VAPS

SYDNEY OPERA HOUSE

VEHICLE AND PEDESTRIAN SAFETY PROJECT

ENVIRONMENTAL ASSESSMENT

CONSTRUCTION MANAGEMENT PLAN

ISSUED

15 July 2010

Prepared by

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1 Introduction

The Sydney Opera House (SOH) proposes to redevelop its loading dock facilities in order to ameliorate vehicle access to its premises and improve pedestrian safety.

The proposal involves the construction of a new underground loading dock and associated dedicated above ground entry in order to minimise the movement of delivery vehicles on the Forecourt and enhance pedestrian safety. The proposal is known as the Vehicle Access and Pedestrian Safety (VAPS) Project.

The VAPS project has been categorised as a Major Project to be determined under Part 75F of the Environmental Planning & Assessment Act 1979. Director General's Requirements have been issued for the preparation of an Environmental Assessment for the proposed development. This Construction Management Report has been prepared in support of the Environmental Assessment for the VAPS Project.

The report addresses the key construction activities, waste management and safety aspects of the project. The identified methodology, procedures and details described in this report are indicative, and will be refined by the contractor engaged to undertake the project prior to commencing construction. This methodology has been developed to provide a basis for assessment of the environmental impacts of the project.

2 Project Description

VAPS addresses long standing issues of pedestrian safety arising from pedestrian and vehicle conflict on the Sydney Opera House Forecourt. The existing loading and unloading arrangements require a large number of delivery vehicles to daily traverse extensive areas of the existing forecourt amid a large volume of pedestrians.

VAPS will minimise intrusion of delivery vehicles into the forecourt through construction of a new underground loading dock. The project will also improve operational efficiency as loading and unloading activities may be carried out at any time of the day or night, as the dock is acoustically separated from the venues and dock access is separate from the pedestrian Forecourt.

VAPS proposed works include the following:

- Access for above ground vehicles from a ramp/tunnel portal within SOH Forecourt, near the Macquarie Street roundabout and adjacent to the Tarpeian Wall.
- An underground loading dock located partly below the forecourt and partly below the arrivals concourse, with dock office, amenities and garbage collection area.
- Extension of existing and new lift services from the existing floor levels to the new loading dock level.
- Two underground corridors linking the dock area with the lifts.

3 Project Area

The project area includes:

- The majority of SOH Forecourt, and the unexcavated area below, from the SOH's monumental stairs to its southern boundary at the Botanic Gardens Gate, along the Tarpeian Wall to Macquarie Street and East Circular Quay. This allows for the required services diversion space as well as the entry ramp/tunnel.
- Approximately half of the Arrivals Concourse and the unexcavated areas below.
- Limited areas within and below the House interior to provide vertical connections within the new Loading Dock.
- Areas within and around the Pedestrian Access Tunnel to the SOH Carpark.

4 Construction

The following construction methodology and associated details and procedures are indicative and will be refined by the contractor engaged to undertake the project. This methodology has been prepared by Savills Project Management to provide a basis for assessment of the environmental impacts of the project.

4.1 Construction Methodology

The VAPS works can be described in the following components:

- Forecourt & Vehicular Concourse Services Diversions.
- Entry Ramp/Tunnel.
- Loading Dock.
- Access Corridors and Lifts.

4.1.1 Forecourt & Vehicular Concourse Services Diversions

In order to commence the works to the entry tunnel and loading dock, it is essential to relocate a significant amount of existing services in the forecourt, and some minor diversions in the vehicular concourse.

These services diversions include High Voltage Cables across the forecourt and vehicle concourse, water mains and gas mains cross the forecourt, Telstra Cables across the forecourt, and stormwater lines across the forecourt and vehicular concourse.

The Diversion of the Bennelong Stormwater Drain is required prior to the commencement of the VAPS works and is currently being assessed under a separate Environmental Assessment Submission. The Bennelong Stormwater Diversion works will proceed and be substantially completed prior to the commencement of the VAPS works.

It is likely that the VAPS Services Diversions Works will be commissioned as part of an Early Works Package to be undertaken alongside the Bennelong Stormwater Diversion Works, in order to minimise the overall duration of works on the Forecourt and thereby the disruption on SOH Forecourt operation.

4.1.2 Entry Ramp/Tunnel

The entry ramp/tunnel is approximately 140m long and will be constructed using a cut and cover construction method for the majority of its length. A small portion (approximately 25m) at its junction with the loading dock will be constructed using tunnelling methods, so as not to compromise the structural stability of the foundations to the monumental stairs which are directly above the tunnel /dock junction. Approximately an eight meter deep rock shelf will be left in position to support the base of the existing monumental stairs.

The ground condition in the forecourt area based on observation is assumed to be Class II/III Sandstone commencing about 0.5m to 1.5m below the surface. This assumption will need to be verified during the detailed design phase.

The approach to the cut and cover portion of the tunnel is to assume the sandstone can be cut vertically and be self supporting, apart from limited rock bolting that may be required in areas of local instability due to adverse jointing. Temporary shoring or battering will be required in the areas with fill material to a depth of 1.5m.

The cut and cover portion of the tunnel is designed as a fully drained system. Any significant water ingress encountered during excavation will be controlled by grouting, in order to achieve the allowable inflow rates nominated in the Design Specification.

The final section of the entry ramp will be constructed as tunnel. The tunnel will initially be supported by shotcrete and temporary rock bolts and in the final case by in-situ concrete lining. This section of the tunnel is designed as a fully tanked system, and hence capable of resisting full external water pressure.

The construction of the entry ramp/tunnel will commence at the Macquarie Street roundabout end, along the Tarpeian Wall and progress toward the monumental stairs. The staging and associated placement of hoardings will ensure that access to and from the Royal Botanical Gardens is maintained throughout the construction period.

Cobblestones within SOH Forecourt will be removed prior to excavation and reinstated at the completion of construction works.

Final adopted excavation and construction techniques will be selected to minimise the construction vibration and avoid impact on surrounding structures and in particular the monumental stair foundations.

4.1.3 Loading Dock

The loading dock forms the main component of the project. The principle dock area including garbage collection is approximately 46m in length (NS direction) and 28m in width (EW direction).

The truck turning bay forms part of this component and is located to the south-east of the principle dock area, and is approximately 15m long (NS direction) and 25m wide (EW direction).

The majority of the loading dock is located underneath the vehicular concourse, with a small portion (approximately 9m * 20m) to the north of the dock which is located below the main entry steps to the Concert Hall and Central Passage.

The vehicular concourse is underlain by stressed concrete tie beams which tie the southern extent of the monumental stairs beams to the southern structure of the main Opera House building. These tie beams are critical to the stability of the existing House building and must be retained.

The main challenge in constructing the loading dock is excavating underneath the tie beams and existing basement areas. A proposed construction sequence for undertaking these works is indicated on the structural plans attached as Appendix A. This approach will be further refined during the detailed design phase.

The ground conditions in this area are typically 1-5m of fill material which overlay Class II/III Sandstone. This is described in a Preliminary Geotechnical Report dated February 2010 and prepared by Douglas Partners.

During excavation, the rock will be pre-cut vertically using large rock saw blades prior to ripping, in order to minimise the transfer of horizontal noise and vibration through the rest of the site. Water pumps will be utilised to remove water seepage through the rock face during excavation. Cement grouting may be required in localised areas if the water ingress exceeds practical volumes.

An innovative process known as Penetrating Cone Fracture (PCF) will also be considered during excavation. PCF is an environmentally friendly rock-breaking technique that involves introducing a pulse of high-pressure gas at the base of a short drill hole, typically 600mm to 1200mm deep. The generated gas penetrates into the small micro-fractures created during the drilling process and natural fissures in the rock. These fractures are forced to expand and propagate into tensile cracks causing the rock to fail. This Tensile breakage mechanism uses low amounts of energy thus achieving low vibration and low noise.

The structure of the loading dock consists of a roof slab (also acting as the concourse ground level slab), base slab, walls and a plant room slab above the truck turning bay. The loading dock is designed as a fully tanked system with the base slab and walls designed to withstand full hydrostatic pressure. The structure will be primarily constructed using a conventional formwork and in-situ concrete approach, with the roof slab utilising precast concrete construction to assist in working around the limited space between existing tie beams.

The portion of the loading dock which is underneath the House basement areas requires an approach which maintains support to the existing structure. This will be achieved by phasing the excavation and providing underpinning and temporary support in strategic locations. An initial concept is indicated on the structural documentation.

At all times during demolition, excavation and construction phases, movement monitoring will be in place.

4.1.4 Access Corridors and Lifts

Two separate access corridors are proposed as part of the VAPS project which extend from the loading dock and travel below existing House building structure providing vertical connection via lifts to the Opera Hall Scenery Store and the Concert Hall.

As these corridors run below existing structure, it is intended to construct them as tunnels using a road header and temporary fibreglass rock anchors and shotcrete to stabilize the roof and walls before placement of the permanent concrete lining.

4.2 Construction Duration and Timing

Construction of the project will take approximately two to two and a half years to complete. The proposed construction hours for all external works will be during standard daytime construction hours, Monday to Saturday as follows:

- Monday – Friday: 7am to 6pm
- Saturday: 8am to 1pm.

However due to the very large volumes of pedestrians accessing the Forecourt, and in order to minimise the adverse visual, heritage, amenity and safety impacts caused by the disruption to the Forecourt during the construction process, it is essential that the duration of the construction phase be kept as short as possible.

As such it is proposed to carry out some limited external construction works outside of standard hours, including:

- The portion of the entry tunnel works which is over the car park pedestrian link. For safety reasons it is preferred to undertake these works outside the car park operating hours.
- Works in the Vehicle Concourse. These works are more than 180 metres from the nearest residences and are naturally screened by the Monumental Stairs.

The carrying out of internal works outside standard construction hours is consistent with previous approvals granted for works on the site. For those limited external works which are not naturally screened, acoustic screening will be put in place to mitigate the noise levels. Monitoring of noise levels will also be put in place to ensure the noise levels comply with the requirements of The City of Sydney “Construction Hours / Noise within the Central Business District – Code of Practice”, 1992.

Furthermore, the deliveries of building materials and spoil removal will be managed so as not to unreasonably impact on the amenity of the patrons of the Sydney Opera House and surrounding neighbours outside standard daytime construction hours.

The ability to carry out internal works and some limited external works outside of usual construction hours is expected to considerably reduce the total construction timeframe; a significant benefit in terms of heritage, safety and visual impacts on the site without any unacceptable amenity impacts to surrounding premises.

4.3 Workforce

The size of the workforce is dependent on the specific construction methodology employed by the contractor engaged to undertake the works and is unable to be identified at this stage. An indicative peak construction workforce is estimated to be approximately 125 persons.

4.4 Construction Equipment

A definitive list of the proposed construction equipment is not currently available as this would be dependent on the specific methodology used by the Contractor engaged to undertake the works. The following is an indicative list of the equipment that may possibly be used during construction:

- Excavators
- Rock Saws
- Rock Hammers
- Backhoe
- Compactor
- Mobile Crane
- Dump trucks for spoil removal
- Semi-trailers for delivery of material
- Concrete trucks
- Concrete pump
- Concrete vibrators
- Cherry pickers
- Generator
- Hand held circular saw
- Site Vehicles

5 Waste Management

It is expected that the following wastes will be generated during construction:

- Spoil
- Brick/concrete materials
- Excavated sandstone
- Services Waste such as bits of wiring, pipe cut-offs and sheet metal cut-offs.
- General Waste from construction activities, such as packaging, scraps and paper.

The management of waste including spoil will be in accordance with relevant NSW legislation and the principles of the waste management hierarchy as set out in the NSW 'Waste Avoidance and Resource Recovery Strategy'. Figure 1 below illustrates the hierarchy for management of wastes.

Figure 1 – The Waste Hierarchy

The proposed waste management measures for VAPS are as follows:

- Excess Spoil – where practical spoil will be reused on-site as backfill. Any surplus spoil that cannot be reused will be transported off-site to recycling facilities or to approved landfill sites.
- Brick/Concrete materials – disposed to appropriately licensed landfill.
- Excavated Sandstone – disposed to appropriately licensed landfill using trucks on road.

- Services Waste - Recycling bins will be provided on site. Recyclable materials will be collected separately and recycled.
- General Waste – Recycling bins will be provided on site. Recyclable materials will be collected separately and recycled.

A Preliminary Contamination Assessment prepared by Douglas Partners and dated June 2010, indicates the site spoil is likely to be classified as General Solid Waste. All transported spoil material will be tested in accordance with the 'Waste Classification Guidelines' (DECC 2008), and will take place in accordance with legislated docket tracking systems that ensure the spoil reaches the appropriate destination. Only licensed contractors and drivers will be used.

A fully detailed Waste Management Plan will be developed by the Contractor engaged to undertake the project. The plan will be framed using the waste management hierarchy principles outlined above. The plan will be prepared prior to construction commencing and will be consistent with the Waste Avoidance and Resource Recovery Act 2001 and the 'Waste Classification Guidelines'.

The plan will:

- Identify requirements for waste avoidance, reduction, reuse and recycling.
- Provide procedures for handling, stockpiling, and reuse of wastes.
- Identify disposal sites and relevant testing as well as transport options.
- Set out procedures for obtaining the required approvals for offsite management of spoil.

6 Other Considerations

Other considerations which will be relevant during the construction period include:

- Safety and the Public
- Noise and Vibration
- Access and Traffic
- Air Quality

6.1 Safety and the Public

The Opera House is to continue operations as normal during the construction period. Ensuring the safety of the public and SOH staff as they continue to access the House building for performances and work will be a key factor in the staging and planning of construction activities. Access to the Royal Botanical Gardens will also be maintained throughout the construction period.

Appropriate hoardings, access gates and signage will be utilised during the construction period to provide a clear delineation between public and construction spaces, and ensure public safety. Works will be appropriately managed and scheduled during performance times.

Prior to commencing construction the Contractor engaged to undertake the works in conjunction with the SOH will prepare a fully detailed works staging strategy, which addresses public access and ensure safety.

6.2 Noise and Vibration

Noise and Vibration issues have been addressed in a report prepared by Acoustic Studio, titled Operational and Construction Noise Assessment dated 14 July 2010. This report forms part of the Environmental Assessment Submission.

6.3 Access and Traffic

Access and traffic issues are addressed in a report prepared by Halcrow, titled Environmental Assessment Traffic Report dated 14 July 2010. This report forms part of the Environmental Assessment Submission.

6.4 Air Quality

The project has the potential to generate dust from the various excavation, construction and truck movement activities during the construction process. Construction plant and equipment has the potential to impact upon local air quality by generating vehicle emissions. However, these potential impacts will be localised, short in nature, and implementation of construction environmental management measures will minimise the potential impacts.

A dust management plan will be prepared by the Contractor engaged to undertake the works prior to commencing construction. The plan will include measures such as:

- Areas with the capacity to cause dust will be dampened to suppress dust emissions.
- Materials transported in trucks will be appropriately covered to reduce dust generation.
- Vehicle movement controls will be installed, particularly entrance and exit from construction work sites.
- Construction activities that generate high dust levels would be avoided during high wind periods.
- Rehabilitation of disturbed surfaces will be undertaken as soon as possible.
- All construction plant and machinery will be fitted with emission control devices complying with Australian Standards and would be regularly maintained.

7 Future Plans

Prior to commencing construction, the Contractor engaged to undertake the works will prepare in conjunction with SOH the following documents:

- Construction Environmental Management Plan

- Safe Work Method Statement

7.1 Construction Environmental Management Plan

A construction environmental plan will be prepared and implemented. The plan will outline environmental management practices and procedures to be followed during site preparation and construction. The plan will cover the environmental protection practices, resources and sequence of activities required to comply with relevant environmental legislation, conditions of any applicable licence, approvals and permits.

The plan will be prepared in accordance with Guideline for the Preparation of Environmental Management Plans (DIPNR 2004) and include:

- A description of activities to be undertaken on the site during the site preparation and construction stages of the project.
- Statutory approvals and other obligations that would be fulfilled during site preparation and construction.
- Details of how the environmental performance of the site preparation and construction works will be monitored, and what actions will be taken to address identified adverse environmental impacts. In particular, the following environmental performance issues will be addressed:
    - Measures to minimise impacts to heritage.
    - Measures to monitor and minimise soil erosion and the discharge of sediment and other pollutants to land and/or water during construction.
    - Measures to monitor and control noise emissions during construction and commissioning.
    - Measures to manage traffic and pedestrian access during construction.
- A description of the roles and responsibilities for all relevant employees involved n the construction of the project.
- Complaints handling procedures during construction.

7.2 Safe Work Method Statement

The Director General's requirements state that a work safe method statement must be provided explaining the delivery and installation of the project whilst ensuring the surrounding heritage fabric. An indicative description of the methodology likely to be adopted to construct the works is provided in this report. This is based on the available concept design documents.

Once the detailed design is complete, the Contractor engaged to undertake the works will develop a detailed safe work method statement which addresses the various activities to be undertaken during

the construction phase, and ensures the safety of the site fabric, construction personnel and the public.

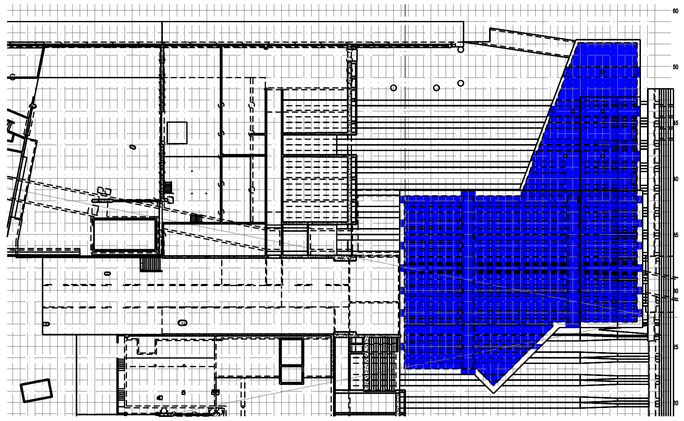
8 Conclusion

This Construction Management Report has been prepared in response to the Director General's requirements for the VAPS Project. The report is based on available concept design documentation.

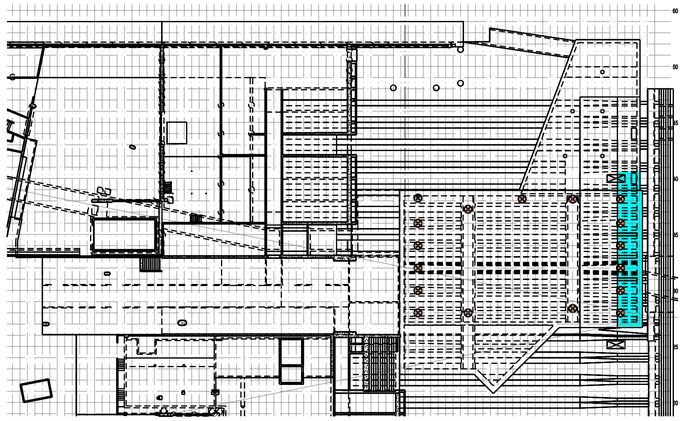
The report provides an indicative construction methodology and associated procedures, which identify how the project may be constructed and how the various environmental issues may be addressed.

The methodology and procedures are indicative and will need to be refined by the Contractor engaged to undertake the works. To this effect, a detailed Construction Environmental Management Plan and a Safe Work Method Statement will be prepared by the Contractor prior to commencing construction and implemented during the site preparation and construction phase.

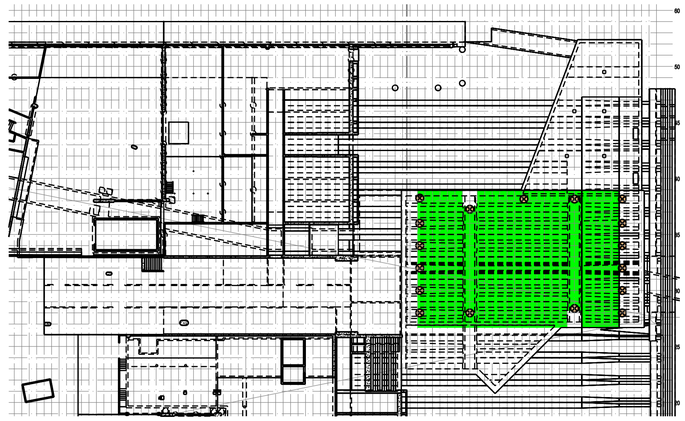
Appendix A - Structural Drawings



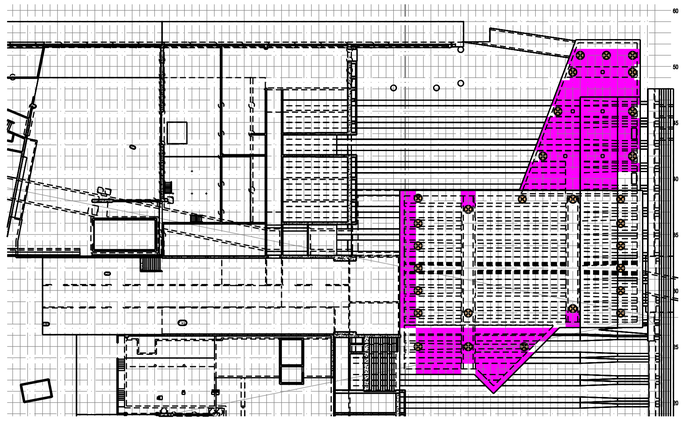
Stage 1
a) Pour slab and beams at Level +12', where shaded



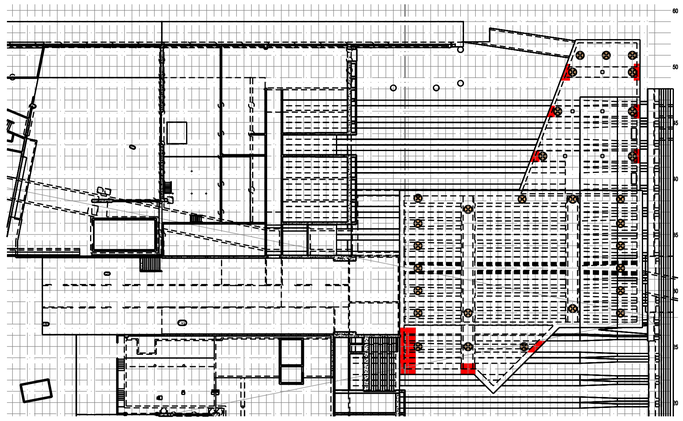
Stage 2
a) Excavate shaded area and install props where shown



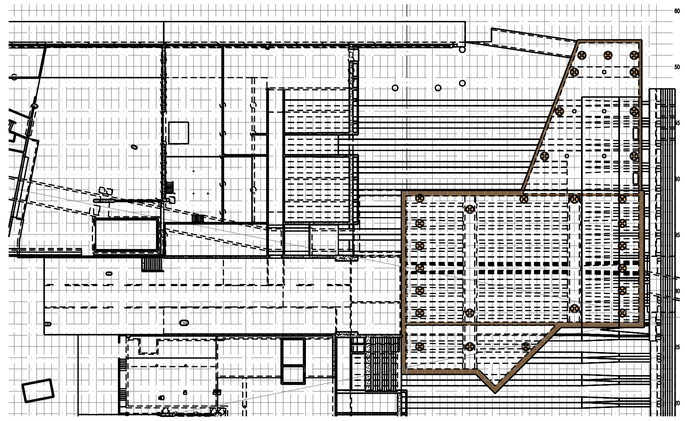
Stage 3
a) Excavate shaded area and install additional props, where shown



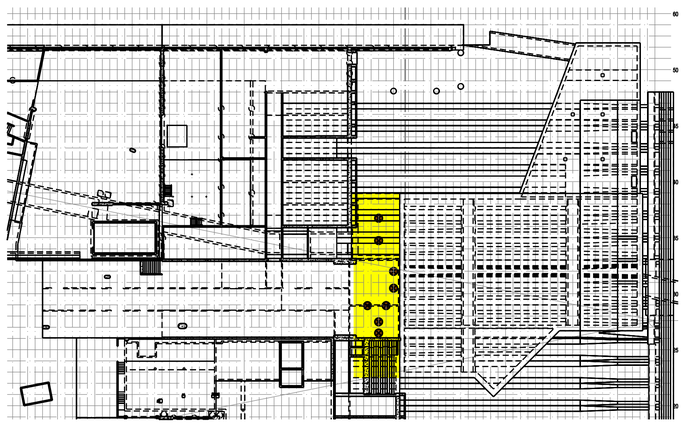
Stage 4
a) Excavate shaded area and install additional props, where shown



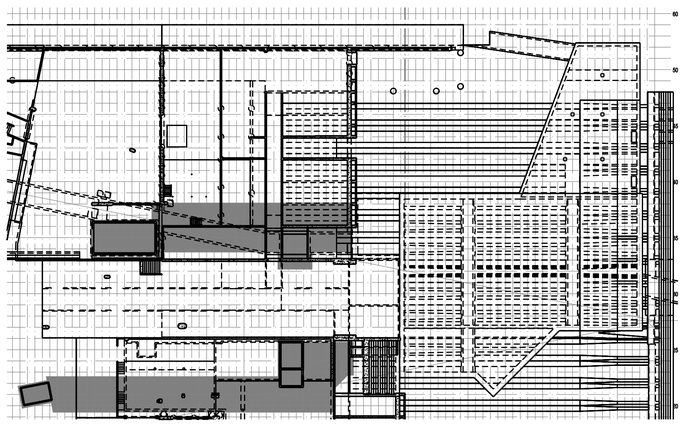
Stage 5
a) Excavate shaded area, as shown



Stage 6
a) Construct shaded walls
b) Construct base slab



Stage 7
a) Excavate shaded area under existing structure between grids Y33-Y39
b) Install props under existing tie beams
c) Excavate remaining shaded area under existing structure
d) Install props under existing foundations
e) Construct new walls within shaded zone
f) Construct 700 thick slab



Stage 8
a) Excavate tunnels, as shaded
b) Construct tunnel structure

Notes:
- ⊗ indicates prop location.

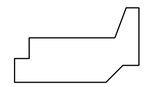
General Notes
Do not scale from drawing. Use marked dimensions.
To be read in conjunction with all other Consultant's drawings.
The Architect to be immediately notified of any discrepancies.

Grid Lines
Original Building Grid to be used.
NEW WORK shown set out to Original Building Grid.
EXISTING BUILDING shown based Original Building Setout & Survey.
Contractor to make Check Survey before commencing ANY construction.

Legend
Reference on drawings to floor level in Imperial units are historical labels and are not to be used for measurements.

Rev	Description	Date	Chk	App
01	Concept Design	21/05/10	MC	MC

Key Plan



Scale / North Point
1:500

Project Title
Sydney Opera House
VAPS Project

SOH Contract | **Location** VAPS | **Level** GR

Drawing Title
Proposed Works
Staging Layouts

Project Number 220133-00
Drawing Number SK-40
Revision 01
Drawing Status CONCEPT DESIGN
Discipline STRUCTURAL

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