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King's Cross Package 6

Structural Alterations

					Acceptance on behalf of Network Rail and JMP		
Rev	Prepared by	Date	Approved by	Date	Required Y	Accepted by	Date
00	**Ella Feekins**	**24/09/09**	**Nick Glaze**	**24/09/09**	Yes		
	[signature]		[signature]			[signature]	25/9/09

Comments and observations

The following accompanying submission document has been referenced in this document:

ENG-REP-G5-OAP-006-SWNS-0217 Issue 2.0, Arup, 23 June 2009

Other references include:

WRB Removals and Demolitions KXP6/N374/WPP/LBMS/WRB/00006

Proposal for Labelling and Protection of Heritage Items KXP6/N374/WPP/LBMS/WRB/00005

This document has been prepared in order to discharge Condition 05 of Listed Building Consent 2006/3394/L.

Structural Alterations within the Northern Building are excluded from this document and will form part of a future submission.

Please note this document has been prepared to describe the Works for the sole purpose to satisfy Town and Country Planning Acts Listed Building Conditions and is a support document to form a fully developed WPP. This document does not have a full health and safety section within it; please refer to the case specific WPP.

Contents

List of Abbreviations

Documents

LBMS:	Listed Building Method Statement
WPP:	Work Package Plan

Locations

MTS:	Main Train Shed
NRPR:	Network Rail Plant Room
OBS:	On Board Services
OPY:	Old Parcels Yard
WCC:	Western Concourse
WRB:	Western Range Buildings

Organisations

EH:	English Heritage
JMP:	John McAslan and Partners
LBoC:	London Borough of Camden
LUL:	London Underground Limited
MoLAS:	Museum of London Archaeology Service
NGB:	NG Bailey
NR:	Network Rail
TW:	Taylor Woodrow

1.0 Introduction

Network Rail is in the process of redeveloping the Grade 1 Listed King's Cross Station. Planning and Listed Building Consent were granted by LBoC in November 2007, subject to conditions and a Section 106 Legal Agreement. This document is submitted to allow discharge of the following condition from the Listed Building Consent:

- Consent 2006/3394/L Condition 5 requires: "Structural Engineers' calculations, specifications, drawings and method statements, in respect of the following, shall be submitted to and approved in writing by the local planning authority, advised by English Heritage before the relevant part of the work is begun. The relevant work shall be carried out in accordance with such approved details.

    a. structural repairs to the historic fabric of the building;

    b. works to the Western Range buildings associated with the reinstatement of the 'Bomb Gap' area;

    c. alterations to upgrade the existing station buildings for increased loading, fire-resistance, operational railway requirements or disproportionate collapse requirements;

    d. ~~strengthening of existing paired cast iron brackets within the ticket hall. Principles and justification for this work should also be included~~. *(Methodology and design not submitted – design development ongoing)*

    e. addition of new structural floors, concrete slabs and steel frames to the existing buildings;

    f. structural framing of the basement area and ground floor of the southern end of the western train shed, to include details of the new base slab to be inserted under Western Range;

    g. all new openings in existing load-bearing walls (~~including puncture through parapet for rafter of new skylight roof~~); *(No longer in the design proposals for the roof)*

    h. alterations to existing stairs, including modifications for strengthening purposes, and installation of new lifts and stairs in existing buildings;

    i. all new extract ducts, smoke risers and other vents to be installed in existing buildings;

    j. structural interface between the new concourse and the Western Range;

    k. ~~structural interventions affecting Platform Y, and associated works to the eastern range.~~" *(Methodology not submitted as not part of Package 6 works)*

1.1 Reference documents

- Listed Building Consent
  2006/3394/L
- Planning Consent Reference 2006/3394/L Number LB05 Existing Structures Design Approvals
  ENG-REP-G5-OAP-006-SWNS-0217
- Proposal for Labelling and Protection of Heritage Items
  KXP6/N374/WPP/LBMS/WRB/00005
- LBMS for Removals and Demolitions
  KXP6/N374/WPP/LBMS/WRB/00006
- LBMS for Roof Repair and Renovation
  ENG-LBMS-TWC-WRB-CBSA-00010
- LBMS for Brickwork Repairs
  ENG-LBMS-TWC-WRB-CBSA-00008
- Masonry Proposals
  ENG-LBMS-TWC-WRB-CBSA-00011
- Civil Specification Volume 1: Piling
  ENG-SPE-G5-OAP-006-CSTR-0143
- Civil Specification Volume 7: Structural Steelwork for Works Excluding the Western Concourse Roof
  ENG-SPE-G5-OAP-006-CSTR-0151
- Master Building Services Specification Volume 6: Technical Specification
  ENG-SPE-G5-OAP-006-CBSM-0134
- Archaeological Specification
  ENG-SPE-JMP-G5-SWNS-0002
- Building Recording Specification
  ENG-SPE-JMP-G5-PA-SWNS-0001
- Salvage Strategy
  ENG-REP-JMP-G5-PA-SWNS-0006

2.0 Scope of Works

2.1 Purpose of structural works

This document describes the methodology to be used for construction of the structural works proposed for the Western Range Building, including structural repairs, foundations, strengthening, new openings and structural framing. The works are in connection with the provision of new passenger and operational facilities for King's Cross Station.

Each description of structural work is cross referenced against Condition 5 from Planning Consent 2006/3394/L and against the protection control matrix in Appendix A. Each method of working and control measure detailed in this document is intended to minimise the disruption to the historic fabric of the WRB and comply with best practice. Structural works will be undertaken in accordance with the accepted documents and drawings referenced in ENG-REP-G5-OAP-006-SWNS-0217. Temporary works proposals are submitted for the piling platforms required for installation of permanent works and these can be found in Appendix C Temporary works drawings.

Protection and salvage of heritage items (KXP6/N374/WPP/LBMS/WRB/00005) and demolition works (KXP6/N374/WPP/LBMS/WRB/00006), including most of the temporary works, that are required to enable the major structural works to be undertaken are described in detail in their respective consented LBMS.

2.2 Identification of structural zones

The works are split into five structural zones as defined on the plan in Appendix B.

Zone 1 consists of the **Northern Building**. *Not part of this submission.*

Zone 2 consists of the **North West Building** and the **Link Building**. The works include the installation of a new steel support frame with piled foundations in the North West Building, and modifications to the atrium involving replacement of the tensioned drop rods and installation of a new glazed roof and support steels. There are new lifts and risers to be constructed in each building and new stairs to the roof.

Zone 3 consists of the **Northern Wing** and the **Bomb Gap**. The works incorporate a reinforced concrete frame with piled foundations between grid lines W21 and W22, which enables a new walkway to be completed between Platform 8 and the WCC Mezzanine. There is a new lift to be constructed. There is a reinforced concrete frame with piled foundations between grid line W18 and W20, which connects to the new Bomb Gap structure and replaces the existing damaged and bulging Northern Wing gable end. A new reinforced concrete ramp is to be constructed to connect the new concrete frames. New roof steelwork is to be installed over the Northern Wing and Bomb Gap and the Bomb Gap façade is to be reinstated.

Zone 4 consists of the **Central Block**. The main works are related to the refurbishment of the old booking hall and installation of new steelwork and a metal deck and concrete slab at roof level to support new items of plant. There is also a new reinforced concrete lift shaft with piled foundations to be constructed. Parapet strengthening repair works are required on the roof and new roof steelwork is to be installed to the east side to tie into the Bomb Gap roof. A new staircase and risers are to be constructed.

Zone 5 consists of the **Southern Wing**. The works include the construction of a new reinforced concrete frame at basement and ground floor level, which facilitates the removal of load bearing walls and forms a walk through from the WCC to Platform 8 at ground floor. There is also a new lift and stair to be constructed.

2.3 Competency

All work will be undertaken by competent contractors appointed in accordance with the Project Procurement Strategy, which has been reviewed and approved by NR and JMP. Site staff responsible for supervision and control of the works, from TW and their appointed Sub-contractors, will be experienced in the assessment of the risks involved and control measures required. Operatives responsible for undertaking the works will have training and certification appropriate to the

work activity. All operatives will be briefed on the importance of the Grade 1 listed structure and the need to protect the building fabric throughout the works.

TW has also appointed a Heritage advisor to review works and provide advice to facilitate the works and to ensure that all protection measures are appropriate.

3.0 Method of work

3.1 Foundations

3.1.1 Piling

The following piled foundations are required within the WRB:

- Piling in Zone 2 to support a new steel frame that will support, repair and strengthen the North West Building;
- Piling in Zone 3 to support a concrete frame required to meet operational railway requirements (Bridge Link);
- Piling in Zone 3 to support a concrete frame associated with the reinstatement of the 'Bomb Gap' area and the north gable end of the Northern Wing;
- Piling in Zone 4 for lift installation required to meet operational railway requirements;
- Piling in the OBS tunnel area adjoining Zones 2 and 3 is required to meet operational railway requirements and link the new NRPR to the WRB. 1 no. 900mm pile is required to support the OBS structure.

The internal **piling operations** will be undertaken in accordance with Civil Specification Volume 1: Piling. The piling technique to be used is bored, cast in situ and a low headroom piling rig will be used. This technique is appropriate in an environment requiring low vibration. A designed piling platform will be installed to ensure stability of the rig and the proposed piling platform for Zone 3 is detailed on the temporary works drawings in Appendix C Temporary works drawings. The design includes temporary support required to ensure the WRB structure is stable under imposed loadings from the piling platform and measures to protect the building fabric from the piling mat and piling operations.

The piling platform is formed from polystyrene blocks and sand fill, which can be removed simply and without disturbance to the building fabric; pressurised air tools will be utilised to remove sand at the interface with the existing structure. Measures to protect the building structure and fabric include timber supports at pre formed demolition created openings and edges. Road plates at transition zones and junctions will be used to uniformly distribute the loading of the trafficking plant. Each pile will be cased into sealed strata to ensure control of ground water during concrete placement.

The structural alterations required to enable these piling activities will be undertaken in accordance with the LBMS for Removals and Demolitions.

The external **piling operations** will be undertaken in accordance with Civil Specification Volume 1: Piling. The piling technique to be used is bored, cast in situ piling. Plant will be located clear of the WRB structure. Each pile will be cased into sealed strata to ensure control of ground water during concrete placement.

This section relates to Condition 5:

b. Reinstatement of the 'Bomb Gap' area
c. Upgrade for operational railway requirements
e. Addition of new steel frames
h. Installation of new lifts

Protection control matrix, sections 2, 6, 7, 8, 9, 11 and 13

3.1.2 Underpinning

Underpinning is required in locations where the permanent works will disturb the existing foundations or where temporary load bearing structures are used to maintain a thrust path through to the existing foundations. The extent of underpinning works within the WRB is to be confirmed by excavating trial pits. The trial pits will be undertaken in conjunction with the MoLAS archaeological watching brief that is required as part of the Archaeological Specification and Listed Building Consent Condition 30. These works will be undertaken in accordance with the LBMS for Removals and Demolitions.

The underpinning works currently proposed include the following:

- Zone 5 – steel sections through corbelled brick foundations and mass concrete fill to support the new gate line;
- Zone 2 – mass concrete fill required at the location of new lift pits to stabilise the existing brick footings during these deep excavations.

In Zone 5 it will be necessary to undertake the underpinning in bays along the existing foundations of the spine and cross walls. Small excavators will be used to excavate trenches and the existing corbelled brickwork will be exposed by hand. Diamond drills will be used to form 250mm diameter openings through the exposed brickwork and corbelled brickwork will be removed locally using hand tools. New steel sections will be installed and grouted in place and then mass concrete extensions to the foundations will be poured.

Where mass concrete underpinning is required, particularly at the location of new lift pits in Zone 2, this will be undertaken in bays using a progressive sequence to maintain the stability of the existing foundations. Small excavators will be used to excavate trenches and mass concrete will be poured in the required location. In some cases it will be necessary for the existing footing to be cut away once underpinning is complete to enable the adjacent new structure to be constructed and waterproofed successfully. Waterproofing in the basement is to be an acrylic render.

This section relates to Condition 5:
c. Upgrade for increased loading
e. Addition of new steel frames
f. Structural framing of the basement area and ground floor of the southern end
h. Installation of new lifts

Protection control matrix, sections 2, 7, 8, 9 and 11

3.2 Concrete frames

The recently constructed concrete structure of the Bomb Gap was part of a separate Listed Building Consent application by LUL. Taylor Woodrow are cladding and roofing the structure. To complete the **reinstatement of the 'Bomb Gap' area** in Zone 3 it will be necessary to deconstruct the existing

gable end of the Northern Wing in accordance with the LBMS for Removals and Demolitions. A new reinforced concrete frame will then be constructed to connect the LUL constructed 'Bomb Gap' reinforced concrete structure to the retained structure of the Northern Wing from basement to loft level.

Piles to support the concrete frame will be installed in accordance with 3.1.1 Piling. A reinforced concrete frame formed from slabs, columns and beams will then be constructed in floors using the control measures identified in 4.1 Placement of concrete and grout. Connections into the LUL 'Bomb Gap' concrete structure will be formed using reinforcement couplers that have been cast into the existing frame. Connections into existing masonry will be formed using the following detail:

Refer to Typical detail 16 on Drawing WRB-CSD-0002, which is to be used where a restraint anchor is required between a retained façade and a new concrete floor slab. An opening is to be drilled into the back of the retained façade and a stainless steel threaded rod will be embedded into the existing masonry by a minimum of 300mm using grout. A bond breaker is to be installed at the interface between the retained façade and the new concrete slab and a channel section will be secured to the threaded rod using a nut and then taped up to prevent the channel from filling with grout. The reinforced concrete slab will be cast with a minimum of 100mm anchor from the channel section into the concrete. Where the connection is formed with a concrete column then this detail will be installed at 450mm vertical centres.

To form the permanent structural works for the **Bridge Link in Zone 3** of the WRB an opening will be formed in the existing structure at ground and first floor level in accordance with the LBMS for Removals and Demolitions. Piles will be installed in accordance with 3.1.1 Piling and these will be used to support a new reinforced concrete frame. The frame will be formed from slabs, columns and beams and will be constructed at a lower level compared to the existing first floor level in order to provide level access onto the MTS link bridge. The control measures to protect the heritage fabric during the reinforced concrete construction are described in 4.1 Placement of concrete and grout.

Refer to section 6.1.4 of the Removals and Demolition LBMS for the method of removing the York stone slabs from the corridors.

Adjacent to the western façade in Zone 3 there is a new **reinforced concrete ramp** to be installed to meet operational requirements. The ramp will connect the Bridge Link structure with the 'Bomb Gap' structure and will accommodate the change in level between these areas. New steel beams will be installed between supporting pad stones at cross walls (using the methodology described in 3.3 Steel frames) to permanently support the existing first floor structure. A section of the existing first floor will then be removed by shortening the existing timber joists in accordance with the LBMS for Removals and Demolitions; this opening will accommodate the new ramp structure. The new reinforced concrete ramp will be constructed spanning between cross walls and will tie into the retained façade using Typical detail 16 on Drawing WRB-CSD-0002 (as described above).

A new reinforced concrete frame is required between grid line **W2 and W7 in Zone 5** to facilitate the new ticket gate line between WCC and MTS. The existing structure at basement, ground floor and first floor will be deconstructed in accordance with LBMS for Removals and Demolitions. The existing foundations to load bearing masonry walls will be strengthened using underpinning as described in 3.1.2 Underpinning. A new frame will then be constructed, formed from reinforced concrete slabs, columns and beams, using the control measures in 4.1 Placement of concrete and grout to protect the heritage fabric from the works. The concrete frame will be tied to the existing masonry, refer to

detail 51G on Drawing WRB-CSD-0051. 16mm diameter stainless steel rods will be drilled and fixed into the existing masonry at 500mm vertical centres, the rods will then be cast into the concrete frame as it is formed.

On review of the methodology of construction and the masonry loadings following intrusive surveys, the design has been developed and the openings will now be supported by a steel frame to provide robust support to the retained walls and to coordinate with the pre-stressing of the frame. Refer to 3.7 Openings for details of the method of work.

This section relates to Condition 5:

b. Reinstatement of the 'Bomb Gap' area

c. Upgrade for operational railway requirements or disproportionate collapse requirements

e. Addition of new structural floors and concrete slabs

f. Structural framing of the basement area and ground floor of the southern end

Protection control matrix, sections 2, 3, 4, 7, 8 and 9

3.3 Steel frames

A structural **metal stud inner frame** (Metsec or similar) is required in Zone 3 to enable reinstatement of the 'Bomb Gap' area on the western façade. Refer to section 4.1 Methodology for Construction of Bomb Gap Façades of the Brickwork Repairs LBMS. The frame will be constructed and fitted to the reinforced concrete edge beam at each floor level with head restraint at each level. This support will enable the new western façade brickwork to be tied back in the 'Bomb Gap' area.

Installation of pad stones within existing masonry to support structural steelwork will be undertaken by first replacing or re-bedding any loose brickwork. Brickwork will be removed to the depth of the new pad stone using perimeter stitch drilling to limit and control the opening size; whole, sound, facing brickwork will be salvaged or saved for reinstatement in accordance with the Salvage Strategy and section 4.3 of the Proposal for Labelling and Protection of Heritage Items. The debonding detail between the existing masonry and the new concrete will be installed and then the concrete pad stone will be formed. Once the new steelwork is installed the existing masonry around the pad stone will be made good by dry-packing, grouting and reinstating brickwork as appropriate; grout will be controlled using the measures detailed in 4.1 Placement of concrete and grout.

Generally structural steelwork will be lifted into place onto pad stones and levelled using shims. Loading assessments will be in place where it is necessary to load out steelwork onto the existing floor structures prior to installing in its final position. Once the steelwork is in position, grout will be poured to fill any void between the steel and the pad stone.

A **structural steel frame** is required in Zone 2 to prevent disproportionate collapse and to enable the floors to be permanently stabilised. Repair work is required in this area to correct the removal of structure in the past, which has caused the floors to sag and has weakened the structure. The steel frame in this location includes cross and plan bracing to stabilise the structure. Prior to installing the new structural steel frame ceiling finishes, timber boarding and floor boards will be removed in order to position the steel directly adjacent to the existing structure. Removal of floor boards and match boarding will be in accordance with the LBMS for Removals and Demolitions and section 4.1 of the Proposal for Labelling and Protection of Heritage Items. Following the completion of any necessary recording, the removal of ceilings will be undertaken in a controlled manner using hand tools in order

to protect the heritage fabric to be retained. Refer to the Removals and Demolitions LBMS 'stage 5' works and section 6.1 Removals.

Steelwork will be lifted onto supporting bolts or pad stones and shimmed to level. It will be necessary in some locations to form connections into existing steelwork and these connections will be formed by drilling the existing plate girders or by forming welded connections between new and existing steelwork. A Structural Engineer's assessment will be made in each case to ensure that the integrity of the existing structure is not compromised by these operations. As steelwork is installed, the connections will be fixed by bolting or welding to maintain stability and will be grouted in place at supports. Where it is required for fire protection, structural steelwork generally will be coated with intumescent paint.

Existing timber floor joists will be wedged off the new steelwork and any prominent bow in the floor will be reduced by either re-levelling of the existing floor boarding using firring or if this is not possible due to condition of existing boards and extent of bowing a new floor will be installed to level the bowing.

Replacement of drop rods is required around the atrium area. Temporary support using floor jacking will be installed in accordance with the LBMS for Removals and Demolition to support loadings and enable the existing load bearing drop rods to be removed. New drop rods will be installed with locking plates and bolts, and turnbuckles will be tightened to transfer the load back into the new structural supports. The new drop rods will require boxing in to ensure fire integrity of the new structure.

There is new **roof steelwork** to be installed in Zone 2 to replace the existing atrium roof structure, in Zone 3 to install a new roof associated with the reinstatement of the 'Bomb Gap' area and in Zone 4 to replace the roof at the MTS side of the Central Block and tie in to the new 'Bomb Gap' area roof. Generally the steelwork will be lifted into place onto a supporting connection or pad stone and will be bolted or grouted into position to ensure stability of the structure.

The new **WCC roof structure** is to be tied to the WRB at first floor level to support the maintenance walkway that separates the two structures and allows for safe maintenance access to the façade of both the WRB and the glazed louvred section of the WCC roof. This is an operational station requirement for safe access. A steel channel will be mechanically fixed through the WRB western façade between R1 and R16 (excluding the projecting Central Block section) using through fixings. Fixings centres will be determined by a pull out test in the existing masonry to limit the extent of the damage to the building fabric. The channel is utilised to ensure that the load from the roof is uniformly distributed along the elevation and flexibility of fixing is maintained. This also ensures that the junction is located above the projecting band course of the Western Range façade.

The interface detail for the Central Block is not a structural junction and is not detailed in this submission; it is a flashing detail that is dressed into the brickwork of the parapet at roof level.

This section relates to Condition 5:

- ***b. Reinstatement of the 'Bomb Gap' area***
- ***c. Upgrade for fire resistance, operational railway requirements or disproportionate collapse requirements***
- ***e. Addition of new steel frames***
- ***j. Structural interface between the new concourse and the Western Range***

Protection control matrix, sections 1, 4, 8, 9 and 10

3.4 Load bearing masonry walls

Load bearing walls are required in some locations (e.g. Zone 3 and 4) to repair the structure following previous alterations and to prevent disproportionate collapse. The new load bearing walls will be stitched into the existing masonry using the technique described in 3.8.6 Masonry infilling. The wall will be built up by hand using the appropriate approved brick and mortar to match the existing brickwork. Where possible bricks salvaged from demolished areas of the Western Range will be used for facing brick masonry repairs. Where this is not possible or the bricks are not for facing repairs or supply is limited, bricks will be selected to match load bearing characteristics of the originals; refer to WRB Masonry Proposal for further details. Once the wall has reached full height, dry packing will be installed tight to the floor above.

The existing eastern façade of the 'Bomb Gap' area incorporates modern structural steel supports and profiled metal sheeting to divide the WRB from the MTS. This support is to be removed and replaced with load bearing masonry stitched into the existing masonry walls using the appropriate approved brick and mortar and the method described above for load bearing masonry walls. New load bearing masonry walls are also to be constructed above MTS roof level to reinstate the eastern façade of the 'Bomb Gap' area.

This section relates to Condition 5:

- ***a. Structural repairs to the historic fabric***
- ***b. Reinstatement of the 'Bomb Gap' area***
- ***c. Upgrade for increased loading or disproportionate collapse requirements***

Protection control matrix, sections 4, 7, 9 and 12

3.5 Floors

3.5.1 Concrete

New reinforced concrete basement slabs are required in Zone 3, 4 and 5 where the existing slabs are to be broken out to enable new foundations to be installed. A new reinforced concrete slab is required at ground floor level in the North West Building to facilitate an operational railway requirement for a change in finished floor level; the existing floors are not compliant with disabled access requirements

Refer to Typical detail 15 on Drawing WRB-CSD-0002, which is to be used where a new concrete slab is to be toothed into an existing masonry wall. Existing masonry is to be removed using hand tools to the depth of a single brick module and at approximately 440mm hit and 440mm miss width (or to suit brick modules if appropriate) and whole, sound, facing bricks are to be salvaged. The inside of the pocket is to be coated with bitumen paint bond breaker prior to the new floor structure being constructed.

To construct the new concrete slabs, the area will be excavated to formation level and blinding will be laid. Below ground drainage will be installed and tested to ensure integrity. Any existing masonry at the edge of the slab will be cleaned and an appropriate interface joint will be fitted. The reinforcement will be fixed and following completion of quality checks, the concrete will be poured using a static pump. Control measures to be used to protect the building fabric from concreting operations are detailed in 4.1 Placement of concrete and grout.

Where reinstatement of floors is required because localised areas of breakout are required for drainage installation, the trench will be back filled in accordance with the public health specification and steel mesh will be installed prior to concreting. Water bar and sealant will be used at the joint between new and existing concrete. Please note that all existing floors at this level are concrete.

This section relates to Condition 5:

c. Upgrade for operational railway requirements

e. Addition of new structural floors and concrete slabs

f. Structural framing of the basement area and ground floor level of the southern end

Protection control matrix, sections 2, 4, 7, 8 and 9

3.5.2 Timber

Joist replacement and strengthening may be required in a number of areas due to poor condition of the historic fabric or to accommodate increased loading requirements, which is applicable to the floor joists in Zone 2, 1st floor.

Refer to Typical details 4.4 and 4.5 on Drawing WRB-CSD-0005, which are to be used where repairs and strengthening are required to existing timber floors. Timber condition inspections will be made as existing timber elements are exposed to determine the need for further repairs.

Floor boards will be lifted using hand tools and where bowed floors are identified then the typical repair will be undertaken following strengthening works, including timber joists being wedged from new structural steelwork below. The bowed timber joist will remain unmodified and planed timber shims (or similar approved) will be used to create a level surface. Floor boards will be reinstated or replaced as necessary and longer fixings will be used if required.

Where floor strengthening is required to support large suspended services items this will be achieved by drilling a bolt hole in the existing timber and fixing a new timber joist to the existing using bolts at 500mm centres. Toothed shear rings and hangers will be installed between the new and existing timbers.

Refer to Typical detail 20 on Drawing WRB-CSD-0002, which is to be used as a **cross wall restraint** tie where a floor has been removed on one side of a cross wall. A survey will be undertaken to confirm the existing construction. To install the cross wall restraint a hole will be drilled through the cross wall and the adjacent floor joists that are to remain in situ and a 16mm diameter stainless steel rod will be installed at 1 metre centres and secured with locking nuts and washers at each end; the nut and washer will be recessed into the cross wall to allow flush finishes. Timber noggins will be nailed between the existing floor joists that the stainless steel rod is passing through, to provide restraint.

Limited removal of floor pugging will be undertaken where necessary to enable the replacement and strengthening details to be implemented.

This section relates to Condition 5:

a. Structural repairs to the historic fabric

c. Upgrade for increased loading

Protection control matrix, sections 1, 4, 7, 9, 10 and 12

3.5.3 Composite construction

Composite slabs are required in a number of locations within the WRB, including in the replacement of the Booking Hall roof required due to increased loading from plant and a Zone 3, 1st floor composite slab that is proposed to accommodate an operational railway requirement for change in floor levels.

Supporting steelwork will be installed on pad stones in accordance with the methodology described in 3.3 Steel frames. Refer to Typical detail for composite slab on Drawing WRB-CSD-0004. Profiled metal decking will be installed onto supporting steelwork and shear studs will be welded using a stud welding gun to the steelwork to provide shear capacity to the slab. Reinforcement for the slab will be fixed and then the slab will be concreted using a static pump and hoses. Control measures to be used for concreting operations are detailed in 4.1 Placement of concrete and grout.

The profiled metal decking will be specified so that it will support the live loadings and the weight of the fresh concrete during the construction phase.

This section relates to Condition 5:

c. Upgrade for increased loading and operational railway requirements

e. Addition of new concrete slabs

Protection control matrix, sections 1, 3, 4, 7, 8 and 9

3.5.4 Metal grid

Open mesh flooring is required for maintenance access to risers in Zone 2 and Zone 4 and may be required in other areas for smaller riser floors where access is required. It will be supported on minor steel sections spanning between pad stones, which will be installed in accordance with the methodology described in 3.3 Steel frames. Sections of metal grid will be lifted onto the supporting secondary steel and fixed in place.

This section relates to Condition 5:

e. Addition of new steel frames

i. New extract ducts, smoke risers and other vents

Protection control matrix, sections 1, 4, 8 and 9

3.6 Stairs and lifts

3.6.1 Lifts

Lift E will be a passenger lift serving the Link Building and OBS tunnel from basement level to third floor level. Construction of the lift pit will require excavation through the existing concrete floor in the basement down to approximately 3 metres below existing floor level. Due to the proximity of these works to structural elements, underpinning will be required and this will be undertaken in accordance with 3.1.2 Underpinning. MoLAS will undertake a watching brief while excavations occur in previously unexcavated earth to ensure no unknown items of heritage significance are lost or damaged. New lift pits are to be formed using reinforced concrete and the control measures detailed in 4.1 Placement of concrete and grout will be used to ensure the heritage structure is not compromised.

At ground level, the wall to the south east of the new lift structure will be deconstructed in accordance with the LBMS for Removals and Demolitions to leave a plate girder support. This will be encased

with reinforced concrete to form a wall which will then support further levels of lift shaft. The lift shaft will be constructed from reinforced concrete in accordance with 4.1 Placement of concrete and grout.

From first floor level upwards existing walls to the east and south will be utilised in the structure to prevent unnecessary demolition. An in situ reinforced concrete wall will be cast to the west which will be toothed into the existing wall using the method described in 3.5.1 Concrete. Floors will be removed in accordance with the LBMS for Removals and Demolitions to allow the lift shaft and adjacent service riser to be formed. Removal of floor boards and joists will be in accordance with the LBMS for Removals and Demolitions and section 4.1 of the Proposal for Labelling and Protection of Heritage Items. A new concrete floor will then be cast that will be tied into the lift shaft walls using starter bar reinforcement and will be toothed into the existing building fabric using the method described in 3.5.1 Concrete. This sequence is repeated on level 2, mezzanine 2 and level 3 and all reinforced concrete works are to be controlled in accordance with 4.1 Placement of concrete and grout.

Lift D is an existing goods lift serving the basement and Platform 8 at ground level. This lift is to be refurbished under the scope of Package 6 and is to be extended to serve the first floor level. The existing floors at the proposed location of the lift shaft extension on first and second floor level are to be removed in accordance with the LBMS for Removals and Demolitions, to the extent of the existing load bearing walls. The lift shaft will be extended using structural blockwork and will be capped at 600mm above structural slab level at second floor level with a concrete capping slab. The floor structure is to be replaced between the lift shaft and the load bearing wall by constructing a reinforced concrete slab which will be tied into the new blockwork shaft and toothed into the load bearing masonry using the method described in 3.5.1 Concrete. The construction of reinforced concrete elements will be in accordance with 4.1 Placement of concrete and grout

Lift C is a new MIP lift to serve the proposed pub balcony located in the OPY. The redundant vaults under the OPY will be filled with mass concrete. Once the concrete has cured the top of the vaults and part of the concrete will be removed to allow the pit of the lift to be cast. As vault bricks are not reusable, they will be broken out with the concrete and taken for disposal off site. The area of breakout will be kept to the minimum required for safe construction in order to preserve as much of the filled vault structure as possible. The new lift pit will be formed in reinforced concrete and the construction will be controlled in accordance with 4.1 Placement of concrete and grout. Once out of the ground the lift is free standing and away from the listed structure.

Lift J is a new lift that is to be formed in Zone 4 from basement to third floor level, with a lift overrun into the roof. There are 4 no. piles to be installed in the basement and these works will be in accordance with 3.1.1 Piling. To form the reinforced concrete lift pit it will be necessary to excavate close to structural walls and where underpinning is required this will be undertaken using the method described in 3.1.2 Underpinning. To form the reinforced concrete lift shaft it will be necessary to remove existing floors and a section of the roof structure, including trimming of roof timbers; this removal will be in accordance with the LBMS for removals and demolitions. As the new shaft is formed, using the control measures identified in 4.1 Placement of concrete and grout, it will be necessary to construct new reinforced concrete floors that connect the shaft to the adjacent load bearing walls. The new floor construction will use the methodology described in 3.5.1 Concrete. The opening through the roof will be made as part of the roof refurbishment works as described in the LBMS for Roof Repair and Renovation.

Lift K will be installed from basement level to second floor level and will be constructed from reinforced concrete using the methods described for Lift J above (without the requirement for piling).

The additional heritage consideration for Lift K is at loft level where the roof truss will be trimmed to allow the shaft to be topped off. This will be done by casting the shaft around the roof truss, attaching cleats to the shaft which will then take the tension of this member. The truss will then be trimmed from the inside of the shaft.

Lift P will be installed from ground floor to second floor level in the North West Building. It will be constructed from reinforced concrete using the method described for Lift J above, although it will not require piling or structural alterations to the roof.

Lift M will be installed from basement to third floor level. It will be formed from a reinforced concrete lift pit and shaft and will be connected into the existing LUL 'Bomb Gap' structure using starter bar reinforcement already cast in. The concreting works will be controlled in accordance with 4.1 Placement of concrete and grout.

This section relates to Condition 5:

h. Installation of new lifts

i. New extract ducts, smoke risers and other vents

Protection control matrix, sections 1, 4, 7, 8, 9 and 12

3.6.2 Stairs

Stair 9

This existing stone stair is to be extended with the addition of a concrete stair from ground level to first floor and then a further extension from second floor to loft level using a steel stair. To support the concrete stair, a new masonry wall will be constructed in the basement. This will give the ground floor slab structural support to resist the point loading imposed from the stair. This concrete stair will be toothed in to the existing masonry wall on each level and on landings as per the standard toothing detail which is explained in 3.5.1 Concrete. Note that this will be only on the southern and western sides of the stair as the east and north integrates with new block work.

At first floor level, the stair will interface with an existing stone landing. Refer to detail 43E on WRB-CSD-0041. A cut will be made in the stone to create a lap for the connection with the new concrete stair. The cut will be formed with sharp saws to ensure a clean face. An opening will be drilled vertically into the lap formed on the existing landing and a bolt will be installed to connect the new and existing structures. The existing stair landing will be propped from below during the alterations. A new steel beam will be installed between cross walls to support the new concrete stair using the method described in 3.3 Steel frames. A 10mm movement gap will be formed between the existing stone landing and the new concrete stair.

Stair 4

At the second floor landing, the stair is to be extended to allow access to the new plant rooms on the 3rd floor of the Central Block. This extension to the stair case will be a steel stair. The base of the stair is to be attached to the York stone existing landing via steel cleats which will be welded onto the new steel stringer. Care will be taken to ensure holes are drilled in the correct position to the correct depth to prevent accidental damage to the existing landing. In areas of the landing where no new fixing is required, the York stone will be protected to prevent impact and surface damage, in accordance with the Proposal for Labelling and Protection.

The stair will be supported on steels at the half landing level. At loft level, the stair will be supported via new pad stones to be installed into the existing masonry as per typical detail shown on WRB-CSD-0003. Whole, sound facing bricks will be salvaged where possible in accordance with the Salvage Strategy. Where this is not possible, bricks will be removed ensuring damage is not caused to surrounding structure by vibration, dust and impact damage.

Stair 10

Stair 10 is located between W7 and W8 and is of a similar construction to Stair 4. The steel staircase will be constructed and be supported by concrete pad stones in the wall as per detail shown on WRB-CSD-0003. The control matrix will be observed to ensure that minimal alteration or damage is caused to any item of heritage value.

Refer to Typical detail steel stair to timber floor connection on Drawing WRB-CSD-0004. Where steel stair sections are to be connected to existing timber floors the size of the existing timbers is initially to be confirmed on site. A new steel UB section is to be installed in accordance with 3.3 Steel frames and packing is to be inserted above to transfer load from the existing floor into the beam. The supporting joist timber is to be trimmed in accordance with the LBMS for Removals and Demolitions and a hanger is to be installed to support the existing joists from the new steel UB section. New steel stringers will be connected to the new steel UB sections and the top stair tread will be installed level with the existing timber floor boards.

This section relates to Condition 5:

c. Upgrade for increased loading
e. Addition of new structural floors, concrete slabs and steel frames
h. Installation of new stairs
i. New extract ducts, smoke risers and other vents

Protection control matrix, sections 1, 4, 7, 8, 9 and 12

3.7 Openings

Openings in façade at Zone 3 (Bridge Link) and Zone 5 are an operational railway requirement to improve passenger flow through the new station arrangement. The openings will be formed in accordance with the LBMS for Removals and Demolitions, using a sequence including temporary needle supports. The permanent works required to support the façade openings are steel lintel arrangements and these will be installed using methods described in 3.3 Steel frames. The channel supports to the reveals will be fixed to a linking concrete tie beam at ground level, to connect the channels and stabilise the openings. Due to the size of the spans in these areas will be necessary to pre stress the lintels to ensure the intended load path arrangement is achieved in the permanent condition. Fire protection will be installed to protect the new structure. Following the lintel installation, work will be required to make good to the external masonry to achieve a coherent façade design; further details regarding masonry repair works can be found in the WRB Masonry Proposal.

Small openings are required in load bearing walls for door installation or door widening. Refer to Typical detail 04 on Drawing WRB-CSD-0001, which is to be used where openings 300 to 1800mm width are to be formed. A survey will confirm existing wall thickness and lintel and pad stone positions and sizing based on existing wall finishes. Any loose brickwork will be replaced or re-bedded and then saw cut at marked positions to enable removal of brickwork to the depth of a single channel. The first channel section will be installed onto pad stones and dry packed tight. This process will be

repeated for the second channel section. Holes will be drilled through both channel sections and the dividing brickwork and threaded bolts will be installed. The brickwork below the double channel lintel will be saw cut and whole, sound, facing bricks will be salvaged as the opening is formed. A steel plate will be fixed to the underside of the lintel using countersunk bolts. Fire protection will be installed to the lintel.

Openings are required in the load bearing walls to enable **below ground drainage** installation. Using the technique described in 3.1.2 Underpinning, openings will be formed through the load bearing walls (generally considered to be corbelled brickwork) below basement slab level to enable the below ground drainage to be installed.

This section relates to Condition 5:

c. Upgrade for fire resistance and operational railway requirements

g. New openings in existing load bearing walls

Protection control matrix, sections 1, 4, 7, 8, 9 and 12

3.8 Repairs

3.8.1 Parapet

A survey of the existing structure will determine the extent of **parapet strengthening** required in the WRB. Parapet strengthening is required in Zone 4 and the existing parapet will be surveyed and temporarily supported to enable the strengthening works to be undertaken. A reinforced concrete upstand will be formed using starter bar reinforcement from the composite roof slab (described in 3.5.3 Composite floors). The parapet wall will be tied to the upstand using brick ties (Halfen HTS-F12 or similar) 200mm long at 600mm centres; ties will be connected to the centre of the nearest available brick, using either mechanical anchors where the required pull-out strength can be achieved, or resin anchors as appropriate if mechanical anchors will not hold.

Alternative strengthening measures to parapet areas may be required once intrusive surveys are complete and extraneous metalwork is identified for removal or damp penetration has destabilised areas. Parapets may require additional stainless steel wind posts.

This section relates to Condition 5:

a. Structural repairs to the historic fabric

Protection control matrix, sections 3, 4, 7, 8, 9 and 12

3.8.2 York Stone floor

Repairs and strengthening are required to **York Stone floors** in a number of locations where structural cracking, delamination or other damage has occurred, e.g. 1st floor corridor between grid lines W7 and W8, where new steel sections will span below the stone corridor between new and existing steel beams. Other strengthening details are to be determined once the soffits of stone slabs have been exposed and other investigatory works have been undertaken.

The strengthening of the floors will be undertaken, where possible, by wedging the stone slabs off new steel joists bolted to corridor walls below the soffit of slabs. Where this is not possible then an alternative detail for support will be developed and proposed to EH.

This section relates to Condition 5:

a. Structural repairs to the historic fabric
c. Upgrade for increased loading
e. Addition of new steel frames

Protection control matrix, sections 4, 8, 9 and 12

3.8.3 Ironwork

Uncoated ironwork/steelwork in non-visible areas, including truss shoes and hangers in roof spaces are to be thoroughly cleaned by wire brushing and then coated with the paint system N-3 as defined in Civil Specification Volume 7: Structural Steelwork for Works Excluding the Western Concourse Roof.

Ironwork/steelwork requiring intumescent paint **fire protection**, including cast iron columns in Zone 2, is to be stripped of existing paint, wire brushed and then coated with the paint system F-1 as defined in Civil Specification Volume 7.

This section relates to Condition 5:

a. Structural repairs to the historic fabric
c. Upgrade for fire resistance

Protection control matrix, sections 4, 8 and 10

3.8.4 Timber strengthening

Timber strengthening is required for a number of timber elements, including timber joists within roof trusses and timber floors (described in 3.5.2 Timber). Refer to Typical details 4.1 - 4.5 on Drawing WRB-CSD-0005, which are to be used where repairs and strengthening are required to existing timber. Timber condition inspections will be made as existing timber elements are exposed to determine the need for further repairs.

Repair of typical **rotten timber bearing,** where decayed zone of timber is assumed to be limited to the embedment zone of the joist within the masonry wall, will be undertaken by installing stainless steel anchor bolts a minimum of 200mm into the existing masonry wall using chemical resin (use of resin will be controlled as detailed in 4.2 Control of resin materials). A pair of steel cleats will be fixed to the stainless steel anchor bolts and to the end of the decayed joist using steel bolts to connect the plates through the decayed joist.

Repair of typical **notched timber,** particularly where the joist has been notched for pipe work, will be undertaken by forming hardwood wedges to fill the notches.

Repair of typical **roof rafter** will be undertaken by removing the extent of the decayed timber (with temporary support in place if required to maintain stability) and replacing with a new timber. A galvanised steel connector will be fixed to the new and the retained timber to transmit tensile forces and a mild steel holding down strap will be fixed to the new timber at wall bearing positions.

This section relates to Condition 5:

a. Structural repairs to the historic fabric
c. Upgrade for increased loading

Protection control matrix, sections 1, 4, 8, 9 and 12

3.8.5 Chimney infilling

Chimney infilling is required in Zone 3 for prevention of disproportionate collapse and may be required in other areas following a survey of the existing chimney flues.

Pilot holes will be drilled into the existing chimney breast masonry to locate the chimney flues. Whole bricks will be removed to create a 300x300mm hole to allow concrete to be poured at each level. Concrete will be poured in 600mm layers, and the chimney breast will be monitored for stability. Upon completion of the concreting, the brickwork will be reinstated in the chimney breast.

This section relates to Condition 5:

a. Structural repairs to the historic fabric

c. Upgrade for increased loading or disproportionate collapse requirements

Protection control matrix, sections 4, 7, 9 and 10

3.8.6 Masonry infilling

Masonry infilling and stitch repairs are required (e.g. Zone 4) in some locations to close up openings that are no longer required, to repair the structure and to prevent disproportionate collapse

Refer to Typical detail 03 on Drawing WRB-CSD-0001, which is to be used where structural brick infills are to be toothed into existing masonry. The existing opening will be prepared by removing any non-structural floor finishes and any finishes required to expose the structural lintel. Any joinery, e.g. windows and frames, in the existing opening will be carefully removed and protected in accordance with the Proposal for Labelling and Protection of Heritage Items LBMS. Floorboards will be reinstated as appropriate following the structural repair works. New masonry will be laid in the opening, toothing the new structural infill wall into the existing wall every 4th course. Dry pack will be installed tight between the new wall and the existing lintel to complete the infill.

This section relates to condition 5:

a. Structural repairs to the historic fabric

c. Upgrade for disproportionate collapse requirements

Protection control matrix, sections 4 and 9

3.9 OBS Tunnel

The construction of the OBS tunnel structure, at basement level of the WRB involves:

- Bulk excavation
- Piling
- Construction of reinforced concrete walls and slab.

The bulk excavation of the OBS tunnel area next to the 'Bomb Gap' is required as part of the works. The site investigation logs indicate that the ground is principally fill material to the WCC structural slab level. Excavation of this fill is required to install a piling platform for the installation of 1 no. 900mm pile to support the OBS structure. Refer to section 3.1.1 for details. The mat will be constructed from crushed concrete material and will be designed to ensure that no surcharge occurs between the mat and the 'Rat Run vaults'. Once the pile has been completed the mat will be removed and the excavation will continue to the required depth. This excavation will encompass the demolition of the

existing basement service corridor (Rat Run) structure which forms part of the WRB basement. MoLAS have recorded the Rat Run structure in accordance with the Building Recording Specification and any materials identified for salvage will be removed prior to the demolition works in accordance with the LBMS for Labelling and Protection of Heritage Items. The demolition will be undertaken in a controlled manner using an excavator for the removal of the majority of the structure and hand demolition at the interface with the WRB main walls as required.

MoLAS will undertake a watching brief while excavations occur in previously undisturbed ground to ensure that no unknown items of heritage significance are lost or damaged. Once all excavation and demolition has been complete, work will begin on the construction of the new reinforced concrete structure. A 20mm protection board will be installed on to the face of the WRB structure in the works area to act as protection to the face of WRB and also fulfil the function of the permanent movement joint between the two structures. This protection board will prevent damage from concrete splashing and potential small impacts to the face of the WRB. Concreting operations will be controlled in accordance with 4.1 Placement of concrete and grout.

During the construction materials will be delivered to the works area by the tower crane which will be under the control of a competent Slinger/Signaller, minimising the potential for damage occurring to the WRB from the lifting operations.

It is not envisaged that the temporary works required for the construction of the roof slab to the OBS will have any effect on the WRB structure as the temporary works will be fixed to the concrete and associated formwork. No support and bracing from the WRB will be required.

This section relates to Condition 5:

j. Structural interface between the new concourse and the Western Range

Protection control matrix, sections 2, 3, 4, 8, 9 and 10

4.0 Control & Protection Measures

In addition to the protection control matrix in Appendix A of this document and the control and protection measures relating to plant, services and COSHH detailed in the LBMS for Removals and Demolitions, there are some additional specific risk items that must be controlled in order for structural alterations to the WRB to be undertaken in a safe manner. Please note that monitoring and recording of the existing structure will be continued throughout the structural alterations to ensure the integrity of the heritage structure; this process is detailed in the LBMS for Removals and Demolitions.

4.1 Placement of concrete and grout

Falsework

Falsework will be erected to support new concrete slabs and beams being constructed. Falsework will have an approved temporary works design and will be installed by a competent operative. The structural capacity of the floor below will be assessed to ensure the transferred loading can be accommodated and supports will be installed below the floor if required. Sole boards will be placed to protect floors and soffits from damage by the supports.

Prior to loading the falsework will be inspected by a Temporary Works Supervisor and a Permit to Load will be issued. Once the concrete has achieved adequate strength the Temporary Works Supervisor will issue a Permit to Dismantle.

Formwork

Formwork will be erected to form new concrete columns, walls, beams and slabs being constructed. Formwork will have an approved temporary works design allowing for the concrete pressure that will be exerted during casting. Formwork will be installed by a competent operative and joints will be sealed to prevent grout loss.

The formwork will be inspected by a Temporary Works Supervisor and a Permit to Load will be issued prior to concrete being placed.

Reinforcement

Care will be taken when handling reinforcement through the WRB. Longer lengths of reinforcement will be assessed to ensure they can be manoeuvred into position without damage to the heritage fabric and if necessary then reinforcement will be spliced to achieve shorter lengths.

Concrete Placement

In most instances, a static pump and connecting hoses will be used to place concrete within the WRB. This is necessary as access to the building is restricted and concrete wagons will be situated on the WCC slab. An assessment will be undertaken to ensure that the outrigger loading from the concrete pump is within the bearing capacity of the WCC slab. The concrete pump, hoses and connections will be inspected prior to every use to ensure that they are in a serviceable condition and the hoses will be secured in a suitable route through the building.

For small volumes of concrete, eg pad stones, it may be possible to mix the concrete at the work location. This will be done by hand mixing in a suitable container or by using an electric mixer. Each area will be assessed for suitability prior to hand mixing and appropriate floor protection measures will be installed as necessary, including plastic sheeting.

Although it will not be possible in most locations because access is not available, where sufficient space is available (eg Zone 3, W18-W20 for piled foundations and ground floor slab) then a concrete wagon will be reversed up to the WRB using a Banksman and the concrete will be directly discharged.

A concrete skip, lifted using the WCC tower cranes, may be used for concreting at roof level, for lift shafts or for the reinforced concrete frame between W18 and W20. A Slinger/Signaller will ensure the skip is secured to the crane's lifting block using appropriate lifting equipment and will check that the hose used to discharge the concrete from the skip is secured back to itself. The lifting operation will be controlled by the Slinger/Signaller.

A designated area will be established on the WCC slab for a concrete wash out area. This will be a lined skip.

Adjacent surfaces will be protected from concrete splash using plastic sheeting.

4.2 Control of resin materials

Where use of resin is required then there will be careful selection of an appropriate material and where possible a control sleeve will be used to prevent leakage of resin. Resin materials will always be installed in accordance with the Manufacturer's recommendations. Protection, for example plastic sheeting, will be placed on heritage items adjacent to the area where resin is being applied. Any

overspill or leaked material on the surface around the fixing will be cleaned off immediately. Disposal of waste resin and resin containers will be at the work area, this waste will then be transported in a secure container for disposal off site.

4.3 Welding

A Hot Works Permit will be required prior to any welding operation taking place and the TW Hot Works Procedure must be followed.

The area surrounding the welding operation will be inspected for flammable materials and temporary fire protection will be placed where appropriate to protect the structure, particularly heritage items.

A dedicated fire point will be in place at the welding operation and a Fire Watchman will monitor the operation throughout and at least 1 hour beyond the completion of the welding operation.

4.4 Dewatering

Trial pits that are to be undertaken to confirm the extent of underpinning works will be monitored for ground water level and ground movement due to water pressures. Bunding will be installed around trial pits to prevent water egress and a pump will be available at the work location if additional water control is necessary.

Should further measures be required to control the risk from flooding then a piezometer will be installed to monitor ground water pressures and if necessary then a pump will be run continuously away from the location of any excavation to draw down water level and reduce the pressures at the excavation. The pump and pump lines will be inspected prior to use and will be regularly maintained, including and inspection to ensure no excessive build up of silt occurs. Pump lines will be secured in a suitable route through the building.

Temporary works will be designed to take account of water pressures and the risk from flooding. Works below ground level will be monitored throughout for water ingress and signs of movement.

Piles will be cased into sealed strata to control ingress of water into the pile shaft.

5.0 Appendices

5.1 Appendix A Protection control matrix

Reference	Hazards/Risk to heritage structure	Risk	Activities	Control Measure	Relevant Control Documents
1	Fire	Damage to heritage structure from fire. Damage to heritage structure from smoke. Damage to heritage structure from extinguishing fire. Due to demolition, removal of fire segregation allowing faster spread	• Welding • Drilling • Cutting of steelwork • Use of combustible chemicals • Floor installation	• Hot works permit • WRB fire strategy • Temporary fire system • Assessment of appropriate use of extinguishers	• Hot works Permit • WRB fire strategy
2	Flooding	Flooding into basement and ground floor areas affecting stability and damaging heritage items.	• Removal and reconstruction of the roof • Excavation causing damage to live services • Open area at North gable end while concrete frame is constructed. • Piling, underpinning and construction of new concrete floor slabs	• Pump available during rain storm events or flood event • Construction methodology maintains protection to vulnerable areas at all times • Control of rate of water flow used for damping down • Coordinated service drawing to be available and checked.	• Task specific WPP's
3	Inclement Weather	Damage from precipitation to	• Construction of concrete	• Sheeted Scaffold	• Task specific WPP's

Reference	Hazards/Risk to heritage structure	Risk	Activities	Control Measure	Relevant Control Documents
		internal heritage structure. Damage to internal heritage structure – internal exposed to external environment. Damage to structures caused by severe winds.	frame • Roof construction • Permanent building openings • Temporary construction openings • Parapet repairs	• Temporary roof • Method of protection for in situ heritage items • Secure windows, doors and any loose items on roof/scaffolding in the event of strong winds	
4	Accidental Damage	Poor handling of structural items during installation resulting in damage to heritage. Impact and/or abrasion to in-situ items during construction activities. Incorrect removal of heritage items.	• Toothing in of flooring and walls • Construction of concrete frames • Temporary construction openings • Permanent building openings • Steelwork erection • Underpinning	• Physical barriers to items of heritage value left in-situ. • Training and competent workforce • Restrictions on access to work areas	• Permit to Work • Task specific WPP's
5	Theft	Heritage items stolen in-situ.	• Staircases • Repairs	• Site Security plan including rooms secured outside of working hours and a secure site	• Site Security Plan • Labelling LBMS • Salvage Strategy

Reference	Hazards/Risk to heritage structure	Risk	Activities	Control Measure	Relevant Control Documents
				hoarding • Control of access/egress to site	
6	Vibration	Damage to retained structure. Damage to adjacent structure.	• Piling • Concreting works	• Low vibration equipment and hand tools • Structural Monitoring • Trained and competent work force	• MoLAS Monitoring Document • Task specific WPP's
7	Dust	Staining to façade from dust settling and getting wet. Staining to internal heritage structure from settled dust getting damp.	• All activities	• High standard of housekeeping • Controlled damping down • Physical protection to items of heritage value	• TW Environmental Management Plan
8	Impact	Plant impact on retained structure. Material impact when removing waste/heritage items.	• All Activities	• Impose restrictions on movement of site plant • Trained and competent work force • Physical barriers • Temporary supports in place before commencing	

Reference	Hazards/Risk to heritage structure	Risk	Activities	Control Measure	Relevant Control Documents
				work where required. • Minimise the lifting of material over or through the structure • Adjusted working method to reduce need for material removal/plant use.	
9	Stability	Heritage structure collapse in part or as a whole. Movement causing damage to retained heritage items. Collapse of retained item due to inadequate support.	• Piling • Structural frame • Underpinning • Flooring • Masonry walls	• Temporary works procedure including permit to load • Approved methodology • Competent designers and sub-contractors • Verify existing structural integrity • Monitoring • Restrictions on loading out of materials	• TW Temporary Works Register and procedure • Approved task specific WPP's • TW Monitoring Implementation Plan • Load assessments

Reference	Hazards/Risk to heritage structure	Risk	Activities	Control Measure	Relevant Control Documents
10	COSHH	Work unable to progress using preferred method	• Steelwork erection (especially connections into existing steelwork) • Repair to ironwork • Chimney strengthening • OBS tunnel works	• Asbestos and Anthrax survey (Level 3) and management plan • Lead survey and management plan • Trained workforce and management team	• McGee Asbestos and Anthrax survey • Lead Survey • TW Environmental Management Plan
11	Explosion	Heritage structure collapse in part or as a whole.	• Use of gas cutting equipment • Use of explosive chemicals • Piling	• All explosive substances/gasses to be stored in secure locations • Trained and competent workforce • Risk assessment for underground hazards	• Approved task specific WPP's
12	Unnecessary removal of heritage items	Prosecution for working outside of permitted works on a Grade 1 listed structure.	• Stairs • Timber repair and strengthening • Toothing in masonry • Openings • York stone floor repairs • Underpinning	• Salvage strategy • MoLAS watching brief • Competent management and supervision • Clear identification of items to be removed • Items to be assessed before work starts	• JMP Salvage strategy

Reference	Hazards/Risk to heritage structure	Risk	Activities	Control Measure	Relevant Control Documents
			• Construction of basement floor slabs • Below ground drainage		
13	Dewatering of excavations	Water ingress through dewatering of excavation to other area Shrinkage in soil creating instability in immediate structure	• Piling • Excavation works	• Trained and competent work force • All equipment to be fit for purpose • Monitoring of excavations • Regular inspections of pump and pump lines	

Relevant control documents form part of TW's robust management procedures and are not appended to this submission as they are health, safety and environmental risk documents.

5.2 Appendix B Location and terminology drawings