The design of the below ground drainage alterations needs to be confirmed at the next stage, once we have the results of the upcoming drainage CCTV survey, which will verify the condition and layout of the network.

The road surface will be re-laid and new gullies installed as required by the architect and M&E engineer. This presents an opportunity to lay the road so that surface water runs away from the Duveen building toward the west boundary.

South Range

Internally in the South Range, the heating and electrical services will mostly be distributed within new RC trenches, replacing existing ones that are too small, as shown on drawing 1910/41/311 and 312. The new trenches will be integrated with the existing fabric by working within the available space between loadbearing walls. Brickwork walls and piers at Level 01 support the vaulted level 02 floor. The foundations of these walls consist of deep corbelled brick footings, which are supported on a mass concrete raft to an overall depth of around 2 metres below the Level 01 floor. The proposed trench widths will fit between piers to maintain their existing load paths, as shown in the section below. At these locations an allowance should be made for carefully cutting down the existing brickwork foundations beneath the openings using non-percussive tools to make space for the base of the trench. The proposed trenches are around 0.75m deep, and well within the depths of the existing surrounding substructures.

The new trench will contain 250 mm thick RC walls and base slabs. The trench will be ground-bearing onto the existing fill that sits on top of the mass concrete foundation. A contingency should be made for excavating soft spots (poorly compacted fill) and replacing with well-compacted new fill. Joints will be provided in the new trenches every 30m to allow for thermal movements.

The lid to the new trench needs to be robust to deal with heavy loads, as the Museum moves objects around the corridors. We have allowed for a 150mm RC cover slab, which will require local openings for access to the services every roughly 10m-20m as defined by the services engineer. Alternatively, proprietary liftable systems such as steel trays or pre-cast concrete could be explored at the next stage if the Museum's maintenance team would prefer more regular access into trenches.

In some parts of the South Range, above ground drainage runs have been incorporated into the existing trench. In these areas, the above ground drainage needs diverting temporarily and then re-laid within the new trench as specified by the M&E engineer.

The trench stops on either side of the Botanical Staircase, and the electrical services will run at high level mounted to the walls within the stairwell area. This will require coring through the west wall of the staircase, which will be at low level to avoid undermining the stone cantilever staircase. The openings will be formed with steel sleeves.

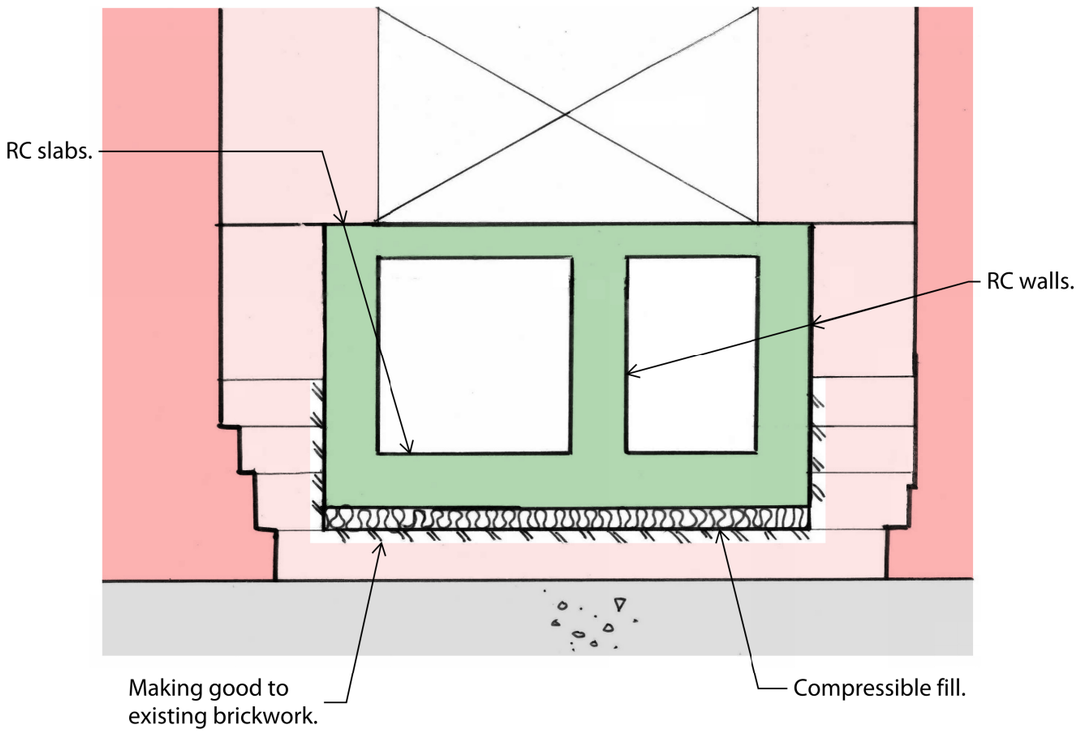

Fig. 25: Proposed internal services trench

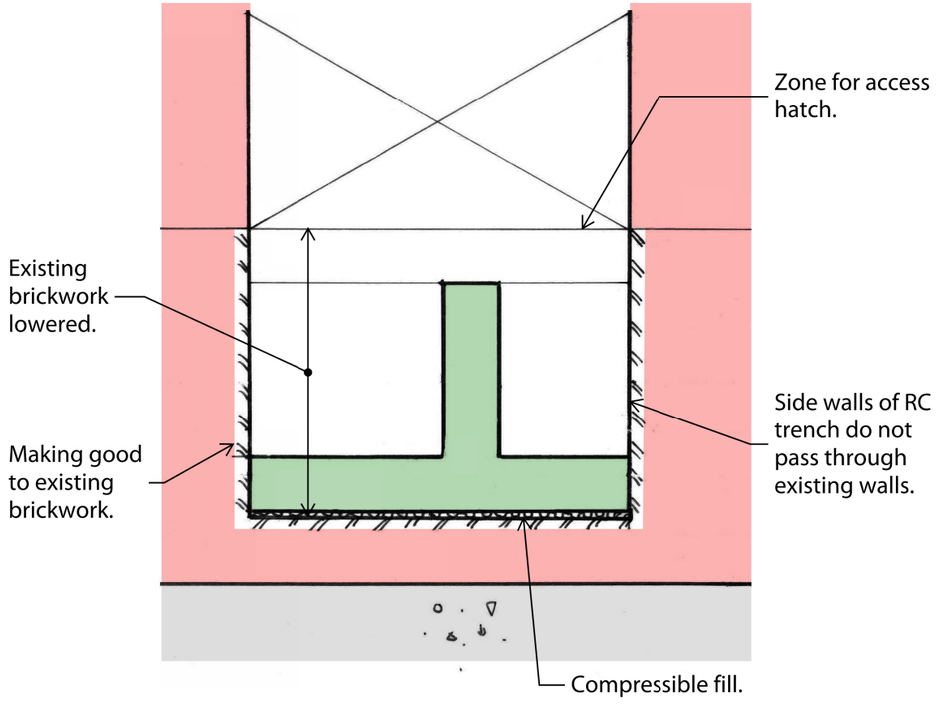

Fig. 26: Proposed internal services trench through existing walls

East Road
The new electrical services will be buried within the East Road. The principles are similar to the West Road. Below ground drainage diversions are needed at the south and north ends of the road to create space for the new services, as shown on drawings 1910/41/313 and 1910/41/314.

A new RC trench is proposed to connect the new ISS to the East Road distribution route. This trench will run between the north façade of the White Wing and the south façade of the existing substation. There is an existing external steel staircase on the route, which needs to be dismantled during the works and re-erected and supported on the trench once installed. Local alterations will be needed to the below ground drainage network along the service trench route. In addition, one of the White Wing lightwells needs to be reconfigured slightly to accommodate the new services, as shown on drawing 1910/41/312. A new RC trench is also proposed to connect the ERB to the North Range internal corridor, as shown on drawing 1910/41/314.

North Range
In the eastern half of the North Range a new trench is proposed to accommodate the mechanical services, with similar principles to the South Range, as shown on drawing 1910/41/315. The electrical services will run above ground externally and discussed further in the M&E Engineer's report.

Calorifier Room 1
Some low-key alterations are needed in the Calorifier Room to incorporate the new heating services. Builderswork openings, such as local coring, is proposed in the reinforced concrete floor slab at level 01 to allow services to enter the Calorifier Room 1 at level 00. To improve the access into the plant room, an existing door opening will be widened with new steel lintels, as shown on drawing 1910/41/318.

Secondary plant rooms
There are many existing plant rooms at Level 01 through the Museum where services will be replaced. We have viewed all areas with the M&E Engineer on site and looked at all existing openings available for resuse to limit interventions in Grade I listed fabric. The M&E Engineer has confirmed that they can reuse the existing openings without additional openings.

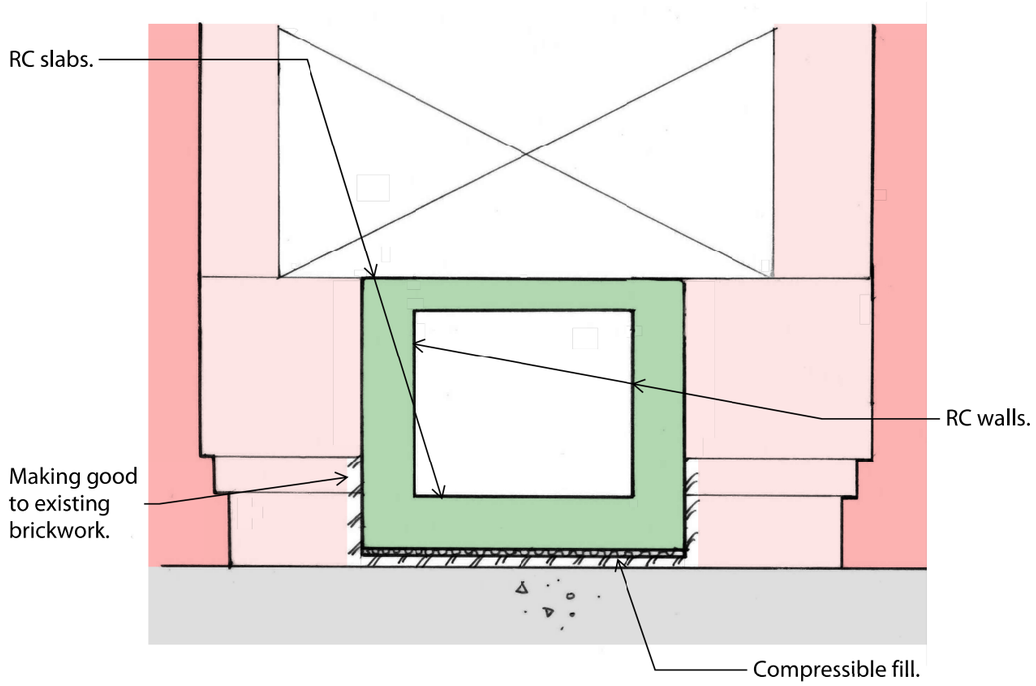

Fig. 27: Proposed internal services trench in North Range

6.0
Sustainability

6.1 Targets and aspirations

We have discussed sustainability measures with the team and, from a structural engineering perspective, looked at a range of measures that achieve robust and adaptable structures serving the Museum for the long term. We have assessed the embodied carbon of various options and identified opportunities to save embodied carbon in the structure. A whole life cycle assessment of the buildings is being carried out by Eight Versa, with input from the rest of the design team. The Museum has set BREEAM Excellent targets for the buildings.

6.2 Proposed scheme

At Stage 3, we have continued to refine the proposed SWEC structure, particularly the floor structure throughout the building. We identified that by making the steel beams and metal decking slab act compositely with shear studs, the steel beams throughout the building could be reduced in size and weight by roughly 40%. This saves a significant amount of steel throughout the building. The design team changed the services distribution strategy in West Road so that an RC trench is no longer needed here. This saves a significant amount of materials and embodied carbon.

6.3 Sustainable design measures

- We have considered the longevity of the new buildings and their future adaptability and developed the structural arrangements and grids in tune with this so that future changes to internal layouts do not trigger significant structural works.
- We have refined the floor structure, and by adopting composite steel and concrete, profiled metal decking floors, we have reduced the weights of the steel beams.
- We are proposing reusing the existing foundations of the SWBH and will consider whether the existing foundations of the portacabins can be reused once they are exposed.
- We have compared shallow pad foundations vs deep piled foundations for the SWEC building and developed a shallow foundation design that limits the use of concrete in the ground and spoil removal from the site.
- We have also considered the concrete design and using cement replacements to reduce the embodied carbon in the concrete.
- We have evaluated the SuDs options available on these sites and discussed these in detail in section 5.
- We have also worked closely with the services engineer to assist in integrating services into the buildings in a practical way that offers flexibility for the future without major structural intervention.

6.4 Actions as part of post-planning design

- Continue to consider the assumed sequence of construction to identify opportunities to reduce temporary works and material transported off-site.
- Develop an efficient detailed design.
- Identify how demolition materials could be reused or salvaged on this site or elsewhere.
- We will continue to work with the services engineer to integrate services efficiently into the estate.

7.0
Next steps

- Site-wide CCTV surveys of the below-ground drainage.
- Review water table monitoring results at the SWEC (results expected September 2023)
- Agree with the Museum on which SuDS option to take forward for the SWEC.
- Site investigations at the ISS will be undertaken once the portacabins have been removed (we understand this is planned for early 2024).
- Consider whether any investigations or opening up works are needed to complete the services distribution design.
- Develop the structural proposals for RIBA Stage 4.
- Agree with UKPN on their requirements for the structure of the ISS.

Alan Baxter

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75 Cowcross Street
London EC1M 6EL
tel 020 7250 1555
email aba@alanbaxter.co.uk
web alanbaxter.co.uk