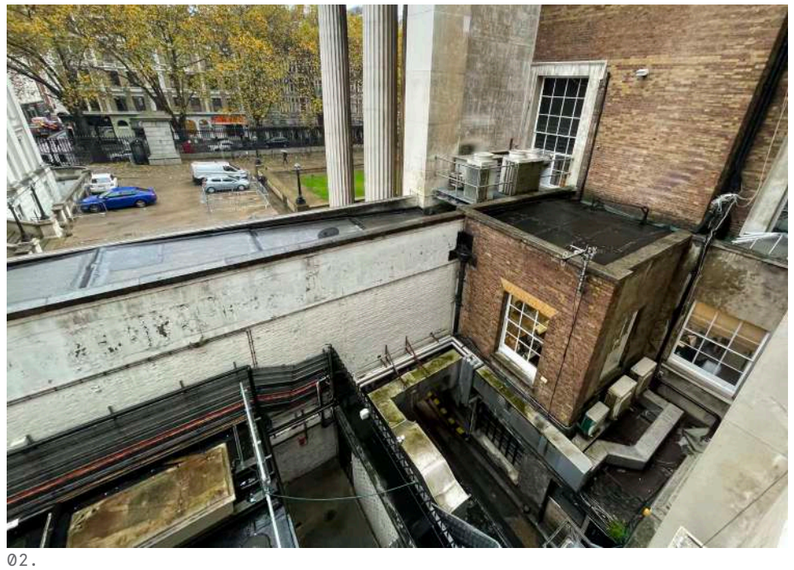

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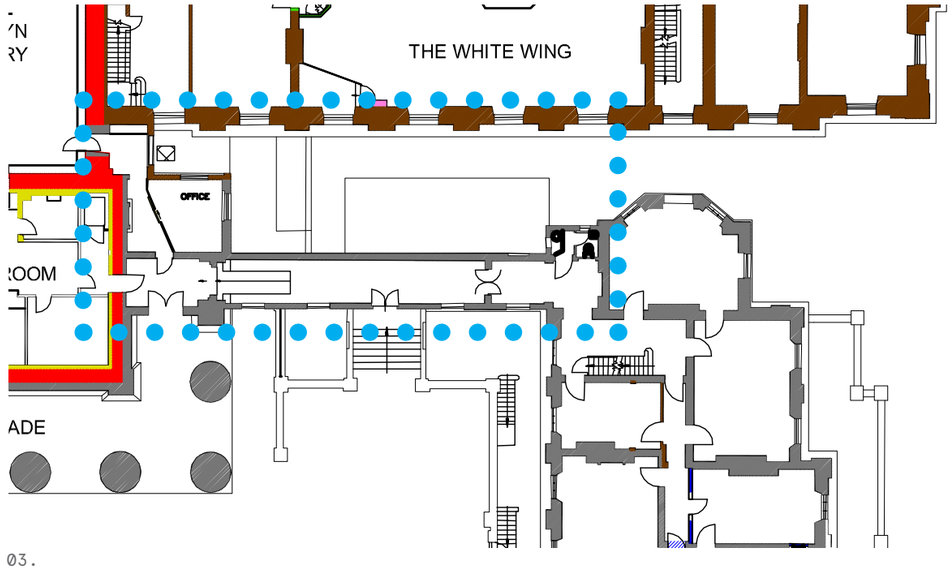

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Project Context—

The Project Need
Water ingress has been identified beneath each of the five roofs within this project. Water staining, flaking paintwork and cracked and subsiding plaster has been noted across the spaces beneath. The security welfare hut is worst affected, where water ingress has caused parts of the plasterboard ceiling to subside, as well as rot to the timber joists and deck, resulting in the space to be closed off from staff.

In the other spaces, water ingress penetrating at the flashings and through the roof coverings themselves is causing damage to existing finishes and fittings, and risking damage to historically significant fabric including original timber joinery in the corridor, as well as the metal structural connections within the slate ceilings themselves, which are showing signs of rust and corrosion.

Investigations into the cause of water ingress from the five roofs has revealed that the problem is likely to have occurred through a combination of factors, primarily:

— Life expiry of the felt, bitumen and asphalt coverings of all roofs
— Design failure in the patent slate roofing pitch and weathering details
— Design failure in the pitch and flashing details of the felt roofs
— Condensation due to lack of insulation within all the roof build-ups

The proposals seek to address the water ingress issues, whilst protecting and conserving the historic fabric in a sensitive and robust manner.

A further issue to address as part of the project is the large amount of mechanical and electrical plant atop the roofs, mainly housed on the 20th century felt roofs. Much of the mechanical plant is life expired and in need of replacement, and much of the electrical plant is out of use or badly organised, cluttering the roofs visually and creating obstacles for water to drain freely, and trapping debris atop the roof surfaces.

The project seeks to relocate and remove items of plant connected to the 19th century roofs, along with replacing life expired mechanical plant and rationalising electrical cabling on the 20th century roofs.

Museum Brief
The Museum is looking to carry out refurbishment works to each of the five roofs and the spaces below, to create long-lasting, robust coverings and roof structures, which secure the roofs against further damage and to halt water ingress in a way which has as little impact as possible on fabric of historic value. As part of the works, the Museum wants to explore options to upgrade the thermal performance of the roofs and create safe access for cleaning, inspection, and maintenance, as well as taking the chance to undergo light-touch repairs and refurbishment to the finishes in the spaces below.


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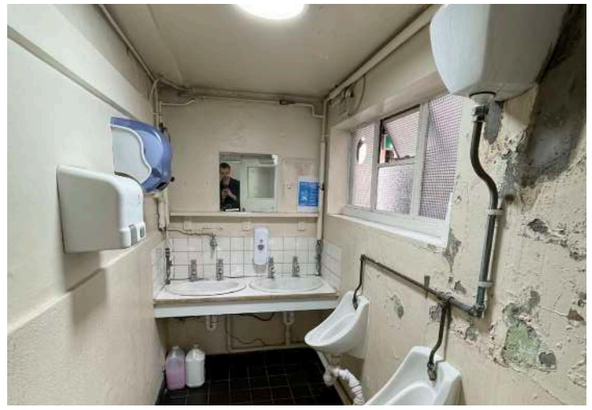
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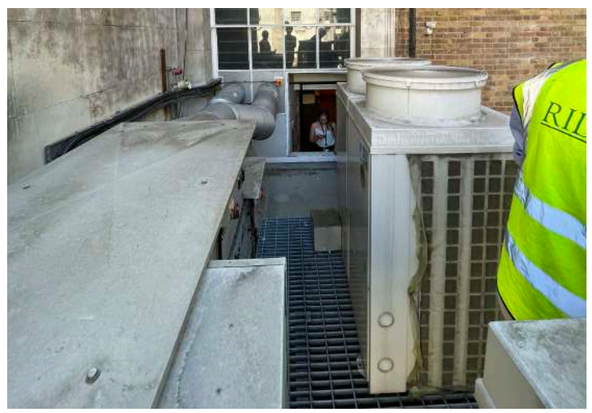
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01. Water ingress to slate joist within roof void of B/3/X03
02. Water damaged joist and deck within B/2/X03
03. Flaking paintwork within Contractor's WC
04. Flaking paintwork within Contractor's corridor
05. Life expired mechanical plant on gantry over B/3/X04
06. Electrical cabling running next to B2/X01

Existing Condition—

Slate Roofs

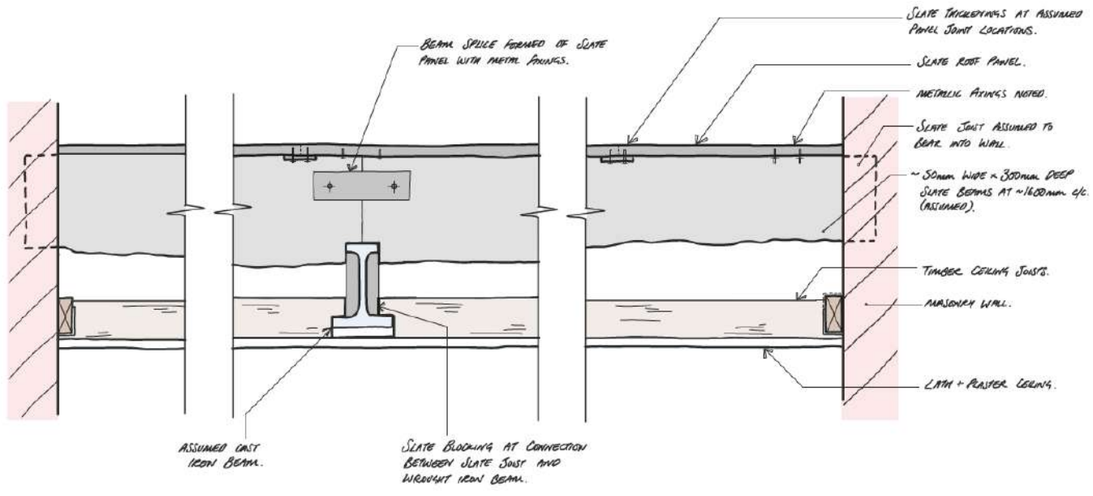
B/3/X03 and B/3/X04 were built between 1845-1865 by Sydney Smirke. Both were constructed as patent slate roofs, with large slate roofing panels bolted together and flashed with copper, laid over various structural systems, outlined below.

Both B/3/X03 and B/3/X04 have significant heritage value in both the rarity of their construction and the relatively few examples left both at the Museum and around the country.

According to the SPAB 'Slating in Wales and the Marshes' - patent slate roofing is considered to have been invented by Charles Rawlinson of Lostwithiel in Cornwall. He was granted Letters of Patent for a 'New Invented Method of Covering Roofs with Slates' in 1772. The method was promoted (and possibly independently 'invented') by the architect James Wyatt, and subsequently used on many buildings in the UK - including at the Palace of Westminster. It is thought that the technique was used at the British Museum due to its resistance to fire spread.

On the two slate roofs within this project, the slates are single lapped and simply butted up at the sides with the joists over-sealed with copper flashings and likely putty. The dominant issue with patent slating is that when the putty hardens and cracks - which can happen quite soon after construction - water ingress occurs at the joints. The SPAB note that despite the technique's apparent regional rarity (likely due to its inherent design fault leading to failure much quicker than a traditionally double or triple lapped slate roof) it is nationally important typology.

B/3/X03 has slate weathering strips below the seams of the panels, sat over a slate ridge beam and slate purlins. The slate purlins are supported by a cast iron beam which seems to be original to the construction. Timber ceiling joists are tied into the underside of the cast iron beam, and support a lath and plaster ceiling.



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01. Photo showing B/3/X03, highlighted in blue
02. Slate panels and joists over lath and plaster ceiling on timber joists
03. Structural Engineer's sketch of existing roof structure of B/3/X02
04. Photo of B/3/X04 from the south, showing the existing line of the roof in blue
05. Photo of B/3/X04 from above, showing the existing line of the roof in blue

Existing Condition—

B/3/X04 is more challenging to assess, as the ceiling is constructed of stone - potentially slate - panels, presumed original to the Sydney Smirke construction.

Due to this find during the opening up works, only small drill holes were made through the slate from below, to determine their thickness and allow access to the void via an endoscope camera, whilst avoid breaking out a section of the ceiling itself. At the west end of the roof, the slate roofing tiles appear to have been propped off the slate ceiling, using unmortared brick piers. Along the main section of the roof, no evidence of the brick piers was found, instead, a series of slate joists at the seams between ceiling panels, bolted together in a similar fashion to the roof panels of B/3/X03.

After their initial construction, both roofs have undergone adaptive repairs performed which are evident today. B/3/X03 features the remains of a bituminous covering applied directly to the slate, which has failed and become loose, flaking away in places.

B/3/X04 has a 20mm asphalt covering, which was applied over a screed, itself applied directly over the original slate. This screed was measured as 85mm in depth in the location It was opened up, directly west of the gantry. The screed was presumably applied in a separate phase to the original construction and looks to contain fly ash, coal, flint and river stone, and reflects the type of screed that would have been used around 1900.

Slate is used extensively throughout the Museum, particularly in the Sydney Smirke additions, appearing as flooring, ceilings and used as small and large format tiles for mansard roofs and structural patent slate roofs respectively; with the latter being the construction used for B/X/03 and B/X04.

Patent slate roofs were originally constructed over the Nineveh and Nimrud Galleries as well as over the Director's Corridor, but these have all since been replaced. A slate or stone ceiling was also used for the Director's Corridor ceiling, similar to the ceiling construction over the Contractor's Corridor, but here inverted cast iron 'T' beams were used, not evident in the Contractor's Corridor (Approved CMP 2008). The 2008 CMP also notes that the 'surviving roofs of slate construction are of particular interest', with the two roofs in this project among the few remaining.

When inspected during the opening up works of February 2023, the slate panels and joists in both roofs show signs of water staining, likely caused through a mixture of water ingress and condensation. Water ingress has been spotted in multiple locations in the rooms below, causing damage to the existing walls and ceiling finishes, as well as original cabinets, door architraves and mouldings.

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01. Slate joist supported by cast iron beam within roof void of B/3/X03
02. Flaking bitumen and disused pipe over B/3/X03
03. Brick piers within roof void of B/3/X04
04. Core through B/3/X04 down to patent slate panel

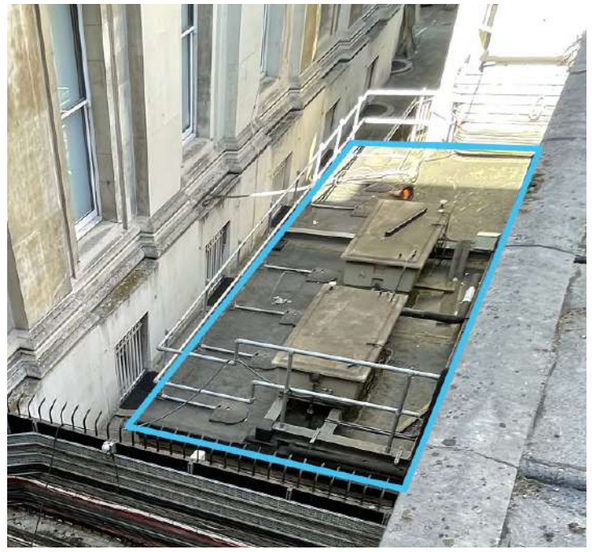
Existing Condition—

Felt Roofs

B/2/X01 is over an infill section of building built between 1926-1965, which today has a felt roof covering over a timber deck, supported by timber joists.

B/2/X02 and B/2/X03 are flat roofs over small buildings built between 1966-1985. B/2/X02 has a felt roof covering built over a screed set to falls, supported by a concrete slab roof structure. B/2/X03 has a felt roof covering over a timber deck, supported by firings on timber joists.

These infill sections came long after the Sydney Smirke designed sections of building they connect to, and are not mentioned as having any significance in the 2008 CMP. The walls are built from brick, with concrete lintels over windows and doors, which are steel and timber construction respectively. The felt roofing is life-expired and its failure has led to water damage to the timber deck and joists of B/2/X01 and B/2/X03, the latter of which has been damaged extensively.



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01. Photo of B/2/X03 (outlined in blue) taken from gantry on B/3/X04
02. Photo of B/2/X03 (outlined in blue taken from below
03. Photo of B/2/X01 (outlined in blue) taken from window of contractor's desk
04. Photo of B/2/X02 (outlined in blue) taken from window of contractor's desk

Existing Condition—

Interiors

The spaces beneath the roofs are not described as having specific historical significance in the 2008 CMP, however it does note that the Sydney Smirke designed interiors of the east residence hold collectively high significance not only for the quality of their surviving architectural features but also examples of high-status dwellings.

The rooms in the Smirke portion of this project have plaster walls, ogee door and window architraves, with recent additions including services mounted to the walls and soffits unsympathetic to the existing spaces. The primary damage related to water ingress has occurred to the slate ceilings and the upper portions of the walls, which show signs of staining and flaking paintwork.

The store room has no features of historic interest, with timber-boarded and painted walls and ceilings. There are some signs of staining to the boarded ceilings.

The WC space has no features of historic interest, with plastered and painted interiors and contemporary sanitaryware. Much of the paint on the ceilings and walls is flaking due to water ingress/ condensation issues.

The rooms in the Security Welfare space built between 1966-1985 are very basic, with plasterboard walls and ceilings, steel-framed windows and modern floor coverings. These spaces have been severely damaged by significant water ingress and the floor finish removed. The plasterboard ceilings have subsided in places and there is significant staining to the walls.

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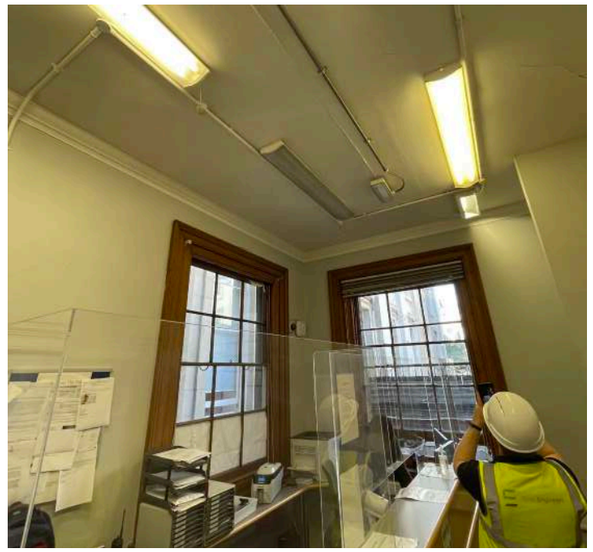

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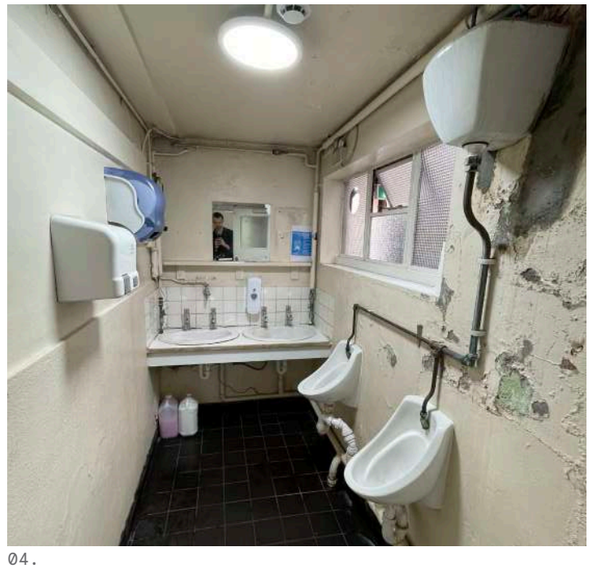

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01. Interior of contractor's corridor below B/3/X04
02. Interior of contractor's desk below B/3/X03
03. Interior of store room, below B/2/X01
04. Interior of contractor's WC below B/2/X02
05. Interior of security welfare hut below B/2/X03

Planning History—

In 2019, consents 2019/5640/L and 2019/5569/P for replacing sections of roof over the south colonnade and south-east wing included permission to replace the five roofs in this project.

Initial permission was granted for full survey access for a design team to complete roof void surveys for all of the South Colonnade and east range roofs. The application correctly identified the three existing bitumen felt roofs, however incorrectly identified the slate roofs, with B/3/X03 shown as copper and B/3/X04 as lead covered over with felt. Although works from this application have been part implemented over areas of the south colonnade, no works were undertaken to the five roofs covered in this application.

In December 2022, consent was granted via exchange of letters for the opening up works from above and below the roofs within this project, to identify their build-ups and condition. The openings proposed within these works have been undertaken and the findings presented as part of this document. As agreed in the consent, the openings have been temporarily patched from above and below as the roofs await a full renovation.

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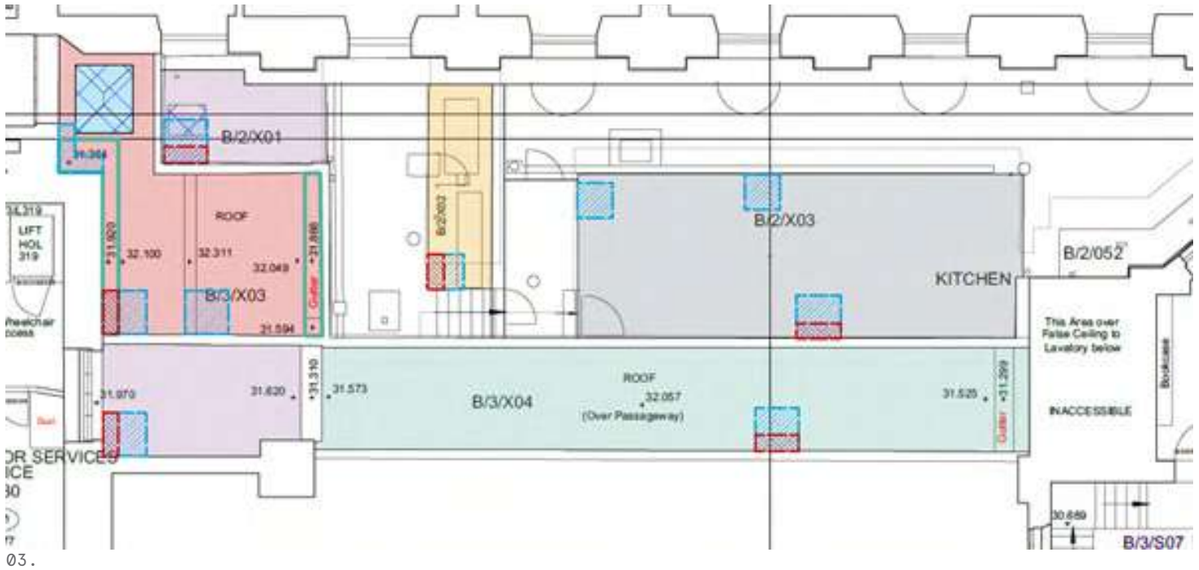

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01. Core taken through B/3/X04, showing asphalt covering, screed and slate roof panel
02. Ceiling opening beneath B/2/X03, showing timber joists, insulation and desk
03. Roof plan showing consented opening up works
04. Roof void of B/3/X03, showing slate roof joist, lath and plaster ceiling and cast iron beam
05. Ceiling opening beneath B/2/X01 showing timber roof joists and deck

Development of Proposals—

Slate Roofs – Structural Appraisal

Given the historic importance of both the rare patent slate roof covering, but also the slate structure, it is proposed that both these elements remain preserved supported and encapsulated to the greatest extent possible as part of the works.

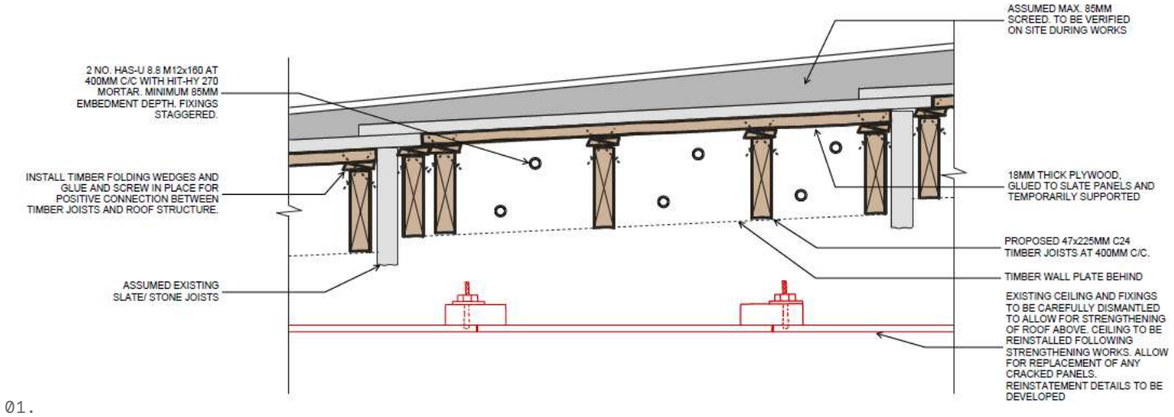
There are two main challenges presented by the existing slate roof; the first is its failure from a waterproofing perspective, with water penetrating through the roof and into the rooms below; the second is that the roof has an unusual structure with slate used as primary structure to support it. Whilst the roof has stood for circa 170 years, it is difficult to justify these materials in their current state or to allow future maintenance access to these roofs. It is therefore proposed by the design team's structural engineer to strengthen these roofs for future safety and longevity, and whilst doing so strengthen them enough to safely allow maintenance access.

The proposal is for new timber reinforcement to be inserted within the existing roof void between the slate roof and stone/slate ceiling. This will ensure the structural stability of the roofs with regard to their own dead load, and have the benefit of enabling live load, allowing people to walk on the roofs for inspection and maintenance. The new timber will not be bonded to the slate, making it possible to remove and reverse the intervention. An impact to the existing fabric will be the fixing of new timber wall plates to the inside face of the existing masonry walls, although this will not be visible once the roof void is closed up.

This reinforcement would require either the stone/slate and lath and plaster ceilings to be taken down, or the slate roofs removed, to allow the new structural members to be installed. The current proposal is to carefully remove the stone/slate ceiling panels, aiming to unbolt the panels from their joists and lift them from their bearings into the masonry wall, thus removing the panels whole in their original sections. There is a risk that some panels may crack as they are being removed, therefore the intention would be to replace like-for-like, if this occurs. The ceiling may also require some additional timber structure, which would be connected to the slates via a similar methodology as the original slate joist connections, with any fixings concealed and not seen from below.

For the small section of slate ceiling at the west end of the contractor's corridor, levels from the building survey suggests the roof void reduces to zero at around the gutter. If this is the case, the ceiling would need to be lowered by circa 250mm to accommodate new structure to the roof. This would bring the ceiling to the same level as the rest of the corridor, retaining a height of 3.4m, down from 3.65m.

For the lath and plaster ceiling, the intention is to fully remove this and replace this like-for-like, possibly reusing the original timber joists if deemed in suitable condition on their removal.



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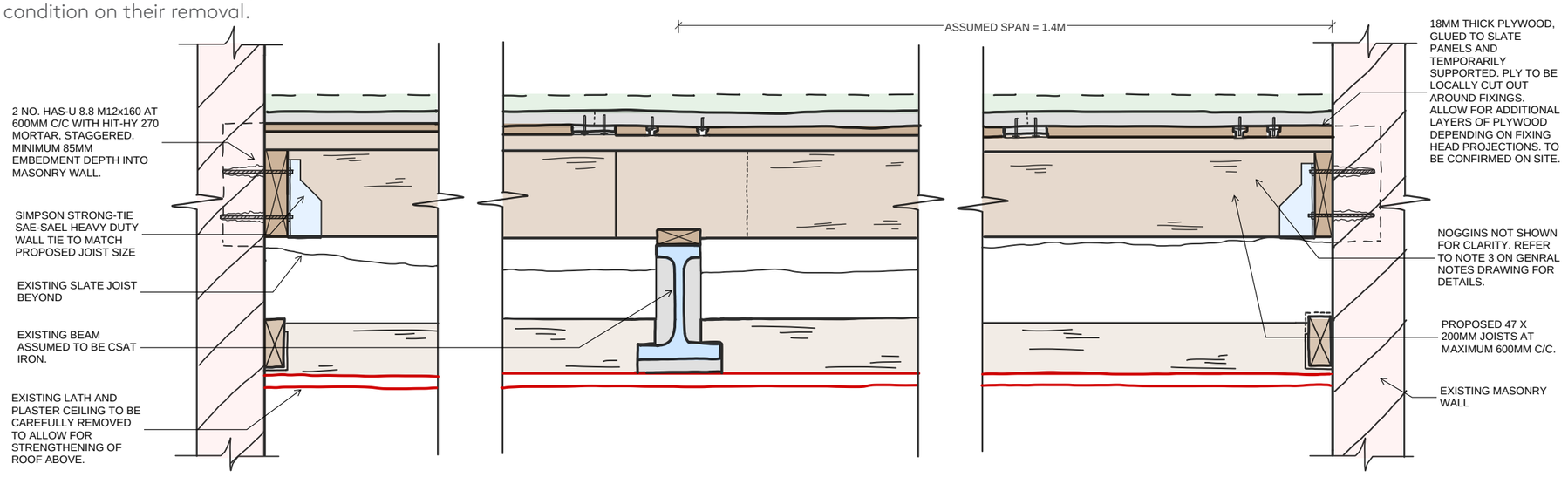

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01. Structural Engineer's section of the proposed structural reinforcement to B/3/X04
02. Structural Engineer's section of the proposed structural reinforcement to B/3/X03

Development of Proposals—

Slate Roofs – Waterproofing Options Appraisal

Regarding waterproofing, 4 primary options were reviewed as potential options:

— Option 1: Retention and full restoration of slate roof coverings and ceilings
— Option 2: Retention and light touch repair of slate roof coverings and ceilings
— Option 3: Retention and encapsulation of slate roof with insulation and cold applied membrane and retention of slate ceilings
— Option 4: Replacement of slate roofs with new copper roof, with the slate ceilings retained.

A summary of our analysis of each option is contained over the next 3 pages.

Options 1 & 2 – Retention and full restoration/light touch repair of slate roof coverings

As part of our research into the viability of this approach, Nex spoke to a number of architects and roofers who had worked on projects involving patent slate roofs. From this, we gained particular knowledge on 2 projects which have successfully restored patent slate roofs of this nature, one at St. George's Church, Everton and another on the Government estate on Whitehall, London.

Both of these projects employed a similar methodology in repairing the roofs, where the original slates were lifted and the substructure - in these cases formed from timber and iron - were inspected and repaired. In the project at St. George's, it was estimated that around 40% of the slates were cracked and damaged as part of this process, and needed to be replaced. Following repair to the structure, a contemporary sarking felt was laid and ventilation introduced via a timber carrier system mounted over the structure, the patent slate tiles were then returned and strips of Compriband – an expanding foam tape typically used to seal gaps around windows in contemporary construction – was used to seal the butt joints between the slates. This joint was then covered over with an 'over-seal slate' for weathering.

The project on the Government estate used a lead flashing with mastic to seal the gap – similar to the presumed copper flashings on B/3/X03 within this project. Both of these projects are reported to be successful in regards to repelling water ingress, with no further leaks reported since their completion within the last 10 years.

The key property that both the above projects shared was that the roofs were pitched between 20-40 degrees, meaning they were able to act as true pitched roofs, where water runs off quickly via the partially lapped slates, without gathering and pooling, which would risk the water penetrating joints or small cracks in the slates themselves. The pitch also protects against driving rain, with any rain that does penetrate likely to run off within the ventilated void between the slates and sarking felt.

A key concern of the design team in relation to restoring the slate roofs in this project is that the two slate roofs are pitched between two and five degrees - a pitch typically considered only be appropriate for a flat roof covering - and well below the minimum 20 degree pitch recommended in British Standard for Slating and Tiling (BS 5534).

This low pitch puts the roofs at significant risk of water ingress via typical rainfall and especially driving rainfall. A roofing subcontractor working with Donald Insall Associates on a project investigating refurbishment of a similar patent slate roof found at the Palace of Westminster advised Nex that they had carried out a test on a sample of refurbished patent slate roof construction with the Building Research Establishment (BRE) as part of their investigations.

Here, a similar detailing and methodology as used on the projects at St. George's and the Government Estate buildings was constructed, with mastic and Compriband used to seal joints in a sample section of patent slate roofing made up, with sarking felt beneath. The sample construction failed the BRE test on both attempts undertaken, with the driving rain test creating the main issue each time, penetrating the roof surface. This roof sample was built at a steeper pitch (seven degrees) than the two/five degrees respectively of the two slate roofs on this project, making the roofs of this project even more likely to fail than the roof tested.

The advice of the roofing subcontractor on the Palace of Westminster project was that if the patent roofs of this project to be restored to their original form, even using contemporary mastics/putties/foam to seal gaps, they would fail to prevent water ingress from day one, worsening over time as the seals degraded.

Due to our research and analysis, the design team does not consider the partial or full restoration of the roofs in their original form to be an appropriate or practical solution for the building and its use, especially given that the historic fabric beneath the roofs, which would be further exposed to damage from water ingress if the roofs are not properly weather sealed.

01. Installation of Compriband over new timber structure at St. George's Church, Everton
02. Finished patent slate roof at St. George's Church, Everton

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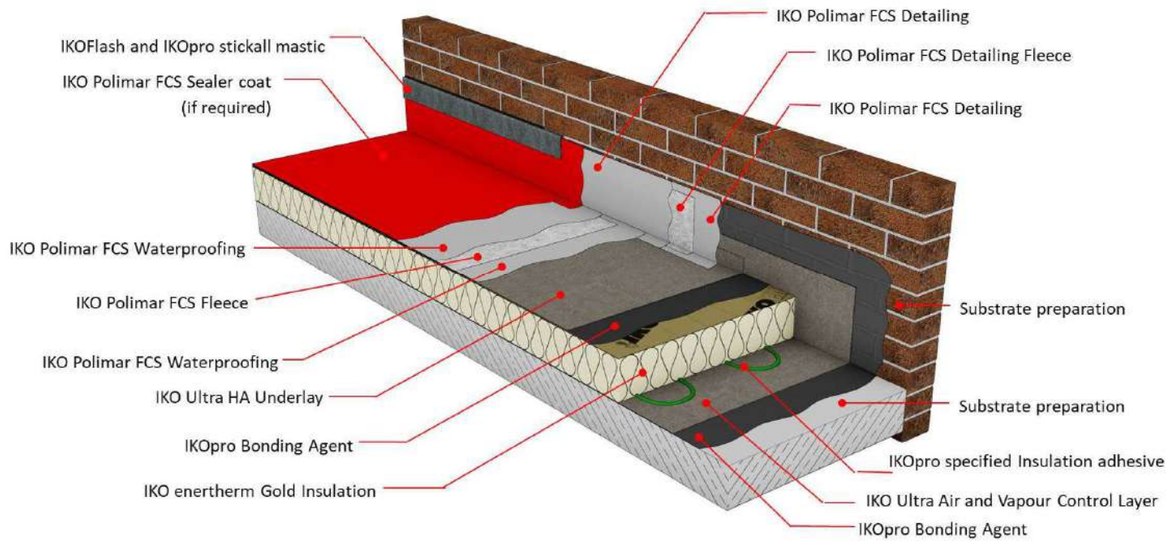
Development of Proposals—

Option 3: Retention and encapsulation of slate roof with insulation and cold applied membrane and retention of slate ceilings

Following the investigation into the possibility of restoring the slate roofs to their original forms, Nex investigated a number of options to encapsulate the slate roofs from above, at the same time investigating to see if there was an opportunity to introduce insulation to the construction, to improve thermal performance and mitigate risk of condensation, which is potentially currently contributing in part to the current water ingress.

After interrogating a number of materials and options, Nex arrived at an option to introduce a cold applied liquid roofing membrane over the slate roof construction. This would be carried out by bonding a vapour barrier over the entirety of the existing roof constructions, before laying varying thicknesses of roof insulation over the top, to create a flat roof system compliant with contemporary flat roofing guidelines and principles, with the exception of a couple of locations where the junctions with existing parapets don not allow the modern day recommended upstand heights, without needing to raise the height of the existing parapet levels. It is considered too harmful to the existing integrity of the Sydney Smirke building to raise the parapets, and therefore bespoke details will be developed for these areas, to allow the parapet levels to remain as they are.

This methodology would create a robust flat roof finish, eliminating water ingress and protecting the spaces below, whilst retaining the existing fabric immediately beneath. The main impact to the original fabric this option poses is the method of fixing to the screed/slate substrate. The vapour barrier would typically be bonded to the substrate in normal roof construction, which leaves the risk that if it were attempted to remove the barrier in future it could leave residue on or damage the substrate. We will look to develop a methodology for removal, and review options with lower adhesion bonding agents to allow it to be removed more easily. The use of a felt covering was also considered, but the liquid system was chosen for its ability to deal better with the complexity of the existing roof contours, and its smarter appearance.



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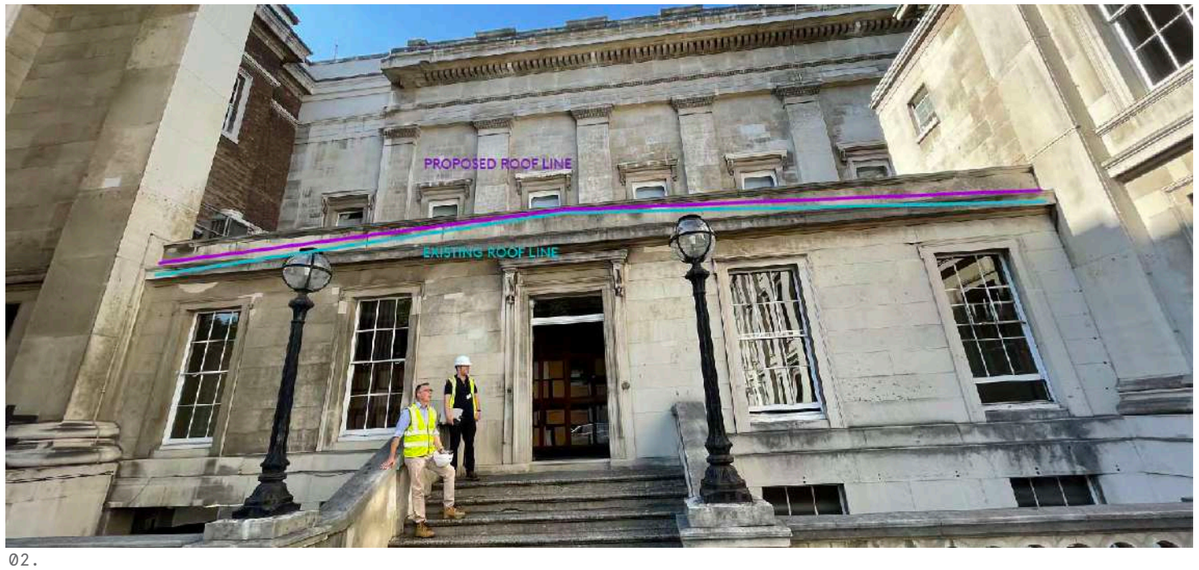
01. Typical buildup of cold applied liquid roofing
02. Existing and proposed roof level of B/3/X04
03. Proposed gutter and flashing of B/3/X03
04. Photo of liquid membrane on a completed project



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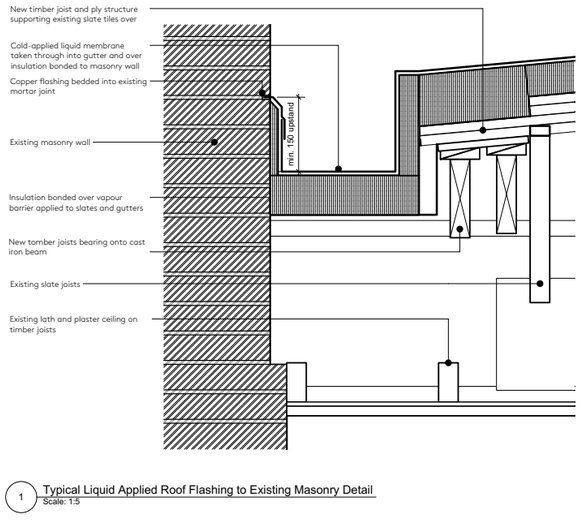

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Development of Proposals—

Option 4: Replacement of slate roofs with new copper roof, with the slate ceilings retained

A further option explored by Nex was to remove and replace the existing slate roof coverings and structure, and replace with new steel and timber structure and a new copper roof, retaining the original ceilings. This option has the benefit of leaving the lath and plaster and stone/slate ceilings in place, and introducing a roof in keeping with other areas of the Sydney Smirke design at the Museum, which would both be a robust covering to prevent water ingress and a more visually attractive and appropriate covering than a contemporary membrane.

The large downside of this option is the loss of the original slate roof covering and the slate structure. Some of the slate joists could potentially be retained alongside new structure, but would likely also need to be removed to allow for the new copper roof, which would require its own steps and falls to be formed in line with contemporary guidance.

Summary

The design team and Museum are in agreement that Option 3 - to retain and encapsulate the slate roofs with insulation and a cold applied liquid membrane, lifting and retaining the slate ceiling - is the best option for the project.

This strategy will create two robust, insulated roofs, whilst retaining a larger proportion of the historic fabric. By reinforcing the roof structure along with the waterproof coverings, the proposals would protect the roofs going forward, as well as the spaces beneath.

The museum will monitor for any condensation that arises after the works. However, from the calculations provided by insulation suppliers during the design process, this is not anticipated, as the roofs will become warm roof via the introduction of insulation.

Roof Lantern

The existing roof lantern towards the north end of B/3/X03 has one cracked pane and is demonstrating signs of water ingress around the bottom edge of the reveal, likely penetrating at the skylight upstand detail.

The skylight appears to be non-original, formed of aluminium framing and wired glass, and possibly replaced a previous skylight in its location. As part of these works, it is proposed to be replaced like-for-like with a new aluminium framed roof lantern, with clear safety glass. This is considered the best option to prevent water ingress in the area, by installing a new skylight with new seals, and providing the opportunity to renew the upstands in accordance with contemporary guidance.

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01. Copper roofing on the Sector A roofs at the east of the British Museum
02. Copper roofing of the dome over the Round Reading Room at the British Museum
03. Existing skylight

04. Existing reveal from within roof void
05. Example product for proposed skylight

Development of Proposals—

Felt Roofs – Options Appraisal

For the existing felt roofs, it is proposed to replace the timber structure where it is damaged and apply a new felt roof covering over new insulation to all. Given the dates of construction and existing materiality used for these roofs, it is considered that this will provide a robust and appropriate solution, without any loss of historic fabric. The design of these elements will pay careful attention to the flashing and structural connection details to the Robert and Sydney Smirke sections of the building they abut, to ensure minimal impact to the existing masonry.

Access - Mansafe System

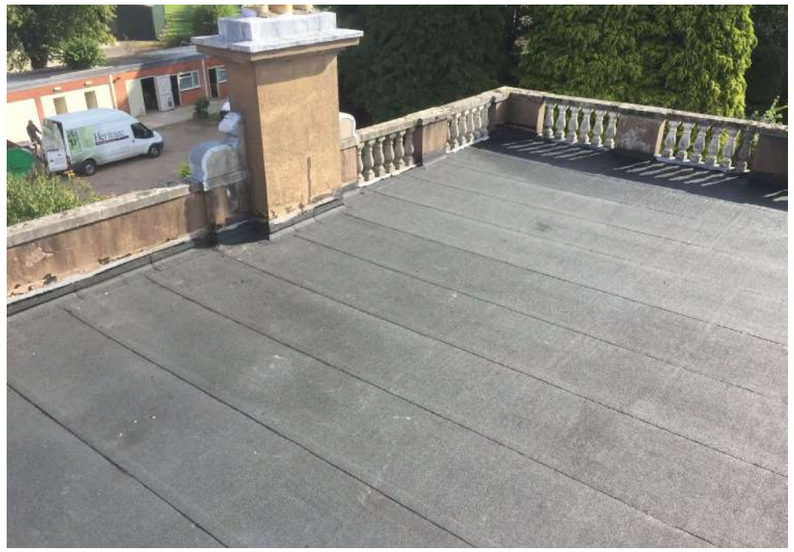
For the B/2/X03 roof, where there is currently an existing rail system, it is proposed to replace this with a similar rail system in the same layout. This system provides the most convenient and safe access to the roof, and the obscured location of the roof to public view results in de minimus visual harm to the building.

For the other roofs of the project, a clip on cable system is proposed, fixing on to the new felt roofs and into the walls adjacent to the slate roofs.

By installing a mansafe system on every roof of the project, future inspection and maintenance can be carried out, ensuring regular maintenance to ensure their longevity, and easily inspect any issues that arise in the future. This has benefit to the roofs themselves, but also to the adjacent external wall fabric and interiors, to ensure any future water ingress is identified and dealt with in a timely manner.

Exterior and Interior Repair/Refurbishment

As described in Nex's drawings, missing areas of mortar are to be repaired externally, fences, doors and windows are to be repaired, repainted and reoiled as necessary and internal walls and mouldings will be repainted, to refresh the internal spaces alongside the new and refurbished ceilings.



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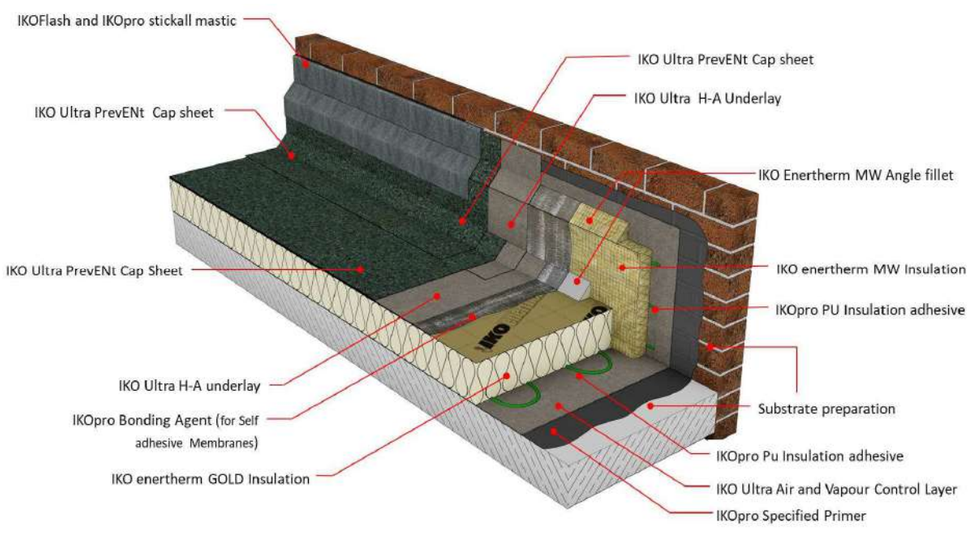

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01. Photo of felt roofing on a completed project
02. Typical buildup of felt roofing over insulation
03. Existing rail mansafe system on B/2/X03
04. Photo of clip on wire mansafe system

Development of Proposals—

Mechanical and Electrical Plant

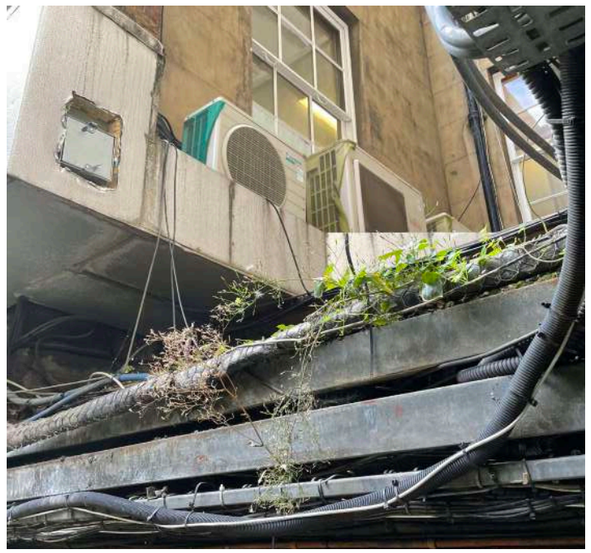
The items of mechanical plant atop the three felt roofs and on the gantry over B/3/X03 are deemed by the design team to be life-expired and in need of replacement. The intention is to replace the items with new models in the same locations, to avoid direct impact on the roofs with historic significance.

New mechanical plant will be mounted on a Big Foot system to allow no penetrative fixings through the roof membrane, as well as easy future removal and replacement.

The large amount of electrical cables running in wall-mounted cable trays mounted predominantly over B/2/X02 and B/2/X03 will be mainly left in place, with temporary relocation where necessary to carry out the roof works, and a rationalisation exercise during the works to remove any cables no longer in use.

The lowest most cable tray above B/X/03 will be removed and the cables in it moved upwards, to create room for the roof to be flashed into the masonry in line with contemporary guidance. Cables currently loosely running between B/2/X03 and the east wing, as well as loosely laid over B/3/X01, will be replaced and rerouted within existing cable tray runs to neaten the appearance of the roofs and ensure they do not obstruct the flow of rainwater or create obstacles for debris to collect at. Any redundant cable trays will also be removed to reduce visual clutter where possible.

All holes within pointing and masonry from the removal of services will be filled to match the existing materials.



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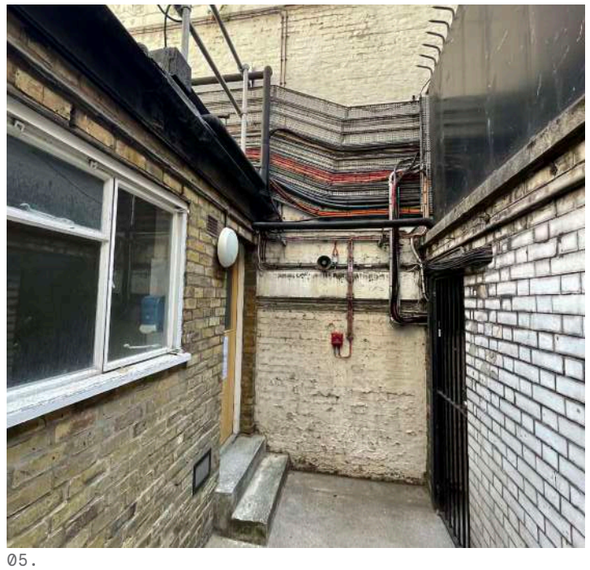

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01. Existing electrical cable runs adjacent to B/2/X01
02. Existing mechanical and electrical plant over B/2/X01 and B/2/X02
03. Existing mechanical plant on gantry over B/3/X04
04. Existing mechanical and electrical plant running adjacent to B/2/X01
05. Existing electrical cabin running over B/2/X03
06. Photo of a Big Foot system

Development of Proposals—

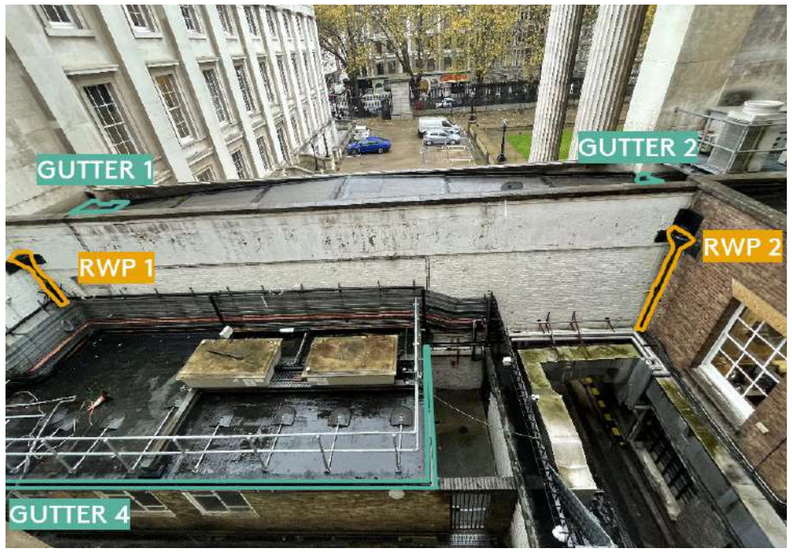
Rainwater Goods

A survey of the existing rainwater goods on the five roofs has been conducted. The rainwater surveyor concluded that the existing sizings of all existing gutters and downpipes was sufficient for existing rainfall, and the worst-case scenarios projected over the next 50 years. The only recommended amendment was to add a further downpipe to roof B/2/X03, to attach to gutter 4. This will be introduced to match the surrounding downpipes, in black painted cast iron, is considered to have de minimus visual impact from a heritage perspective.

The only further works to the rainwater goods are proposed for gutters 4, 5 and 6. These are currently formed from cast iron and are in various states of disrepair, and have been adapted with PVC additions in places. The gutters are proposed to be replaced in cast iron, like-for-like in size and material.

The existing copper gutters 1, 2 and 3 on the slate roofs are proposed to be encapsulated externally, with a vapour barrier, insulation and cold applied liquid membrane bonded over the top in the same configuration as the proposed build up over the slate roofing. This will protect the gutters from water ingress and condensation and leave them in place should they be revealed in future.

All rainwater pipes serving the roofs are proposed to remain in place, and have flaking paintwork stripped and repainted black to upkeep their original finish and protect them moving forwards.



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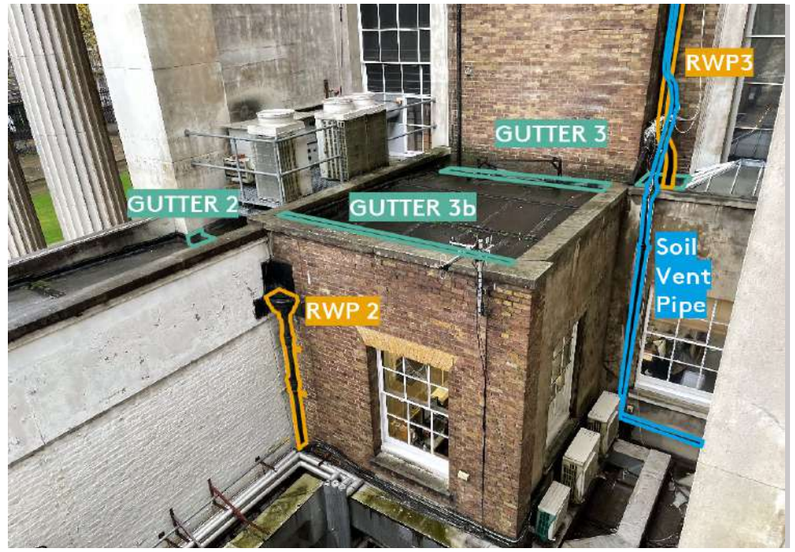

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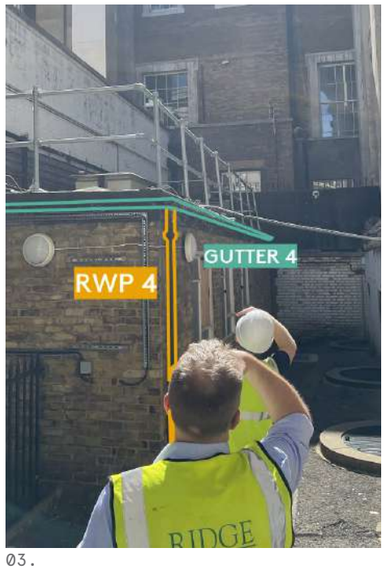

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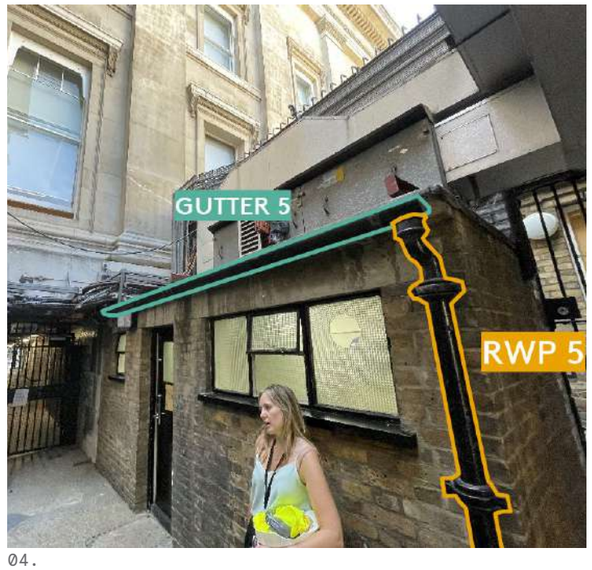

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01. Rainwater goods atop B/3/X04 (above) and B/2/X03 (below)
02. Rainwater goods atop B/3/X04 and B/3/X03(above) and B/2/X01 (below)
03. Rainwater goods top B/2/X03
04. Rainwater goods to B/2/X02
05. Rainwater goods to B/2/X01

Summary & Conclusion—

Summary of Proposals

The proposal arrived at for the slate roofs B/3/X03 and B/3/X04 are summarised as follows:

— Take down the original lath and plaster and stone/ slate ceilings
— Reinforce the existing roof panels with new timber structure
— Return the slate ceiling with new structure, repairing drill holes from opening up works and replacing any slates cracked during their removal
— Replace the lath and plaster ceiling like-for-like, retaining original timber joists where their condition is suitable
— Apply a vapour barrier, insulation and cold applied roof membrane over the existing roof coverings and gutters
— Replace the metal framed roof lantern on B/3/X03 with a like-for-like metal framed replacement.
— Install a clip-on mansafe system, ensuring minimal visual impact from above and to the south, as well as a low profile

The proposal arrived at for the timber joist and felt roof B/2/X01 are summarised as follows:

— Remove felt roof covering and repair existing timber roof joists
— Make good the opening made in the ceiling during opening-up works
— Introduce new tapered insulation and felt roof covering
— Install a clip on mansafe system, ensuring minimal visual impact and low profile

The proposal arrived at for the concrete slab and felt roof B/2/X02 are summarised as follows:

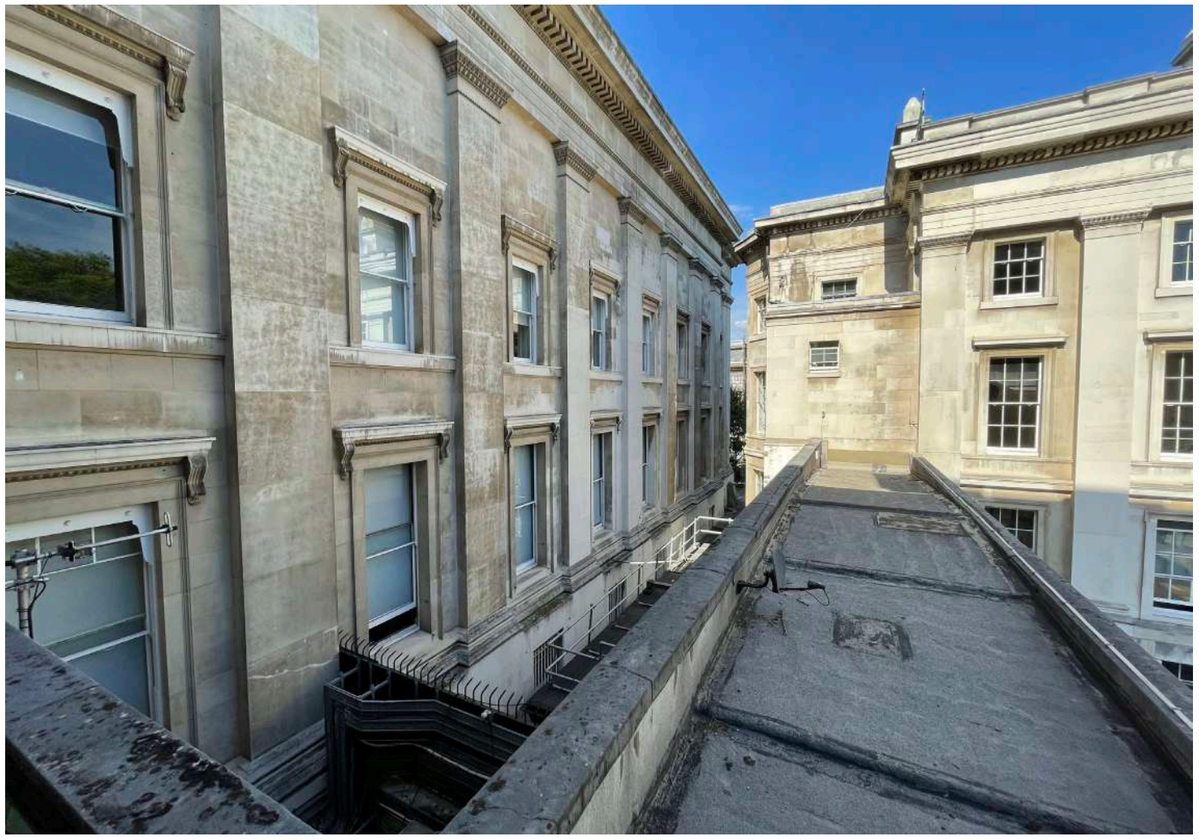
— Remove felt roof covering and repair screed
— Introduce new insulation and felt roof covering
— Install a clip on mansafe system, ensuring minimal visual impact and low profile

The proposal arrived at for the timber joist and felt roof B/2/X03 are summarised as follows:

— Remove felt roof covering and existing timber roof joists and deck, which are severely water damaged
— Replace roof joists in the same location as the original, along with a new timber roof deck
— Introduce new tapered insulation and felt roof covering
— Replace the existing rail mansafe system like for like with a new rail

Conclusion

The proposals outlined in this document will secure the roofs and the spaces below against water ingress, whilst sensitively protecting historic fabric where appropriate. The works also present a chance to improve the thermal performance of the roofs, allow safe future access for maintenance, and replace and rationalise the existing plant housed on the roofs. These changes will serve to improve and protect a series of key functional spaces within the Museum's day-to-day operation.



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01. View over B/3/X04