

## **Appendix C – Noise and vibration technical report**

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# Wynyard Station Upgrade

## Construction Noise and Vibration Impact Assessment



## Wynyard Station Upgrade

### Construction Noise and Vibration Impact Assessment

Client: Transport for NSW

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## Quality Information

Document Wynyard Station Upgrade





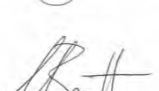
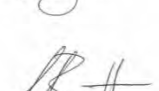
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## 1.0 Introduction

### 1.1 The proposal

Transport for NSW (TfNSW) proposes to upgrade Wynyard Station in Sydney (the proposal) to accommodate the expected future passenger demand at the station and improve the station amenity. The proposal is being assessed under the provisions of Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). For the purposes of these works, TfNSW is the proponent and the determining authority under Part 5 of the EP&A Act.

The key features of the proposal include:

- Refurbishment of the York Street foyer.
- Reconfiguration of the unpaid concourse area, including widening the northern concourse area and inclusion of the southern unpaid concourse area within the expanded paid concourse.
- Expansion of the paid concourse area and reconfiguration of the gateline to respond to pedestrian movements, including the provision of new ticket gates.
- Refurbishment of the concourse level.
- Refurbishment and de-cluttering of Platforms 3 and 4 and provision of a new staircase between the platforms and the paid concourse area.
- Refurbishment and de-cluttering of Platforms 5 and 6, including demolition of the former escalator enclosures and re-orientation of one staircase between the platforms and the paid concourse area.
- Reconfiguration of the station facilities, including relocation of the Station Manager's Office and new or refurbished amenities (such as public and staff toilets).
- Fit out of Transport House basement levels for station facilities, including the reconstruction of stairs to the concourse.
- Other works relating to the provision of services to support the station upgrade, within roof and wall cavities throughout the station and within adjoining properties.

Construction works for the proposal are required to be carried out 24 hours, seven days a week to enable the station to remain operational, to avoid unacceptable impacts on the broader Sydney rail network and to manage noise impacts on passengers, station staff, retailers and commercial properties. Further detail on the construction activities is provided in **Chapter 4**.

### 1.2 Purpose of this report

AECOM Australia Pty Ltd (AECOM) has been commissioned by TfNSW to undertake a Construction Noise and Vibration Impact Assessment of the proposed Wynyard Station Upgrade (WSU) project. This report supplements the REF for the proposal.

The scope of this construction noise impact assessment is as follows:

- Establish the existing background noise levels in the vicinity of Wynyard Station.
- Establish the environmental noise and vibration limits that would apply during construction of the station upgrade.
- Predict changes in road traffic noise levels from additional traffic generated by the construction.
- Determine the likely impacts of construction noise and vibration generated by the works on nearby sensitive receivers, retail receivers and pedestrians (including commuters) within the station.
- Where necessary, provide details of reasonable and feasible mitigation measures to reduce noise and vibration impacts from the works.

The proposed upgrade to Wynyard Station essentially comprises station infrastructure upgrades and would not result in changes to existing train movements at the station. As such, rail noise (including regenerated noise) would not change and has not been assessed as part of this proposal in accordance with the *Rail Infrastructure Guideline* (RING).

The replacement and/or relocation of existing plant and substations, the installation of building services systems within new office spaces, as well as the installation of additional operational plant (such as water treatment plant), could introduce additional noise sources within back-of-house areas. However, these are not expected to give rise to increased operational noise levels within the station or to nearby sensitive receivers given they would be installed within existing enclosed plant rooms underground and/or away from public areas.

Emergency ventilation systems would also be installed within the modified or new staircases. As these would only be used during times of an emergency (for example, during a fire), these systems have not been assessed. However, any such system would need to be installed in accordance with Australian Standards, which provide maximum sound pressure levels within occupied spaces and fire isolated exits.

Definitions for acoustic terminology used within this report can be found within **Appendix A**.

### 1.3 Relevant guidelines

The following policies and guidelines are relevant for this assessment:

- *Interim Construction Noise Guideline (ICNG)*, Department of Environment and Climate Change (DECC), 2009.
- *Assessing Vibration: A Technical Guideline (AVATG)*, Department of Environment and Conservation (DEC), 2006.
- *NSW Road Noise Policy (RNP)*, Department of Environment, Climate Change and Water (DECCW), 2011.
- *NSW Industrial Noise Policy (INP)*, Environment Protection Authority (EPA), 2000.
- *Rail Infrastructure Noise Guideline (RING)*, Environment Protection Authority (EPA), 2013.
- *Construction Noise Strategy (CNS)* Transport Construction Authority (TCA), 2011.
- *German Standard DIN Standard 4150: Part 3 1999 Structural Vibration in Buildings - Effects on Structures*, 1999.
- *British Standard 7385: Part 2 1993 Evaluation and Measurement of Vibration in Buildings*, 1993.
- *British Standard 6472: Part 1 2008 Evaluation of Human Exposure to Vibration in Buildings*, 2008

## 2.0 Existing environment

### 2.1 Wynyard Station

Wynyard Station is located in the north of Sydney's CBD. At the surface, Wynyard Station is surrounded by George Street, Clarence Street, Wynyard Lane, York Street, Erskine Street and Margaret Street (refer to **Figure 1**). The platforms and paid concourse area are located directly below York Street and Wynyard Park. Part of the station is within Transport House, including the York Street foyer. The existing configuration of Wynyard Station is shown on **Figure 2** and **Figure 3**.

Wynyard Station comprises public domain areas (including the paid and unpaid concourse areas, the platforms and mezzanine level below Wynyard Park dome) and station facilities (which include the Station Manager's Office and back-of-house facilities, and customer amenities such as public toilets and telephones, vending machines and ATMs, and retail and commercial spaces).

The existing station layout comprises:

- Pedestrian access via:
  - four escalators within Transport House connecting the concourse level to York Street foyer
  - escalators, a pedestrian lift and stairs to Carrington Street and Wynyard Park
  - stairs to the Hunter Arcade
  - direct access to the Metcentre
  - direct access via two ramps to George Street.
- Fire stairs and emergency accesses and egresses.
- Station and rail operations systems, such as tunnel lighting, ticket gates, ticket vending machines, customer information systems and CCTV.
- Electrical, communications, mechanical and hydraulic services, such as power, fire systems, ultra-high frequency and mobile telephone services, air conditioning, ventilation and drainage. Services are provided for entrance, concourse and platform areas and are located within roof and/or wall cavity spaces, and in some instances interface with or extend into adjacent properties.
- Public domain areas, including:
  - The unpaid concourse area, which is divided into five areas, referred to in this document as the northern, eastern, southern, western and upper unpaid concourse areas. The upper unpaid concourse area is accessed via the Carrington Street escalators or lift.
  - The paid concourse area, separated from the unpaid concourse area by ticket gates.
  - Platforms 3 and 4, which are located upstairs from the paid concourse area and are accessed via four sets of stairs and a lift.
  - Platforms 5 and 6, which are located downstairs from the paid concourse area and are accessed via four sets of stairs and a lift.
  - York Street foyer.
  - Mezzanine areas which are located upstairs from the eastern unpaid concourse area and accessed via the Carrington Street escalators and lift.

- Station facilities, including:
  - Back-of-house areas:
  - Station Manager's office, staff amenities and storage rooms directly north of the paid concourse area.
  - Public facilities, including:
    - Public toilets directly south of the paid concourse area.
    - Other amenities for customers, such as public telephones and ATMs.
  - Station facilities directly south of the paid concourse area.
  - Retail and commercial spaces:
    - Concourse Bar.
    - Individual food, service-related and retail outlets.
  - Redundant and remnant features from previous works, including escalator enclosures and stair cases.

The Kent Street pedestrian tunnel has been closed as part of the Wynyard Walk project.

There is no direct vehicular access to Wynyard Station. Deliveries to the retail facilities located in the unpaid concourse area and surrounding pedestrian links are conducted via George Street, Carrington Street and York Street.

Access is also provided via two goods lifts located on Wynyard Lane and York Lane. The goods lift located on Wynyard Lane is also used by other businesses, including Coles and the Menzies Hotel. The second goods lift, accessed via York Lane, is located in Transport House and services the basement levels of Transport House. Currently York Lane has restricted access, due to construction works associated with Wynyard Walk.

The basement levels (excluding the western concourse area which extends into Transport House) are currently vacant, used for building services (such as plant rooms) or being occupied by Wynyard Walk construction activities.



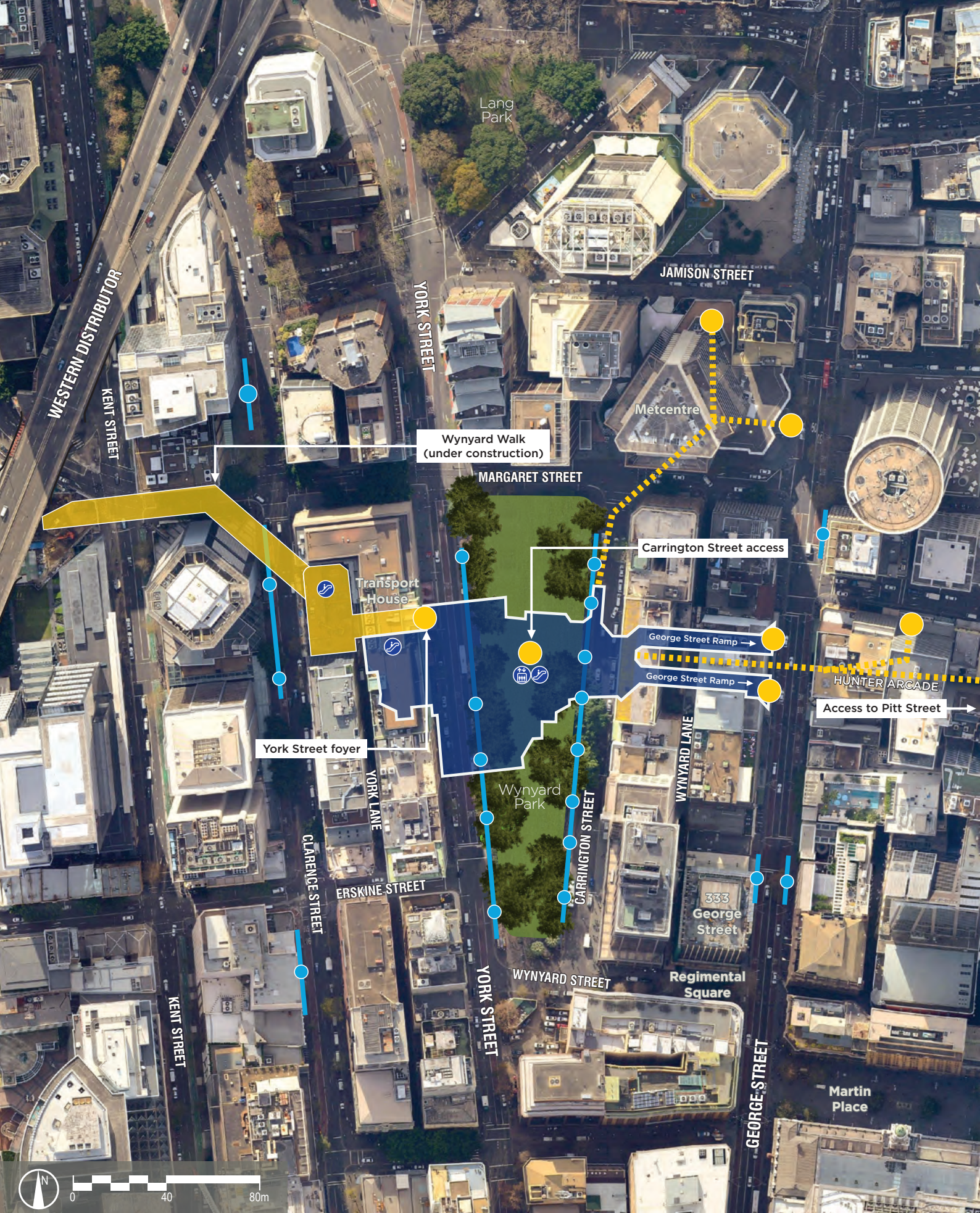




Figure 1 - Surrounding road network and key pedestrian accesses for Wynyard Station

- |   |   |   |
|---|---|---|
| <span style="display: inline-block; width: 20px; height: 10px; background-color: #003366; border: 1px solid black;"></span> Wynyard Station | <span style="display: inline-block; width: 20px; height: 10px; background-color: #0070C0; border: 1px solid black;"></span> Bus zone                      |  Escalator   |
| <span style="display: inline-block; width: 20px; height: 10px; background-color: #FFD700; border: 1px solid black;"></span> Wynyard Walk    | <span style="display: inline-block; width: 10px; height: 10px; background-color: #0070C0; border: 1px solid black; border-radius: 50%;"></span> Bus stand |  Lift  |
|   |   | <span style="display: inline-block; width: 10px; height: 10px; background-color: #FFD700; border: 1px solid black; border-radius: 50%;"></span> Pedestrian access point |



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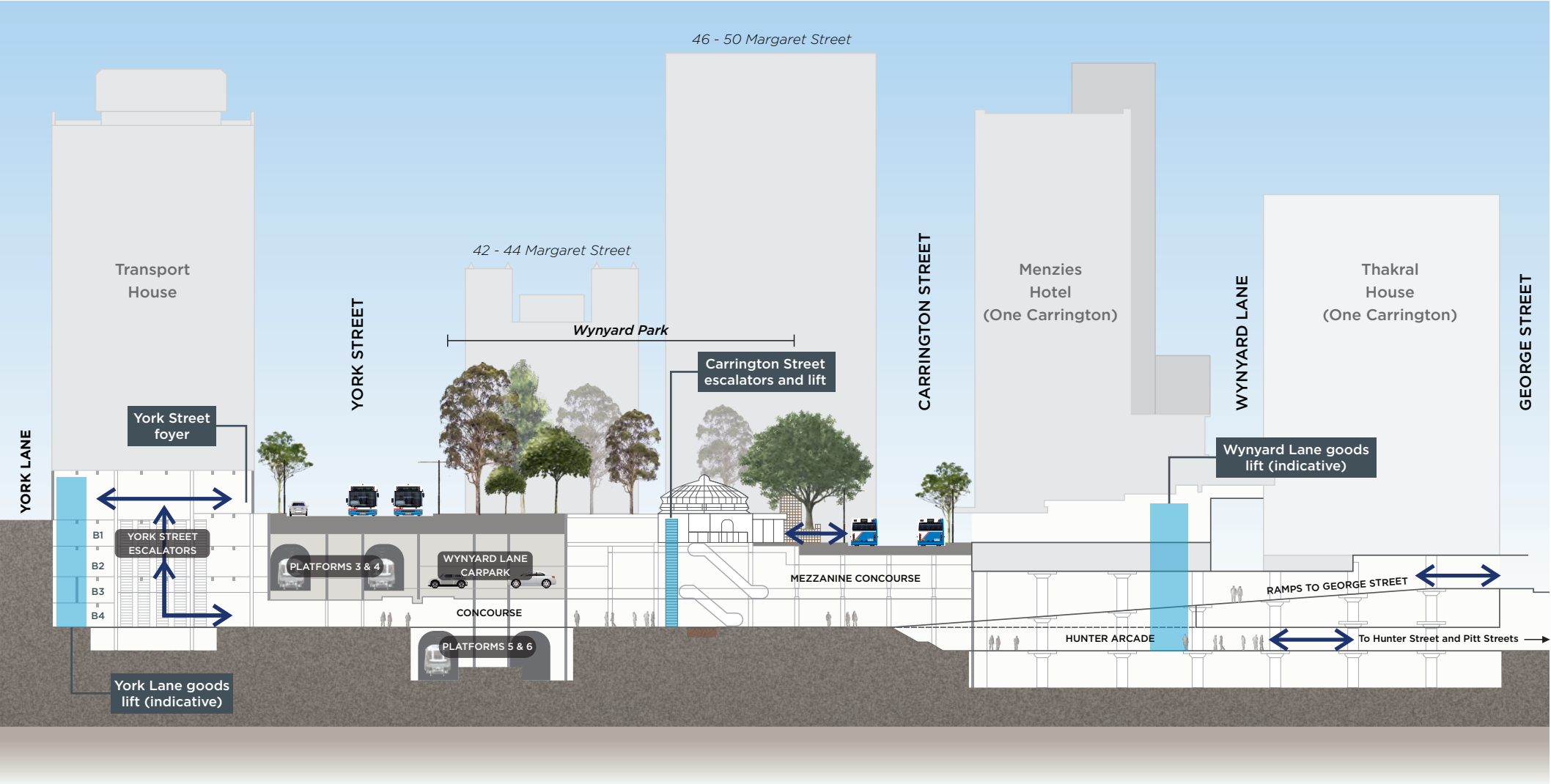
Figure 2 - Existing Wynyard Station layout - concourse level

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WEST

EAST



NOT TO SCALE

Figure 3 - Wynyard Station cross section

-  Lift
-  Current main access

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## 2.2 Surrounding land uses

### 2.2.1 Pedestrian arcades

Three pedestrian arcades have direct connections to Wynyard Station: the Metcentre, the George Street ramps and the Hunter Arcade. These contain numerous individual food, service-related and retail stores.

### 2.2.2 Wynyard Lane Car Park

The Wynyard Lane Car Park is located directly adjacent to the eastern wall of Platform 3, and is accessed by customers via the upper unpaid concourse area. Vehicular access to the car park is via Wynyard Lane. Vehicles exit the public car park via Cumberland Street.

### 2.2.3 Areas above ground

The areas above ground in the immediate vicinity of Wynyard Station consist of high density commercial land uses, with occasional residential buildings, hotels and churches. For the purposes of this assessment, hotel receivers have been distinguished from other commercial uses to provide a conservative assessment of potential noise impacts,

Key non-retail receivers surrounding the station include:

- The Menzies Hotel, 2 Carrington Street.
- Residential apartments at 42 – 44 Margaret Street.
- Scots Presbyterian Church, located on the ground floor of 42 – 44 Margaret Street.
- St Phillip's Anglican Church, 2 York Street Sydney.
- Travelodge Wynyard, 7-9 York Street, Sydney.
- The York by Swiss-Belhotel, 5 York Street, Sydney.
- The Carrington Apartments (serviced apartments), 57 – 59 York Street, Sydney.
- Navitas Professional, La Trobe University, Sydney Institute of Business and Technology, Macquarie University, and the Australia College of Applied Psychology, 11-17 York Street, Sydney.
- 50 Clarence Street, Sydney.
- The Amora Hotel, 11 Jamison Street, Sydney.

The nearest residential receivers are located to the north of the station at 42 – 44 Margaret Street, Sydney. The nearest hotel receivers are located at the Menzies Hotel, located directly adjacent to Wynyard Park, at 14 Carrington Street, Sydney.

Wynyard Park represents a key landscaped open space area in the vicinity of the station, which is heavily used by the surrounding population. Wynyard bus stops are located around the perimeter of this park.

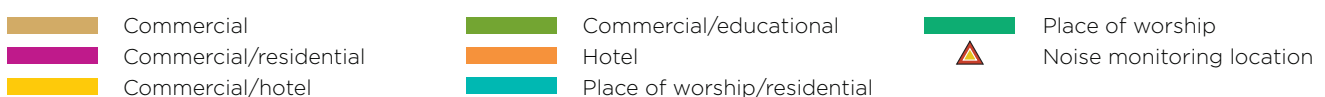
Receivers in the vicinity of Wynyard Station are identified on **Figure 4**.

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**Figure 4 - Sensitive and other noise receivers**





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#### 2.2.4 Surrounding development activities

There are five development projects currently in planning or construction phases proximate to the proposal site. These include:

- One Carrington Street – a commercial office tower development located immediately east of the proposal site. This project would impact the George Street ramps and Wynyard Lane.
- Wynyard Walk – provision of a new western entrance to Wynyard Station from Barangaroo.
- CBD and South East Light Rail (CSELR) – provision of light rail along George Street.
- 333 George Street redevelopment - A new commercial and retail tower development located adjacent to Regimental Square with street frontages on George Street and Wynyard Lane.
- Sydney City Centre Bus Infrastructure modifications, which include changes to bus infrastructure within the immediate vicinity of Wynyard bus stops.

These projects are discussed further in **Section 4.2** of this report.

### 2.3 Background noise monitoring

Noise monitoring was conducted to determine existing background noise levels at sensitive receivers (residences, places of worship and hotels). A noise logger was located on the balcony of the 3<sup>rd</sup> floor of the Travelodge on York Street, Sydney. The noise logger monitored noise levels continuously from 17-23 June 2014. A second noise logger was located on a balcony on the second story of Lisgar House, 30-32 Carrington Street, Sydney. The noise logger logged from 3-13 July 2014.

The noise logger used was a type 1 Cirrus CK 680 (serial no. G061710). It was calibrated prior to and after the monitoring sessions with a drift within  $\pm 0.5$  dB and holds relevant NATA calibration certificates.

The logger measured the noise levels over the sample periods and then determined  $L_{A10}$ ,  $L_{A90}$ ,  $L_{Amax}$ , and  $L_{Aeq}$  levels of the noise environment. The  $L_{A10}$  and  $L_{A90}$  levels are the levels exceeded for 10 percent and 90 percent of the sample period respectively. The  $L_{Amax}$  is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The  $L_{A90}$  is taken as the background noise level. The  $L_{Aeq}$  level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The background noise level is defined by the EPA as *'the underlying level of noise present in ambient noise when all unusual extraneous noise is removed'*. It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is considered to be represented by the  $L_{A90}$  descriptor. The noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the EPA's NSW *Industrial Noise Policy* (INP), for each monitoring location. The ABL is established by determining the lowest ten-percentile level of the  $L_{A90}$  noise data acquired over each period of interest. **Table 1** presents individual ABLs for each day's assessment periods.

The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period. **Table 1** also presents the existing  $L_{Aeq}$  ambient noise level selected for each day, evening and night-time period, in accordance with the INP. An overall representative  $L_{Aeq}$  noise level is determined by logarithmically averaging each assessment period for the entire monitoring period.

Noise monitoring conducted during periods of extraneous weather conditions was excluded from the data set. The INP advises that data may be affected where adverse weather such as wind speeds higher than 5 m/s or rain occurs. Given the proximity of the noise loggers to each other and low variability of the measured noise levels, the collected data was deemed sufficient to provide representative noise levels of the area.

Graphical noise logging results are presented in **Appendix B** and periods where data has been omitted are indicated.

**Table 1 Existing background (L<sub>A90</sub>) and ambient (L<sub>Aeq</sub>) noise levels**

Measurement Date	L <sub>A90</sub> Background Noise Levels, dB(A)			L <sub>Aeq</sub> Ambient Noise Levels, dB(A)		
	Day <sup>1</sup>	Evening <sup>2</sup>	Night <sup>3</sup>	Day <sup>1</sup>	Evening <sup>2</sup>	Night <sup>3</sup>
<b>Travelodge on York Street, Sydney</b>						
Tuesday 17 June, 2014	-	60	- <sup>4</sup>	-	67	- <sup>4</sup>
Wednesday 18 June, 2014	64	60	55	70	68	64
Thursday 19 June, 2014	64	61	55	70	68	65
Friday 20 June, 2014	64	61	55	70	68	64
Saturday 21 June, 2014	58	59	55	66	66	65
Sunday 22 June, 2014	59	58	54	66	64	61
Monday 23 June, 2014	- <sup>4</sup>	60	-	- <sup>4</sup>	68	-
<b>RBL</b>	<b>62</b>	<b>60</b>	<b>55</b>	-	-	-
<b>Log Average</b>	-	-	-	<b>69</b>	<b>67</b>	<b>64</b>
<b>Lisgar House, 30-32 Carrington Street, Sydney</b>						
Thursday, 3 July 2014	-	61	56	-	69	65
Friday, 4 July 2014	63	62	56	70	69	65
Saturday, 5 July 2014	- <sup>4</sup>	- <sup>4</sup>	56	- <sup>4</sup>	- <sup>4</sup>	65
Sunday, 6 July 2014	- <sup>4</sup>	59	56	- <sup>4</sup>	66	65
Monday, 7 July 2014	- <sup>4</sup>	61	55	- <sup>4</sup>	69	65
Tuesday, 8 July 2014	63	61	- <sup>4</sup>	70	69	- <sup>4</sup>
Wednesday, 9 July 2014	- <sup>4</sup>	- <sup>4</sup>	55	- <sup>4</sup>	- <sup>4</sup>	65
Thursday, 10 July 2014	- <sup>4</sup>	- <sup>4</sup>	56	- <sup>4</sup>	- <sup>4</sup>	65
Friday, 11 July 2014	64	62	56	70	69	65
Saturday, 12 July 2014	- <sup>4</sup>	- <sup>4</sup>	- <sup>4</sup>	- <sup>4</sup>	- <sup>4</sup>	- <sup>4</sup>
Sunday, 13 July 2014	- <sup>4</sup>	-	-	- <sup>4</sup>	-	-
<b>RBL</b>	<b>63</b>	<b>61</b>	<b>56</b>	-	-	
<b>Log Average</b>	-	-	-	<b>70</b>	<b>69</b>	<b>65</b>

**Notes:**

1. Day is defined as 7:00 am to 6:00 pm Monday to Saturday and 8:00 am to 6:00 pm Sundays and Public Holidays.
2. Evening is defined as 6:00 pm to 10:00 pm Monday to Sunday and Public Holidays.
3. Night is defined as 10:00 pm to 7:00 am Monday to Saturday and 10:00 pm to 8:00 am Sundays and Public Holidays.
4. Measurement omitted due to being affected by adverse weather conditions



## 3.0 Noise and vibration criteria

### 3.1 Construction activity noise criteria

The EPA's *Interim Construction Noise Guideline* (ICNG) is the principal guidance for the assessment and management of construction noise in NSW. This document is used as the basis for establishing construction noise management levels.

The ICNG recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the EIA process'. Predicted noise levels at nearby sensitive receivers are compared to the levels provided in Section 4 of the ICNG.

Where an exceedance of the management levels is predicted, the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practises to minimise the noise impact. The proponent should also inform all potentially impacted sensitive receivers of the nature of the works to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A), residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The Interim Construction Noise Guidelines defines what is considered to be feasible and reasonable as follows:

- *Feasible*  
*A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*
- *Reasonable*  
*Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."*

The construction noise management levels (NML) for residential receivers are detailed in **Table 2**.

**Table 3** presents the NMLs applicable to residences nearby to this proposal. It is noted that the measured background noise levels were very similar at the two logger locations – Logger 1 – Travelodge and Logger 2 – Lisgar House, therefore the more conservative data has been used to determine the NMLs.

**Table 2** Setting and applying noise at residences

Time of Day	NML, $L_{Aeq,15min}$ , dB(A) <sup>1</sup>	How to Apply
<b>Recommended standard hours:</b> Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. <ul style="list-style-type: none"> <li>Where the predicted or measured <math>L_{Aeq,15min}</math> is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> <li>The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.</li> </ul>
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. <ul style="list-style-type: none"> <li>Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ol style="list-style-type: none"> <li>Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences).</li> <li>If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.</li> </ol> </li> </ul>
<b>Outside recommended standard hours</b>	Noise affected RBL + 5 dB	<ul style="list-style-type: none"> <li>A strong justification would typically be required for works outside the recommended standard hours.</li> <li>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</li> <li>Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.</li> <li>For guidance on negotiating agreements see section 7.2.2 (ICNG).</li> </ul>

Notes:

- Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

**Table 3** Construction noise management levels – Residential receivers

Logging Location	Period	RBL, $L_{A90}$ dB(A)	Standard Hours Noise Management Levels, $L_{Aeq}$ dB(A)	Out of Hours Noise Management Levels, $L_{Aeq}$ dB(A)
Logger 1 <sup>1</sup>	Day	62	72	67
	Evening	60	N/A	65
	Night	55	N/A	60

1 - Travelodge

**Table 4** presents the noise management levels applicable to other noise sensitive receivers, such as educational facilities and places of worship and commercial receivers as recommended by the ICNG. Hotels have been

considered as a residential land use rather than a commercial land use. This provides a conservative assumption as the residential NML is more stringent than that which would be applied to a commercial receiver.

**Table 4 Construction noise management levels – Other receivers**

Land Use	Noise Management Levels, $L_{Aeq,15min}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	45 dB(A) Internal noise level
Places of worship	45 dB(A) Internal noise level
Passive recreational areas	60 dB(A) External noise level
Commercial Premises (including offices, retail outlets)	70 dB(A) External noise level

**Table 5** presents the noise management levels applicable to receivers within the Wynyard Station concourse area for the purposes of this assessment. As the retail spaces within the concourse area have open fronts, the noise management level for retail spaces from **Table 4** has been reduced by 10 dB. This is to take account of the fact that the façades are not likely to provide the same noise attenuation as the façade of a standard retail space on street level.

**Table 5 Construction noise management levels – Receivers within the concourse area**

Land Use	Noise Management levels, $L_{Aeq,15min}$ (applies when properties are in use, eg when retail outlets are open)
Commercial premises (including offices, retail outlets)	60 dB(A) External noise level

### 3.2 Additional construction noise and vibration mitigation measures

TfNSW's *Construction Noise Strategy* (CNS) provides practical guidance on how to minimise, to the fullest extent practicable, the impacts on the community from airborne noise, ground-borne noise and vibration generated during the construction of TfNSW projects, through the application of feasible and reasonable mitigation measures. Where exceedances are still expected to occur after standard mitigation measures have been applied, the CNS recommends the implementation of the additional mitigation measures shown in **Table 6**, **Table 7**, **Table 8** and **Table 9** below.

The provision of additional mitigation is based on the predicted exceedances above RBLs and when the exceedances occur. The RBLs can be found in **Table 1**.

**Table 6 Additional mitigation measure matrix – Airborne noise**

Time period		Mitigation measures L <sub>Aeq(15min)</sub> noise level above background noise level (RBL) Qualitative assessment of noise levels			
		0 – 10 dB(A) Noticeable	10 – 20 dB(A) Clearly Audible	20 – 30 dB(A) Moderately Intrusive	>30 dB(A) Highly Intrusive
Standard	Weekday (7am-6pm)	-	-	LB, M	LB, M
	Saturday (8am-1pm)				
	Sun/Pub Hol (Nil)				
Out of hours works period 1	Weekday (6pm-10pm)	-	LB	LB, M	M, IB, LB, RO, PC, SN
	Saturday (7-8am) & (1-10pm)				
	Sun/Pub Hol (8am-6pm)				
Out of hours works period 2	Weekday (10pm-7am)	LB	LB, M	LB, M, IB, PC, SN	AA, M, IB, LB, PC, SN
	Saturday (10pm-8am)				
	Sun/Pub Hol (6pm-7am)				

Note: - Table 9 is to be read in conjunction with this table

**Table 7 Additional mitigation measure matrix – Ground-borne noise**

Time period		Mitigation measures	L <sub>Aeq(15min)</sub> noise level above background noise level (RBL)	Qualitative assessment of noise levels
		0 – 10 dB(A) Clearly Audible	10 – 20 dB(A) Moderately Intrusive	>20 dB(A) Highly Intrusive
Standard	Weekday (7am-6pm)	LB	LB	LB, M, SN
	Saturday (8am-1pm)			
	Sun/Pub Hol (Nil)			
OOHW Period 1	Weekday (6pm-10pm)	LB	LB, M, RO, SN	LB, M, IB, PC, SN, RO
	Saturday (7-8am) & (1-10pm)			
	Sun/Pub Hol (8am-6pm)			
OOHW Period 2	Weekday (10pm-7am)	LB, M, SN	M, IB, LB, PC, RO, SN, AA	M, IB, LB, PC, RO, SN, AA
	Saturday (10pm-8am)			
	Sun/Pub Hol (6pm-7am)			

Note: **Table 9** is to be read in conjunction with this table

**Table 8 Additional mitigation measure matrix – Ground-borne vibration**

Time period		Mitigation measures
Standard	Weekday (7am-6pm)	M, LB, RO
	Saturday (8am-1pm)	
	Sun/Pub Hol (Nil)	
OOHW Period 1	Weekday (6pm-10pm)	M, IB, LB, PC, RO, SN
	Saturday (7-8am) & (1-10pm)	
	Sun/Pub Hol (8am-6pm)	
OOHW Period 2	Weekday (10pm-7am)	M, IB, LB, PC, RO, SN, AA
	Saturday (10pm-8am)	
	Sun/Pub Hol (6pm-7am)	

Note: **Table 9** is to be read in conjunction with this table

**Table 9 Description of additional mitigation measures**

Abbreviation	Mitigation Measure	Explanation
LB	Letter Box Drops	All residences should be notified as a minimum by letterbox drop seven days ahead of construction activities.
M	Monitoring	Attended noise monitoring is to be undertaken as follows: At the commencement of out of hours works (within the first two nights), where out of hours works activities change; and Noise measurements shall be undertaken in accordance with the procedure documented in AS1055.1-1997 Acoustics - Description and Measurement of Environmental Noise - General Procedures.
IB	Individual Briefings	Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.
RO	Project Specific Respite Offer	Residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. The offer could comprise pre-purchased movie tickets or similar offer. This measure is determined on a project-by-project basis.
PC	Phone Calls	Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.
SN	Specific Notifications	Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise management levels. This form of communication is used to support periodic notifications, or to advertise unscheduled works.
AA	Alternative Accommodation	Alternative accommodation options should be provided for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level.

### 3.3 Sleep disturbance

The ICNG requires a sleep disturbance analysis where construction works are planned to extend over more than two consecutive nights. On the basis of the ambient noise environment during the night-time period, the predicted  $L_{A1}$  noise levels and number of expected  $L_{A1}$  noise events should be predicted in order to determine the likelihood of potential sleep disturbance.

The ICNG makes reference to the NSW *Environment Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999), now superseded by the *Road Noise Policy* (RNP), for guidance in assessing the potential for sleep disturbance.

The guidance provided in the RNP for assessing the potential for sleep disturbance recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the  $L_{A1(1 \text{ min})}$  noise level outside a bedroom window should not exceed the  $L_{A90(15 \text{ minute})}$  background noise level by more than 15 dB. The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, '*Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions*'. Therefore, given that a closed window will provide approximately 20 dB in noise attenuation from outside to inside, external noise levels of 70-75 dB(A) are unlikely to result in awakening reactions. At this location, it is considered reasonable to assume windows would remain closed within residential and hotel buildings during the night-time, due to the existing high road traffic noise levels and the likely use of air conditioning systems for cooling. For this assessment a sleep disturbance screening criteria of 70 dB(A) at the affected façade has been adopted.

### 3.4 Construction traffic noise criteria

The EPA's *Road Noise Policy* (RNP) is the current State policy document for assessing road traffic noise. In the absence of any alternate guidance, it has been used to assess the noise arising from construction traffic movements generated by the proposed development. The RNP does not require assessment of noise impact to commercial or industrial receivers.

York, Margaret, Carrington, Clarence and George Streets are located within close proximity to the site. George Street is considered to be an arterial road and the other streets are considered to be sub-arterial roads as per categories within the RNP. York, Carrington, Clarence and George Streets carry significant volumes of bus traffic, particularly during peak travel times.

**Table 10** presents the road traffic noise criteria from the RNP. The external noise criteria are applied 1 metre from the external facade of the affected building.

**Table 10 Road traffic noise criteria**

Road category	Type of project/land use	Assessment criteria, dB(A)	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Arterial / sub-arterial roads	Existing residences affected by additional traffic on existing roads generated by land use developments	$L_{Aeq,15hr}$ 60	$L_{Aeq,9hr}$ 55

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. Noise mitigation is therefore not considered where noise increases are less than 2 dB. In this case, existing road traffic noise levels do exceed the RNP criteria and the 2 dB allowance is triggered.

### 3.5 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in **Table 11**.

**Table 11 Standards/guidelines used for assessing construction vibration**

Item	Standard/guideline
Structural damage	<i>German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)</i> <i>British Standard 7385: Part 2 1993 Evaluation and Measurement of Vibration in Buildings (BS 7385)</i>
Human comfort (tactile vibration) <sup>1</sup>	<i>Assessing Vibration: A Technical Guideline (AVATG)</i>

Note 1: This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- Continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities for example, a tunnel boring machine.
- Impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities.
- Intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

#### 3.5.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in **Table 12**. DIN 4150 states that for buildings exposed to higher levels of vibration than recommended vibration would not necessarily result in damage.

BS 7385 is referenced in the TfNSW's *Construction Noise Strategy*. However, the DIN 4150 provides more stringent criteria, as well as criteria for structures that are sensitive to vibration (such as heritage buildings). As such, BS 7385 has not been considered further in this assessment.

**Table 12** DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

### 3.5.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline *Assessing Vibration: A Technical Guideline* is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in **Table 13**. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

**Table 13** Preferred and maximum vibration dose values for intermittent vibration ( $\text{m/s}^{1.75}$ )

Location	Daytime (7 am – 10 pm)		Night-time (10 pm – 7 am)	
	Preferred	Max	Preferred	Max
Residences	0.2	0.4	0.13	0.26
Offices, educational institutions and places of worship	0.4	0.8	0.4	0.8

### 3.5.3 Ground-borne noise

Vibration generated by activities such as the use of impact drills and hand-held breakers may travel through the building structure and enter building spaces. This causes the floors, walls and ceilings to vibrate and to radiate noise. This noise is commonly referred to as structure or ground-borne noise or regenerated noise. Ground-borne noise is typically low frequency and if audible, is perceived as a 'rumble'.

In general, ground-borne noise level values are relevant only where they are higher than the airborne noise from the construction activities such as where there is significant shielding from the location where the construction activities are being undertaken.

The ground-borne noise management levels as outlined in the ICNG are adopted for this project and presented in **Table 14**. The ground-borne noise levels are applicable during the evening and night-time periods only, as the objective is to protect the amenity and sleep of people when they are at home. An additional management level has been developed for commercial and educational receivers and is shown in **Table 14**, as these receivers are not covered by the ICNG.



**Table 14 Recommended ground-borne noise goals for construction activities**

Time	Ground-borne noise goals
Residential receivers	
Evening (6pm to 10pm)	40 dB(A) $L_{Aeq}$ (15 min)
Night-time (10pm to 7am)	35 dB(A) $L_{Aeq}$ (15min)
Commercial and educational receivers <sup>1</sup>	
When in use	45 dB(A) $L_{Aeq}$ (15 min)

Note 1: *The ICNG does not present ground-borne noise management levels for non-residential spaces. This has been based on a relaxation of 5 dB(A) from the residential criterion.*

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## 4.0 The proposal

### 4.1 Proposal overview

The upgrade to Wynyard Station would increase capacity and improve pedestrian flows in order to meet current and future passenger demand. The proposal would include:

- Refurbishment of the York Street foyer.
- Reconfiguration of the unpaid concourse area, including widening the northern concourse area and inclusion of the southern unpaid concourse area within the expanded paid concourse.
- Expansion of the paid concourse area and reconfiguration of the gateline to respond to pedestrian movements, including the provision of new ticket gates.
- Refurbishment of the concourse level.
- Refurbishment and de-cluttering of Platforms 3 and 4 and provision of a new staircase between the platforms and the paid concourse area.
- Refurbishment and de-cluttering of Platforms 5 and 6, including demolition of the former escalator enclosures and re-orientation of one staircase between the platforms and the paid concourse area.
- Reconfiguration of the station facilities, including relocation of the Station Manager's Office and new or refurbished amenities (such as public and staff toilets).
- Fit out of Transport House basement levels for station facilities, including the reconstruction of stairs to the concourse.
- Other works relating to the provision of services to support the station upgrade, within roof and wall cavities throughout the station and within adjoining properties.

The proposed layout is shown in **Figure 5**.

Works associated with the proposal would be undertaken across multiple levels: York Street level, the basement levels of Transport House, the station concourse and mezzanine level, station platforms, basement levels of the Menzies Hotel and within the Hunter Arcade. Construction access may also require temporary works within the Wynyard Lane public car park and in Wynyard Park.

Wynyard Station would remain operational during the upgrade and passenger services would be maintained throughout construction of the proposal. The following key functional requirements would be maintained during construction:

- A safe and operational station.
- Effective flow paths, fire and life safety provision for pedestrians throughout all stages of work
- Appropriate interfaces with surrounding land uses and developments, including the Metcentre, Wynyard Walk, and the proposed One Carrington Street development including the George Street ramps and the Hunter Arcade.
- Minimal disruption, where feasible, to surrounding businesses and properties.

For these reasons, construction works for the proposal are required to be carried out 24 hours, seven days a week. This is discussed further in **Section 4.1.4**.

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Figure 5 - Proposed Wynyard Station - concourse layout (indicative)

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#### 4.1.1 Construction program and activities

The estimated construction duration of the proposal is approximately 18 months, with site establishment and enabling works scheduled to occur in the first quarter of 2015.

An indicative construction program is provided in **Table 15**. The final staging and works associated with each stage would be determined by the contractor during detailed design and construction planning.

As shown in **Table 15**, a number of construction activities would occur concurrently. However, some activities must occur sequentially to ensure the station remains operational.

Investigative and early works (not the subject of this assessment) have commenced.

**Table 15 Construction program**

Activity	2015				2016	
	Q1	Q2	Q3	Q4	Q1	Q2
<b>Site establishment and enabling works</b>						
<b>Station platform works</b>						
<b>Unpaid concourse</b>						
Eastern concourse						
Northern unpaid concourse						
Western concourse and York Street foyer						
<b>Station facilities construction and fit out, including Transport House basements</b>						
<b>Paid concourse</b>						
Concourse de-cluttering and refurbishment						
Widening to the east and ticket gates						
Widening to the west and ticket gates						
<b>Demobilisation</b>						

The works associated with each stage of the construction program are discussed below.

##### *Site establishment and enabling works*

Site establishment works would include the installation of hoarding along the unpaid concourse and platforms, demolition of retail spaces and some back-of-house areas and the installation of temporary toilets. As part of the enabling works, redundant structures and retail spaces located within the eastern unpaid concourse would be removed to increase space for pedestrian flows during construction. Site compounds would also be established at this stage, with necessary works to facilitate access to construction areas. This could include the installation of temporary construction hoists to each platform and a hoist between Wynyard Lane Car Park and the concourse (with a potential extension to Wynyard Park if required).

The southern unpaid concourse would be closed to the general public at this time and the toilets, retail and office spaces located adjacent to the southern concourse demolished. This would be subject to further pedestrian modelling during detailed design to ensure adequate pedestrian flows are maintained.

Enabling activities would include the installation and/or adjustment of utilities and rail systems. These activities would occur progressively as construction works commence within the public domain and station facilities. Redundant services would be removed following the installation and testing of the new systems.

##### *Platform works*

Platform works would involve the de-cluttering and refurbishment of the four station platforms, refurbishment of existing stairs, construction of new stairs and the demolition of redundant stairs.

#### *Unpaid concourse area*

Works associated with the unpaid concourse area would be coordinated with other work areas in the station as well as the Wynyard Walk project. It is likely that works would focus initially on the eastern unpaid concourse area. More significant construction works would shift to the northern and western unpaid concourse areas (including York Street foyer) once the relocated Station Manager's Office is operational. Final works in this area would be carried out once Wynyard Walk excavation works are complete.

A temporary works platform would be provided above the York Street escalators for construction works to be safely undertaken above the escalators.

#### *Station facilities*

These works would entail the construction and fit out of the back-of-house areas, works within Transport House basements and the replacement of existing stairs connecting the basement levels of Transport House to York Street and the concourse level. This includes the construction, fit out and commissioning of the new Station Manager's Office to enable the existing office to be demolished as part of the widening of the northern unpaid concourse. Station facilities that would not be used for back-of-house purposes would be serviced.

#### *Paid concourse area*

The expansion, de-cluttering and refurbishment of the paid concourse area would be coordinated with other work areas in the station including station platforms. Works would generally progress from east to west to reflect works within the unpaid concourse area. The majority of the major works, being the widening of the concourse area and installation of ticket gates, would be undertaken in the final stages of the program.

#### *Demobilisation*

Temporary facilities (such as construction compounds, toilets and hoist structures) would be removed, along with hoarding, and finishing details would be completed.

### **4.1.2 Construction access**

There are multiple access points to Wynyard Station that would be used during the construction of the proposal as detailed below (refer to **Figure 6**). It is anticipated that the primary access points would be used regularly for the duration of construction works, and the secondary access points would be used less frequently.

#### **Primary access points**

##### **- Margaret Street and George Street.**

Direct access to the concourse via the George Street ramps would be facilitated by the provision of a works zone on the westbound lane of Margaret Street between George Street and Carrington Street. This would allow materials to be loaded/unloaded and transported from the George Street ramps via the existing footpath using forklifts, skates and trolleys. There may be a need to trim or remove the existing tree adjacent to the loading/unloading area in Margaret Street to accommodate the works. For safety reasons the pedestrian pathway adjacent to Margaret Street may be closed while material is moved from the station via the George Street ramps. Loading/unloading may also occur directly on George Street.

##### **- Wynyard Lane**

Two access points are proposed on Wynyard Lane, an existing goods lift (located in the Menzies Hotel) and the Wynyard Lane Car Park. As part of the Wynyard Lane Car Park access point, a temporary construction hoist would be established between the car park and the station concourse below.

The material would be transported to/from Wynyard Lane to the goods lift (via an existing driveway) or to/from Wynyard Lane Car Park (to access the temporary construction hoist) using a forklift, skates or trolleys.

If Wynyard Lane becomes unavailable, heavy vehicles would load and unload on Cumberland Street opposite the current exit of the Wynyard Lane Car Park with material transported to the temporary construction hoist via the car park tunnels. The Cumberland Street access would require the use of space on the westbound lane of Cumberland Street, which currently contains four restricted off street car parking areas (for authorised vehicles).

## Secondary access points

### - York Lane

Occasional construction access would be provided via York Lane to access Transport House and the York Lane lift, with heavy vehicles unloading/loading in York Lane. The lift would be used until it is decommissioned and reconstructed as part of this proposal. As York Lane is partly closed due to Wynyard Walk construction, vehicles would need to reverse into the lane under traffic control.

### - York Street

An existing loading zone on York Street would be used for the purposes of the project until the zone is removed as part of the Sydney City Centre Bus Infrastructure modifications

### - Carrington Street

Occasional access to the concourse would be provided using the passenger lift and escalators within the Wynyard Park dome via Carrington Street. The material would be transported from Carrington Street to the lift using forklifts, telehandlers, skates or trolleys.

### - Hi-rail access

Hi-rail access (for on-track plant such as a lifter and trailers to bring in materials via rail) to Platforms 5 and 6 would be provided via hi-rail on-ramps west of Circular Quay Station. For Platforms 3 and 4, hi-rail access points south of North Sydney Station and north of Central Station would be used. This would only be available when trains are not running (for example, during weekend possessions).

Priority would be given to using existing access points via George Street ramps and Wynyard Lane goods lift, together with access via the Wynyard Lane Car Park and temporary construction hoist constructed from the car park to the concourse (subject to negotiation with the landowner). Should these access points no longer be available or become insufficient for construction requirements, the Wynyard Park compound and associated construction hoist (to the car park below) would proceed.

An indicative layout of Wynyard Park compound is provided in **Figure 7**. The use of the Wynyard Park compound (if required) would occur within and outside standard construction hours, however deliveries would only occur between 8pm and 10pm. It would be necessary to utilise part of York Street to provide a works zone for two heavy vehicles for deliveries. Material would be loaded/unloaded using forklifts and trolleys between the stopping zone and the compound. Pedestrian and traffic control measures would be required while the loading and unloading of heavy vehicles is underway.

There would also be four internal vertical access points to improve access from the concourse areas to the platforms during construction, including:

- A new construction hoist from the southern concourse area to Platforms 5 and 6 close to the existing disused escalator enclosure.
- A new construction hoist from the southern concourse area to Platforms 3 and 4 via a new aperture in Platforms 3 and 4 that would be used for the proposed new staircase.
- The existing glass lift from the concourse area to Platforms 3 and 4.
- The existing glass lift from the concourse area to Platforms 5 and 6.

Access for personnel and minor hand held deliveries would be via:

- Transport House fire stairs via York Lane.
- Transport House lift via York Street foyer.
- York Street escalators.
- Platform stairs.
- Hunter Arcade tunnel and stairs.
- Metcentre.
- Northern fire stairs from the eastern concourse area to Wynyard Park and Carrington Street.
- George Street ramps.



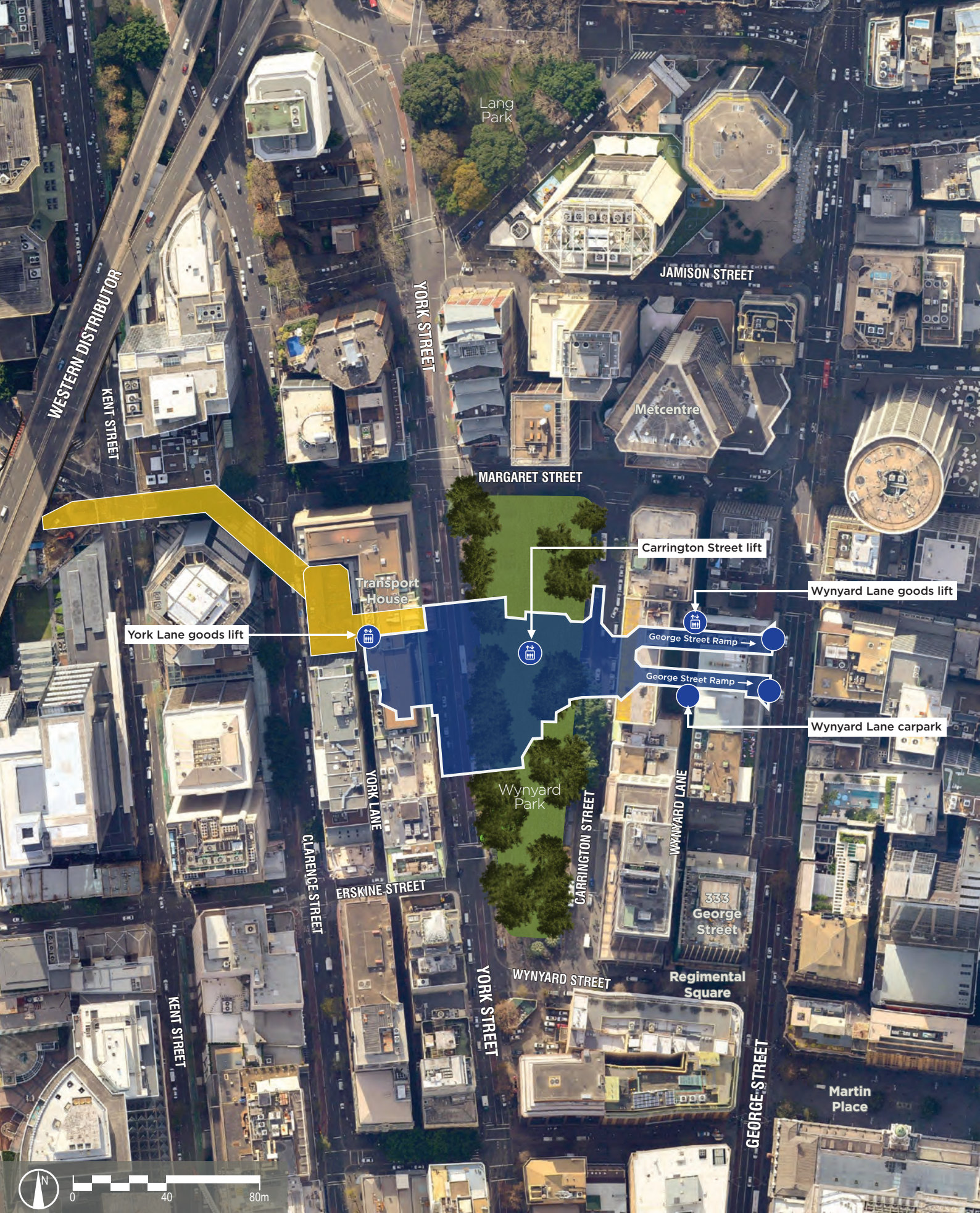


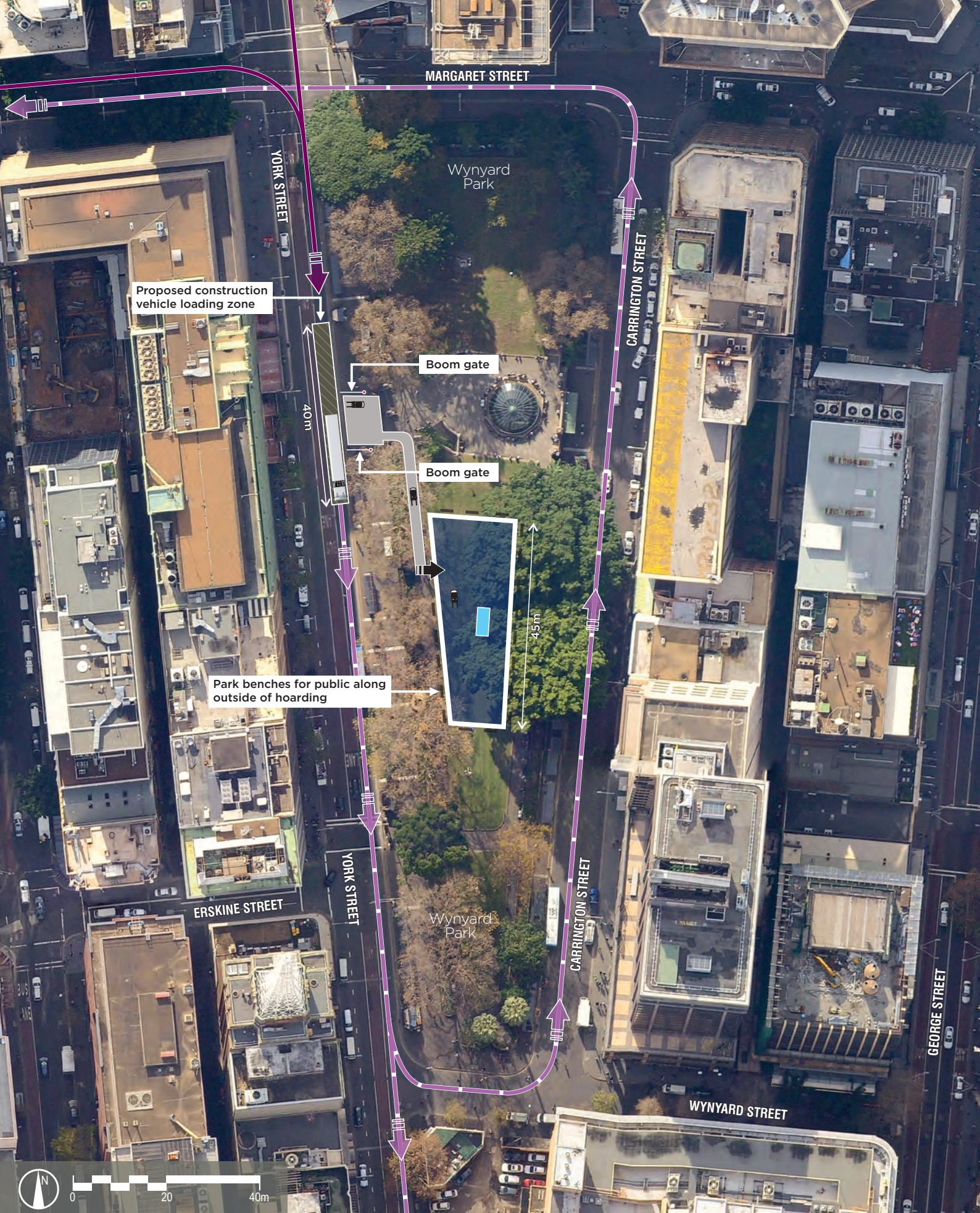
Figure 6 - Construction access points

- Wynyard Station
- Wynyard Walk (under construction)
- Construction access point








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**Figure 7 - Wynyard Park compound**

- |   |  |   |                        |
|---|--|---|------------------------|
|  | Proposed hoist location                    |  | Inbound vehicle route  |
|  | Proposed Construction vehicle loading zone |  | Outbound vehicle route |
|  | Proposed Construction path (forklift)      |   |                        |



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#### 4.1.3 Construction compounds

During construction, laydown and storage areas would be provided at the following locations:

- Basement space below the Menzies Hotel, accessed via the Wynyard Lane goods lift.
- Areas behind hoardings along the unpaid concourse.
- Basement areas of Transport House.
- Wynyard Lane Car Park.
- Wynyard Park.
- Vacant retail spaces.
- Vacant station back of house areas.

Access via Wynyard Lane Car Park or Wynyard Park would be subject to negotiations with Brookfield and would require landowners consent. The use of Wynyard Park would only occur if Wynyard Lane is closed off for construction of the proposed One Carrington Street Development or they become insufficient for construction requirements. If this occurs, it is proposed to access the Wynyard Lane Car Park via Cumberland Street and the existing underground tunnel.

The proposal would also be supported by an off-site compound to ensure the limited space available at the station is efficiently used. This off-site support compound would be used to store materials and waste generated by the proposal. This site is likely to be located in an industrial area in proximity to the CBD with good arterial road access, such as Homebush Bay, White Bay or Port Botany. This would be confirmed during detailed design and would be subject to a separate assessment.

#### 4.1.4 Construction hours

Construction works are required to be carried out 24 hours, seven days a week to enable the station to remain operational, to avoid unacceptable impacts on the broader Sydney rail network and to manage noise impacts on passengers, station staff, retailers and commercial properties. By virtue of being an underground station, construction access to the station is also constrained and would become increasingly constrained as developments surrounding the station commence construction.

Works that predominately occur in areas behind hoardings within the concourse area, in areas outside the public domain, or works that are typically less noisy (in order to minimise noise impacts) would be carried out during standard construction hours where feasible and reasonable:

- 7 am to 6 pm Monday to Friday.
- 8 am to 1 pm Saturdays.
- No works on Sundays or Public Holidays.

However, as Wynyard Station is a busy underground station that needs to remain operational during the upgrade, many construction activities may potentially be completed at night to minimise pedestrian impacts and noise impacts on rail customers, staff and retail operators (and their customers). For this reason a number of construction activities would be completed outside of standard construction hours. These may include (but are not limited to):

- Installation and removal of hoarding.
- Demolition works.
- Removal of redundant services.
- Installation of utilities (such as lighting), ceiling works and station systems.
- Waterproofing and fire insulation.
- Concrete works (including preparation of reinforced concrete).

- Removal and installation of ticket gates.
- Tiling and other architectural finishes.
- Commissioning of operational systems.
- Deliveries of construction material and plant, and the removal of construction wastes.

The use of the Wynyard Park compound would occur within and outside standard construction hours, however deliveries would only occur outside standard hours. Materials handling between the compound and the station below would occur 24 hours a day, 7 days a week.

Works that are required to be undertaken outside standard construction hours would be conducted in accordance with Transport for NSW's *Construction Noise Strategy* (2011), where practicable.

Given the need to avoid disruption to rail and bus commuters and the limited accesses to construction areas, out of hours deliveries would be required, including:

- Deliveries via the York Lane between 8pm and 10pm Sunday to Thursday.
- Deliveries via Wynyard Lane Car Park and Wynyard Lane goods lift would occur 24 hours, 7 days a week except between 7am and 9am, weekdays and subject to City of Sydney requirements.
- Deliveries via Margaret Street and the George Street ramps between 10 pm – 5am, Monday to Thursday.
- Deliveries via Wynyard Park between 8pm and 10pm Sunday to Thursday.

The scheduling of construction activities for the proposal would:

- Maintain safe and adequate access for customers to access and egress the public domain.
- Maintain a sufficient level of noise amenity for customers, station staff and people using retail spaces surrounding the public domain and adjoining pedestrian arcades.
- Minimise disruption to the surrounding road and pedestrian network due to construction activities, in particular, the Wynyard bus stops on York and Carrington Streets.
- Ensure a safe working environment for construction workers within areas that interface with rail systems.
- Minimise conflicts with surrounding businesses or major construction activities, due to competing access requirements.
- Minimise disruption to services within the station or surrounding buildings (for example water and power).

The proposed scheduling of construction activities would also have the additional benefit of reducing the impact on commercial, retail and educational receivers in the vicinity of the station.

#### 4.1.5 Construction vehicle movements

To ensure the functionality of the surrounding road network, as well as the safety of construction workers and the general public, construction traffic would be subject to careful traffic management.

Generally, construction heavy vehicle movements would be restricted to when accesses are available.

The maximum and average number of vehicle trips for each access point as identified in **Table 16** would not occur at the same. The maximum number of heavy vehicle trips generated per day is 30 heavy vehicles trips (or 60 movements) during peak periods, which would reduce to approximately 15 heavy vehicle trips per day (or 30 heavy vehicle movements).

**Table 16 Construction heavy vehicles**

Access point	Proposed hours	Daily heavy vehicle trips	
		Average	Maximum
George Street ramps (including Margaret Street works zone)	10pm – 5am, Monday to Thursday	3	7
Wynyard Lane (via goods lift and/or Wynyard Lane Car Park)	24 hours, 7 days a week, excluding 7am – 9am, Monday to Friday <sup>1</sup>	12	18
Cumberland Street <sup>1</sup>	24 hours, 7 days a week, excluding 7am – 9am, Monday to Friday	10	20
York Street loading bay	8pm – 10pm, Sunday to Thursday	3	5
York Lane	9am – 6pm, Monday to Friday 8am – 1pm Saturday	9	18
Wynyard Park compound <sup>2</sup>	8pm – 10pm, Sunday to Thursday	9	18
Hi-rail ramp from west of Circular Quay Station, south of North Sydney Station and north of Central Station <sup>3</sup>	Weekend track possessions deliveries	15	30
Hi-rail ramp from west of Circular Quay Station, south of North Sydney Station and north of Central Station	Mid-week (overnight) track possession deliveries	5	10

Note 1: Cumberland Street would only be used if Wynyard Lane is not available for access.

Note 2: The trips associated with the Wynyard Park compound would only occur if access via Wynyard Lane Car Park is not available.

Note 3: During weekend possessions there would be out of hours deliveries to Wynyard Station. This is based on four hi-rail movements every three hours over a weekend possession.

The origin and destination of heavy vehicle movements is presently unknown. However, regional access / egress to the construction site for other deliveries to site would be via the Sydney Harbour Bridge, the Eastern Distributor and Western Distributor. This would require the use of streets including (but not limited to) York Street, Wynyard Street, Margaret Street, Hunter Street, George Street, Erskine Street, Kent Street, Essex Street, Carrington Street, Wynyard Lane, York Lane and Cumberland Street. This may alter once CSELR construction commences.

Heavy vehicles accessing the site via Wynyard Lane and York Lane would require traffic controls during unloading/loading of the trucks due to the width of the lane relative to the size of the vehicles. Vehicles of up to 10 tonne would be allowed to enter Wynyard Lane; however no heavy vehicles would be allowed to enter the Wynyard Lane Car Park due to height restrictions. Vehicles of up to six tonne would be allowed to enter York Lane, at a rate of up to two vehicles per day for up to three months.

Heavy vehicles would load and unload material onto forklifts on Wynyard Lane, which would then transfer the material to the construction areas one of two ways, via the goods lift located on Wynyard Lane or via the construction hoist between the Wynyard Lane Car Park and the concourse. Loading/unloading activities would occur on Cumberland Street, if access to Wynyard Lane becomes prohibited or restricted due to the proposed One Carrington development.

The construction workforce would be encouraged to use public transport, given the limited availability of car parking. However, it is anticipated that approximately 10 light vehicle movements per shift would be required for smaller equipment and deliveries.

## 4.2 Surrounding development

As described in **Section 2.2.4**, there are a number of other projects that are currently in planning or construction phases in proximity to Wynyard Station (refer to **Table 17**). These include:

- One Carrington Street development – a proposed commercial office tower development located immediately east of the proposal site. This project would impact the George Street ramps, Hunter Arcade, Wynyard Lane Car Park and Wynyard Lane.
- Wynyard Walk – provision of a new western entrance to Wynyard Station from Barangaroo.
- CBD and South East Light Rail (CSELR) – provision of light rail along George Street, including a stop at Wynyard.
- Sydney City Centre Bus Infrastructure modifications – provision of new bus stops, shelters and layovers, including in the vicinity of Wynyard Park.
- 333 George Street redevelopment – new retail and commercial development.

These developments and their interaction with the proposal are discussed further in **Section 5.4**. There are also a number of other developments or transport initiatives that will affect Wynyard Station such as bus network changes, Barangaroo development, the proposed Barangaroo Ferry Hub and Sydney rail network changes (such as the NWRL). These would both directly and indirectly influence passenger numbers and use of the station.

**Table 17** provides an overview of the potential overlap of construction activities associated with the proposal and other major construction activity in the locality. **Table 18** provides the indicative construction schedule of these developments relative to the proposal.

**Table 17 Surrounding development**

Project	Description	Timeframe
One Carrington Street (formerly referred to as the CityOne development) Brookfield	<ul style="list-style-type: none"> <li>New commercial office tower between Carrington Street and George Street, incorporating Thakral House (301 George Street), 14-28 Carrington Street (which includes the Menzies Hotel), the former Shell House (2-12 Carrington Street) and 285 George Street.</li> <li>An upgrade of the eastern access ways to Wynyard Station, including retail and concourse areas (i.e. the George Street ramps) as well as links to Wynyard Lane, Hunter Connection and Wynyard Park. This includes pedestrian access over and under Wynyard Lane.</li> <li>Five levels of retail linking George Street, Carrington Street and Wynyard Station. New ground level retail on Margaret Street.</li> <li>Basement level car park.</li> </ul>	Mid 2015 to 2018
Wynyard Walk TfNSW	<ul style="list-style-type: none"> <li>A new western entrance to Wynyard Station.</li> <li>An underground pedestrian link (tunnel) from Wynyard Station to the intersection of Kent Street and Napoleon Street (approximately 100 metres long).</li> <li>Public pedestrian plaza (Napoleon Plaza) and pedestrian bridge to link to Barangaroo development (delivered as part of the Barangaroo development) and the Barangaroo Ferry Hub (proposed by TfNSW).</li> <li>Pedestrian bridge over Sussex Street.</li> </ul>	Currently under construction. Due for completion in 2016.



Project	Description	Timeframe
CBD South East Light Rail (CSELR) TfNSW	<ul style="list-style-type: none"> <li>Approximately 12 kilometres of new light rail track between Circular Quay, Central, Kingsford and Randwick, including 20 light rail stops one of which is to be located on George Street adjacent to the Wynyard Station entrance.</li> <li>A pedestrian zone on George Street between Hunter Street and Bathurst Street.</li> <li>Associated infrastructure, maintenance and stabling facilities and public domain improvements.</li> </ul>	Mid 2015 to 2019
Sydney City Centre Bus Infrastructure Roads and Maritime Services	<ul style="list-style-type: none"> <li>Installation or removal of bus stops and bus shelters on Jamison Street, York Street (south of Barrack Street) and Clarence Street.</li> <li>Provision of new bus layovers, including areas along York Street near Wynyard Park.</li> <li>Removal or relocation of parking, loading zones and/or taxi zones, including parking and an off-peak taxi zone on York Street opposite Wynyard Park.</li> <li>Longer term, the area generally encompassing the bus infrastructure, rail station and light rail station at Wynyard would be further developed as a strategic interchange precinct under the Access Strategy.</li> </ul>	Late 2014 to mid 2015
333 George Street redevelopment Charter Halls Funds Management Ltd	<ul style="list-style-type: none"> <li>New retail and commercial development, with ground floor retail, incorporating 331 George Street and 333-339 George Street.</li> <li>Basement car park accessed off Wynyard Lane.</li> </ul>	Currently under construction. Due for completion in mid 2016

Table 18 Indicative construction periods for surrounding future or current developments

Development / project	2014	2015				2016	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Wynyard Station Upgrade <sup>1</sup>							
One Carrington <sup>1</sup>							
CSLER							
Sydney City Centre Bus Infrastructure							
333 George Street redevelopment							

Note 1: Timing is subject to obtaining the relevant approvals under the *Environmental Planning and Assessment Act 1979*

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intentionally.

## 5.0 Construction noise and vibration assessment

### 5.1 Construction noise modelling

#### 5.1.1 Construction scenarios

In consultation with TfNSW, 27 distinct stages of construction, for the purposes of the noise and vibration impact assessment, have been assumed to occur during the upgrade works. These stages are shown in **Table 19** and have been grouped into three categories:

- Works behind hoardings (within the station);
- Works in open areas (within the station), being works that can only occur for limited periods and largely during evening and night periods; and
- Works within Wynyard Park (outside the station).

Ten scenarios have been modelled (these are indicated in light blue in **Table 19**). These scenarios are the worst case activities of the typical work activities provided to AECOM. All the typical work activities are presented in **Table 19** below.

Construction may be undertaken during both standard and out-of-hours periods.

#### 5.1.2 Construction sources

Noise sources(equipment) and their respective sound power levels for each construction activity are shown in **Table 19**. Sound power levels were obtained from AECOM's data base, Australian Standard AS2436-2010, "Guide to noise and vibration control on construction, demolition and maintenance sites" and published datasets by the UK Department for Environmental, Food and Rural Affairs (DEFRA). The sound power levels are representative of equipment in good working order. In AECOM's experience,  $L_{A1}$  sound power levels are typically up to 8 dB above  $L_{Aeq}$  sound power levels.

Scenarios highlighted in light blue represent the 10 scenarios that have been carried forward for modelling.

The loading and unloading activities are excluded from the construction noise assessment as they take place outside the construction site and do not require consideration under the ICNG. However, given these would occur during sensitive hours of the evening and night, mitigation measures have been recommended.

**Table 19 Construction activities**

Scenario	Construction activity	Time	Equipment	Sound Power Level, dB(A)
<b>Works behind hoardings</b>				
1	Demolition/ Strip Out	Night	Excavators	94
			Breaker	109
			Hand-held breaker	108
			Compressor	100
			Disc Cutter	107
			Grinder	108
			Elevated work platform	87

Scenario	Construction activity	Time	Equipment	Sound Power Level, dB(A)
2	Installation of services reticulation	Day	Elevated work platform	87
			Chop saw	107
			Grinder	108
			Disc cutter	107
3	Commissioning of operational systems	Day and night	Alarms	112
			Sirens	112
4	Installation of tiling and architectural finishes	Day	Elevated work platform	87
			Disc cutter	107
			Hand tools	94
			Lifting equipment	93
5	Construction of brick and block-work	Day	Cement mixer	89
			Paddle mixer	89
6	Preparation of reinforced concrete	Day	Forklift	93
			Hand tools	94
			Compressor	100
7	Delivery of materials and recovery of waste	Day and night	Forklift	93
			Pallet trucks	98
			Wheeled bins	-
8	Concreting	Night	Concrete mixer	89
			Pump	100
			Pokers	97
			Compressor	100
9	Hazmat removal	Day	Elevated work platform	87
			Alloy tower	-
			Hand tools	94
			Vacuums	101
10	Strip out redundant services	Day	Elevated work platform	87
			Alloy tower	-
			Hand tools	94
11	Installation of services	Day	Elevated work platform	87

Scenario	Construction activity	Time	Equipment	Sound Power Level, dB(A)
			Cable dispenser	-
			Hand tools	94
12	Installation of ceilings, lighting and station systems	Day	Elevated work platform	87
			Disc cutter	107
			Hand tools	94
Work in open areas				
13	Demolition/break-out	Night	Excavators	94
			Breaker	109
			Hand-held breaker	108
			Compressor	100
			Disc cutter	107
			Grinder	108
			Elevated work platform	87
14	Installation of services	Night	Elevated work platform	87
			Chop saw	107
			Grinder	108
			Disc cutter	107
15	Commissioning of operational systems	Day and night	Alarms	112
			Sirens	112
16	Erection of hoarding (night)	Night	Forklift	93
			Pallet trucks	98
			Hand drills	88
			Circular saws	110
			Elevated work platform	87
17	Hazmat removal (night)	Night	Elevated work platform	87
			Vacuums	101
			Alloy Tower	-
			Hand tools	94

Scenario	Construction activity	Time	Equipment	Sound Power Level, dB(A)
18	Preparation of reinforced concrete (night)	Night	Elevated work platform	87
			Disc cutter	107
			Hand tools	94
			Lifting equipment	93
			Elevated work platform	87
19	Delivery of materials and recovery of waste (nights / days)	Day and night	Pallet trucks	98
			Wheeled bins	-
20	Concreting (nights)	Night	Concrete mixer	89
			Pump	100
			Pokers	97
			Compressor	100
21	Removal / installation of ticket gates (nights)	Night	Forklift	93
			Pallet trucks	98
			Breaker	112
			Grinder	108
			Lifting equipment	93
22	Strip out redundant services (night)	Night	Elevated work platform	87
			Alloy tower	-
			Hand tools	94
23	Installation of services (night)	Night	Elevated work platform	87
			Cable dispenser	-
			Hand tools	94
24	Installation of ceilings, lighting and station systems (night)	Night	Elevated work platform	87
			Disc cutter	107
			Hand tools	94
25	Installation of tiling and architectural finishes (night)	Night	Elevated work platform	87
			Disc cutter	107
			Hand tools	94



Scenario	Construction activity	Time	Equipment	Sound Power Level, dB(A)
Wynyard Park				
26	Excavation of Wynyard Park access shaft	Night <sup>1</sup>	Excavator	94
			Cranes	99
			Concrete saw	110
			Breaker	109
27	Use of Wynyard Park during site deliveries <sup>2</sup>	Night <sup>1</sup>	Forklift	93
			Winch/lift	96

Notes: 1 – This activity may be completed during the daytime or night-time, however a night-time assessment has been undertaken to provide a worst case scenario.

2 – This scenario includes random bangs and clangs from delivery activities

3 – “-” indicates that no significant noise is associated with the plant item

### 5.1.3 Modelling and conditions

In order to assess noise impact from the site during construction, a noise model was created to represent ‘reasonable’ worst periods of construction activities. The activities highlighted in blue in **Table 19** are considered to represent the worst case activities and have been modelled. The activities not highlighted are likely to result in lower noise levels.

The construction of the proposal has been modelled using Odeon 12.0 and SoundPLAN 7.3. Odeon was used to model the internal space including Wynyard Station and the immediate concourse area including the escalators to York Street and the Carrington Street exit. The following features were included in the Odeon Model:

- Building dimensions;
- Building internal surface absorption;
- Internal receivers such as retail receivers;
- Construction noise sources;
- Open areas where noise can break out into the outside environment.

SoundPLAN was used to model the external environment in the region of Wynyard Park. The following features were included in the Sound Plan noise model:

- Ground topography;
- Ground absorption and reflection;
- Buildings;
- Receivers (shown in **Figure 4**); and
- Construction noise sources (listed in **Table 19**).

Noise emissions from the construction sites have been modelled using an implementation of the CONCAWE propagation algorithm with neutral metrological conditions.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to fixed building structures will also vary as the construction equipment moves around the site.

The hoarding included within Wynyard Station has been modelled based upon the proposed January 2015 Construction Occupation Drawing NR-WSUP-100-010 (no date).

## 5.2 Construction noise assessment

Predicted construction noise levels have been grouped into ranges which indicate the level of intrusiveness experienced. For residential receivers, each range has been assigned a colour and the colouring scheme is presented in **Table 20**. Where receivers are not specifically listed noise levels would be less than those presented in **Table 21**.

**Table 20 Construction airborne noise results colouring scheme**

Application	Description	Exceedance greater than background noise level (RBL), dB(A)	Noise level, dB(A)	Scheme
Exceedances	Noticeable	0-10 dB(A)	-	GREEN
	Clearly audible	11-20 dB(A)	-	BLUE
	Moderately intrusive	21-30 dB(A)	-	ORANGE
	Highly intrusive	> 30 dB(A)	-	PURPLE
Predicted noise level	Highly Noise Affected	-	> 75 dB(A)	RED

Construction noise results for receivers predicted to have an external noise level of 40 dB(A) and above are shown in **Table 21**. Noise contours are presented in **Appendix C**. As shown in **Table 21**, some exceedances have been predicted. Reasonable and feasible mitigation measures would need to be considered and these are discussed further in **Chapter 6**.

Results in red indicate where the predicted noise levels at residential receivers are predicted to exceed the highly noise affected level of 75 dB(A). The highly affected noise levels only apply to residential receivers. No residential receivers have been predicted to fall within this category.

For educational establishments located in 11 – 17 York Street and during the loudest scenario (the commissioning of operational systems), the maximum internal noise levels are predicted to be up to 59 dB(A). This would exceed the internal NMLs for educational establishments. However the activities associated with the scenario are also expected to be of short duration and it is understood that periodic testing of these systems is currently undertaken. Other construction activities would be less than predicted internal NML for educational establishments for the loudest assessed scenario.

For the church located at 42 – 44 Margaret Street, Sydney, internal noise levels are predicted to be below the internal NML of 45 dB(A).

For Wynyard Park, existing background and ambient noise levels are higher than the passive recreation criteria. Therefore construction noise is not expected to impact significantly on the use of the park.

For receivers within the station public domain, mezzanine level (Coles) and surrounding pedestrian arcades, noise levels are within the noise management levels, except during the installation of services behind hoardings. During these activities, noise exceedances of up to 2 dB have been predicted for retail receivers in the north-eastern corner of the unpaid concourse area.

For the majority of receivers (predominantly pedestrians) within the station and surrounding pedestrian arcades, exposure to elevated noise levels would be temporary given the transitory use of these spaces. However, workers within the station and nearby retail spaces, and customers of certain retail businesses (such as cafes), could be exposed for a longer duration depending on the location of the works relative to these receivers. Works that generate significant levels of noise have already been scheduled outside standard hours to minimise such exposure. However, feasible and reasonable noise mitigation would be investigated where noisy works occur during standard construction hours and/or during extended retail hours (such as Thursday night). Further, work health and safety requirements would provide an additional framework for construction noise management. This would be managed during detailed construction planning.

Table 21 Construction L<sub>Aeq</sub> airborne noise level results (external)

Worst Affected Receiver	Type	Time <sup>1</sup>	RBL <sup>2</sup> , L <sub>A90</sub> 15 min	NML, L <sub>Aeq</sub> 15 min	Predicted, L <sub>Aeq</sub> 15 min dB(A)	RBL exceed- ance	NML exceed- ance <sup>3</sup>
<b>Demolition/break-out works in open areas</b>							
42-44 Margaret Street	Church / Residential	Night	55	60	42	-	-
2-12 Carrington Street	Hotel	Night	55	60	41	-	-
<b>Installation of services in open areas</b>							
42-44 Margaret Street	Church / Residential	Night	55	60	43	-	-
2-12 Carrington Street	Hotel	Night	55	60	40	-	-
<b>Removal / installation of ticket gates in open areas</b>							
42-44 Margaret Street	Church / Residential	Night	55	60	42	-	-
<b>Excavation of Wynyard Park access shaft</b>							
42-44 Margaret Street	Church / Residential	Night	55	60	56	1	-
2-12 Carrington Street	Hotel	Night	55	60	56	1	-
5 York Street	Hotel	Night	55	60	53	-	-
7-9 York Street	Hotel	Night	55	60	52	-	-
1 Clarence Street	Hotel	Night	55	60	50	-	-
2 York Street	Commercial / Residential	Night	55	60	49	-	-
40-50 Clarence Street	Commercial / Residential	Night	55	60	49	-	-
<b>Use of Wynyard Park during site deliveries</b>							
14-28 Carrington St	Commercial	Day	-	70	50	-	-
30-32 Carrington Street	Commercial	Day	-	70	50	-	-
37 York Street	Commercial	Day	-	70	50	-	-
33-35 York Street	Commercial	Day	-	70	49	-	-
34-36 Carrington Street	Commercial	Day	-	70	49	-	-
50 Carrington Street	Commercial	Day	-	70	49	-	-
39-41 York Street	Commercial	Day	-	70	48	-	-
19 York Street	Commercial/ Educational <sup>4</sup>	Day	-	70	47	-	-
54-62 Carrington St	Commercial	Day	-	70	47	-	-
45-47 York Street	Commercial	Day	-	70	45	-	-
43 York Street	Commercial	Day	-	70	45	-	-
2-12 Carrington Street	Hotel	Night	55	60	45	-	-
11-17 York Street	Commercial/ Educational <sup>4</sup>	Day	-	70	44	-	-

Worst Affected Receiver	Type	Time <sup>1</sup>	RBL <sup>2</sup> , L <sub>A90</sub> 15 min	NML, L <sub>Aeq</sub> 15 min	Predicted, L <sub>Aeq</sub> 15 min dB(A)	RBL exceed- ance	NML exceed- ance <sup>3</sup>
42-44 Margaret Street	Church / Residential	Night	55	60	44	-	-
46-50 Margaret Street	Commercial	Day	-	70	44	-	-
49-51 York Street	Commercial	Day	-	70	44	-	-
341 George St Street	Commercial	Day	-	70	42	-	-
53-55 York Street	Commercial	Day	-	70	42	-	-
5 York Street	Hotel	Night	55	60	41	-	-
57-59 York Street	Hotel	Day	-	60	41	-	-
7A York Street	Commercial	Day	-	70	41	-	-
7-9 York Street	Hotel	Night	55	60	41	-	-
273 George Street	Commercial	Day	-	70	40	-	-
61 York Street	Commercial	Day	-	70	40	-	-
<b>Demolition/break-out works behind hoardings</b>							
Coles	Retail	Day	-	60	58	-	-
Retail in north-east corner of the concourse area	Retail	Day	-	60	58	-	-
<b>Installation of services reticulation works behind hoardings</b>							
Coles	Retail	Day	-	60	58	-	-
Retail in north-east corner of the concourse area	Retail	Day	-	60	62	-	2
<b>Installation of tiling and architectural finishes behind hoardings</b>							
Coles	Retail	Day	-	60	51	-	-
Retail in north-east corner of the concourse area	Retail	Day	-	60	55	-	-
<b>Commissioning of operational systems</b>							
11-17 York Street	Commercial/ Educational <sup>4</sup>	Day	-	65	79	-	9
19 York Street	Commercial/ Educational <sup>4</sup>	Day	-	65	57	-	-
33-35 York Street	Commercial	Day	-	70	48	-	-
42-44 Margaret Street	Church / Residential	Night	55	60	48	-	-
46-50 Margaret Street	Commercial	Day	-	70	46	-	-
2-12 Carrington Street	Hotel	Night	55	60	45	-	-
14-28 Carrington St	Commercial	Day	-	70	45	-	-
37 York Street	Commercial	Day	-	70	45	-	-
30-32 Carrington Street	Commercial	Day	-	70	44	-	-
34-36 Carrington Street	Commercial	Day	-	70	44	-	-

Worst Affected Receiver	Type	Time <sup>1</sup>	RBL <sup>2</sup> , L <sub>A90</sub> 15 min	NML, L <sub>Aeq</sub> 15 min	Predicted, L <sub>Aeq</sub> 15 min dB(A)	RBL exceed- ance	NML exceed- ance <sup>3</sup>
50 Carrington Street	Commercial	Day	-	70	43	-	-
5 York Street	Hotel	Night	55	60	42	-	-
2 York Street	Commercial / Residential	Night	55	60	42	-	-
39-41 York Street	Commercial	Day	-	70	42	-	-
273 George Street	Commercial	Day	-	70	41	-	-
54-62 Carrington St	Commercial	Day	-	70	41	-	-
341 George St Street	Commercial	Day	-	70	40	-	-

Notes: 1 – Properties are assessed under the most stringent time period during which they are likely to be occupied

2 – Rating background levels (RBL) are provided for residential receivers only.

3 – Refer to Table 3 and Table 4

4 – Educational establishments have an internal noise management level of 45dB(A),

### 5.3 Sleep disturbance assessment

**Table 22** presents the predicted maximum L<sub>A1</sub> (1 min) noise levels. The predicted L<sub>A1</sub>(1 min) noise levels indicate that the screening sleep disturbance criteria is unlikely to be exceeded during the night-time construction works.

**Table 22 Construction L<sub>A1</sub> noise level results**

Worst Affected Receiver	Type	Time	RBL, L <sub>A90</sub> 15 min	Sleep disturbance screening criterion, L <sub>A1</sub> (1 min)	Predicted, L <sub>A1</sub> (1min) dB(A)	Sleep disturbance screening criterion exceedance
<b>Demolition/break-out works in open areas</b>						
42-44 Margaret Street	Church / Residential	Night	55	70	50	-
2-12 Carrington Street	Hotel	Night	55	70	49	-
<b>Installation of services in open areas</b>						
42-44 Margaret Street	Church / Residential	Night	55	70	51	-
2-12 Carrington Street	Hotel	Night	55	70	48	-
<b>Removal / installation of ticket gates in open areas</b>						
42-44 Margaret Street	Church / Residential	Night	55	70	50	-
<b>Excavation of Wynyard Park access shaft</b>						
42-44 Margaret Street	Church / Residential	Night	55	70	64	-
2-12 Carrington Street	Hotel	Night	55	70	64	-
5 York Street	Hotel	Night	55	70	61	-
7-9 York Street	Hotel	Night	55	70	60	-
1 Clarence Street	Hotel	Night	55	70	58	-
2 York Street	Commercial / Residential	Night	55	70	57	-

Worst Affected Receiver	Type	Time	RBL, $L_{A90\ 15\ min}$	Sleep disturbance screening criterion, $L_{A1(1\ min)}$	Predicted, $L_{A1(1\ min)}$ dB(A)	Sleep disturbance screening criterion exceedance
40-50 Clarence Street	Commercial / Residential	Night	55	70	57	-
Wynyard Park - site deliveries						
2-12 Carrington Street	Hotel	Night	55	70	53	-
42-44 Margaret Street	Church / Residential	Night	55	70	52	-
5 York Street	Hotel	Night	55	70	49	-
7-9 York Street	Hotel	Night	55	70	49	-
Commissioning of operational systems						
42-44 Margaret Street	Church / Residential	Night	55	70	56	
2-12 Carrington Street	Hotel	Night	55	70	53	-
5 York Street	Hotel	Night	55	70	50	-
2 York Street	Commercial / Residential	Night	55	70	50	-

Notes: 1 – RBL +15dB(A)

## 5.4 Cumulative construction noise assessment

Simultaneous noise from works within a site compound and construction vehicle movements associated with the proposal has the potential to increase noise levels at nearby sensitive receivers

At the time of writing this report, construction of four other major projects are likely to occur in the vicinity of the Wynyard Station Upgrade during the proposed construction period. These are One Carrington Street, Wynyard Walk, 333 George Street and the CBD and South East Light Rail (CSELR). It is also possible that construction road traffic from these projects may use some common routes within the CBD in the immediate vicinity of the proposal.

Construction work on Wynyard Walk is currently being undertaken and is expected to be completed in 2016. Approval for a modified design for the One Carrington Street development is currently being sought from the Department of Planning and Environment. Works are expected to begin in 2015 and be completed 2018. Early works for CSELR are expected to begin in 2014, with main construction to begin mid-2015 and conclude 2019. 333 George Street is currently under construction and is scheduled to be completed in 2016.

Construction works associated with One Carrington, 333 George Street, Wynyard Walk and the CSELR include significant surface works compared to the proposal and are therefore likely to generate higher levels of construction noise than the proposal at receiver locations. However, during periods where this proposal would be the dominant source of construction noise, the greatest increase in construction noise levels resulting from contributions from the other projects would be 3 dB.

## 5.5 Construction traffic assessment

The average and maximum construction heavy vehicle trip numbers are provided in **Table 16**. At the access points identified in **Table 16**, heavy vehicles would load/unload onto forklifts. The maximum heavy vehicle trips per hour during peak construction periods would be around three heavy vehicles. This would increase to nine heavy vehicle movements per hour, if Wynyard Park compound is established (due to limited delivery hours).

The construction workforce would be encouraged to use public transport. However, it is anticipated that approximately 10 light vehicle movements per shift would occur to deliver smaller equipment and deliveries.

Due to the significant existing traffic volumes on George, York and Margaret Streets, the increase in noise as a result of construction traffic is expected to be negligible (less than 1 dB).

Construction of the One Carrington project is likely to prevent construction traffic associated with the proposal from accessing Wynyard Lane. At this point in time, construction access would be via the Cumberland Street exit of Wynyard Lane Car Park. The additional construction traffic movements would be offset by a reduction in private vehicles exiting the car park as the car park would be closed to private vehicles. In addition existing road traffic noise levels are very high in this area due the significant volumes of traffic using the Bradfield Highway (Sydney Harbour Bridge). Construction traffic would therefore have a negligible effect on road traffic noise levels at residential receivers in this area.

To use the York Lane access point, trucks would reverse up York Lane from Erskine Street. This would occur only during the evening period and unloading would be for a maximum period of 20 minutes. It is recommended that broadband reversing beepers be installed on any truck using the Wynyard Lane access point.

As noted in **Section 4.1.2** Hi-Rail equipment would be used during rail possession works. The equipment would enter the railway line system at Central Station or North Sydney Station. Given the equipment would enter and leave the railway line system once in any one day, the noise impact would be negligible and is not considered any further in this assessment.

The cumulative construction traffic impact from the other projects referred to in **Section 5.4** above and this proposal is likely to be negligible given the significant existing traffic volumes as noted above.

## 5.6 Construction vibration assessment

### 5.6.1 Vibration measurements

Three vibration intensive items of construction plant have been considered in order to assess the impact of structure-borne noise and vibration on nearby sensitive receivers. The three items of plant assessed are:

- A hammer drill with a chisel point;
- A hammer drill with a drill bit; and
- An angle grinder.

The vibration generated by these items of plant was measured within Wynyard Station, in a closed retail space, on the concourse level, on Monday 25 August 2014 at 10am. The following equipment was used:

- Frequency Analyser (Brüel & Kjær (B&K) LAN-XI Type 3050, S/N 3050-106831 (and a Dell laptop running B&K PULSE LabShop)).
- Accelerometer (Dytran 3233A , Serial number 151 (sensitivity 1000 mV/g)).

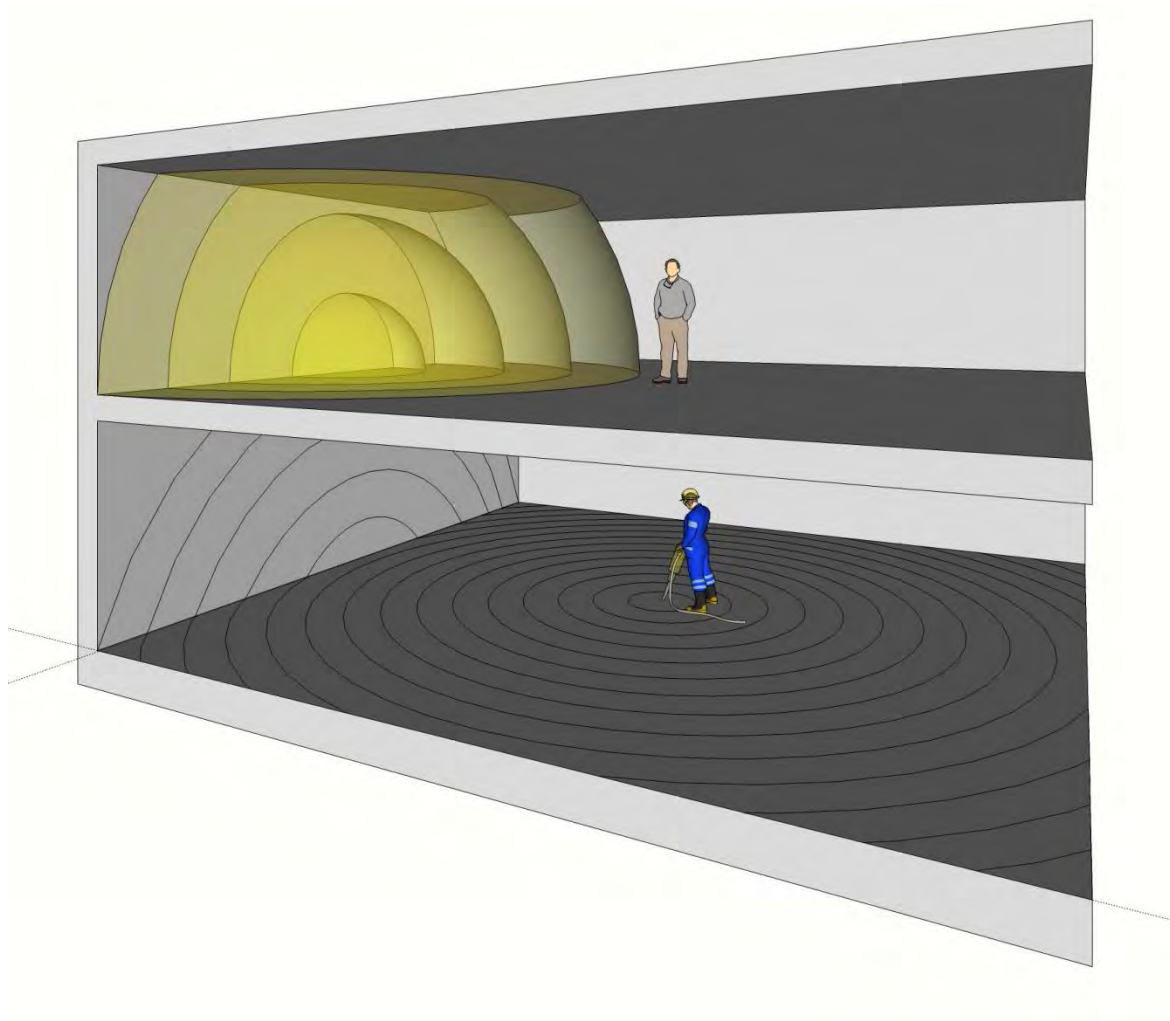
The accelerometer was hot-glued to the concrete slab. A location in the middle of the slab was chosen, one metre from the item of plant being measured. Due to the continuous nature of the vibration measurement for a time period of between 30 and 60 seconds was chosen. A 4 second integration time with a 95 per cent overlap was applied to the measured time signal. Results of the site measurements are presented in **Appendix D** in 1/3 octaves, in the frequency range 4 – 1000 Hz.. These measured vibration levels have been used to assess regenerated noise levels in **Section 5.6.2**.

### 5.6.2 Predicted structure-borne noise levels

Structure-borne noise, in addition for airborne noise (refer to **Section 5.2**), can be a significant source of noise for construction projects within buildings. In contrast to airborne noise the propagation path for structure-borne noise is through structural elements of the building. The vibration energy after travelling through the building may then reradiate as sound energy from large surfaces such as walls, ceilings and floors.

A typical structure-borne noise path is illustrated in **Figure 8**. In this figure vibration is generated by the impact from a jackhammer. The vibration transfers through the floor and walls of the structure and is reradiated as noise in a nearby room.





**Figure 8 Structure-borne noise path**

Based on the measured results vibration levels have been calculated at the nearest sensitive receivers. These results have been based upon

- The measured vibration levels discussed above;
- The assumed vibration attenuation levels from floor to floor and bay to bay (Nelson, 1987)

The regenerated noise levels have been calculated using the following relationship (Nelson, 1987):

$$L_p = L_v - 27$$

Where  $L_p$  is the regenerated noise level in dB and  $L_v$  is the predicted root mean square (rms) vibration velocity level in the space in dB.

The predicted structure-borne noise levels for use of the three types of vibration intensive construction equipment at the most affected receivers are presented in **Table 23**.

It is predicted that regenerated noise levels may exceed the noise management levels at the nearest retail receivers, at the NSW Service Centre and in the foyer of Transport House. These exceedances may range from 6-25 dB. Retail receivers within adjoining pedestrian arcades (such as the Metcentre) are expected to experience structure-borne noise levels that are lower than the regenerated noise levels predicted for retail receivers located within the concourse areas.

Exceedances are not predicted at the educational establishment on level 2 of Transport House or at the nearest residential receiver at 50 Clarence Street.

**Table 23 Predicted regenerated noise levels at selected receivers**

Receiver	Location	Source Location	Predicted structure-borne noise level			NML	Exceedance		
Equipment in use			1	2	3		1	2	3
Retail	Concourse level	Adjacent retail space - Concourse level	70	73	51	45	25	28	6
Retail - Coles	Mezzanine level	Adjacent retail space - Concourse level	70	73	51	45	25	28	6
Retail	Carrington Street (Wynyard Dome)	Retail space - Concourse level	59	61	40	45	14	16	-
11 – 17 York Street	Foyer – York Street level	Near York St escalators	53	56	35	45	8	11	-
19 York Street	NSW Service Centre – York Street level	Near York St escalators - Concourse level	53	56	35	45	8	11	-
11 – 17 and 19 York Street	Educational establishment – Level 2	Near York St escalators - Concourse level	42	45	25	45	-	-	-
Residence	50 Clarence St – Level 12	Near York St escalators - Concourse level	< 30	< 30	< 30	35	-	-	-

### 5.6.3 Predicted vibration

The estimated vibration dose value (eVDV) has been calculated using the following formula (BS 6472-1:2008):

$$eVDV = 1.4a_w t^{0.25}$$

Where  $a_w$  is the weighted rms vibration acceleration in  $m/s^2$  and  $t$  is the total duration of the vibration. It has been assumed that the total duration of the vibration is 8 hours.

The estimated vibration dose values when the three types of vibration intensive equipment are in use are presented in **Table 24**.

VDV management levels (human comfort) are more stringent than structural damage criteria, including for heritage buildings. The estimated vibration dose values are not expected to exceed the VDV management levels and therefore would also be below structural damage criteria.

**Table 24** Estimated vibration dose values at selected receivers

Receiver	Description	Estimated VDV <sub>s</sub> (m/s <sup>1.75</sup> )			VDV Management Level	Exceedance		
		1	2	3		1	2	3
Retail	Concourse level	0.63	0.60	0.10	0.8	-	-	-
Retail - Coles	Above concourse level	0.63	0.60	0.10	0.8	-	-	-
Retail	At level of Carrington Street	0.39	0.36	0.06	0.8	-	-	-
11 – 17 York Street	Commercial lobby – York Street level	0.30	0.28	0.05	0.8	-	-	-
11 – 17 and 19 York Street	Educational establishment – Level 2	0.19	0.17	0.03	0.8	-	-	-
Residence	50 Clarence St – Level 12	<0.03	<0.03	<0.03	0.26	-	-	-

## 6.0 Mitigation measures

Due to the exceedances presented in **Chapter 5**, mitigation and management measures have been recommended and detailed in **Table 25**. The mitigation and management measures focus largely on further consultation and mitigation to address predicted exceedances in airborne and structure-borne noise levels at retail, commercial and educational establishments.

**Table 25 Mitigation and management measures**

Identification number	Mitigation and management measure
1	<p>A Construction Noise and Vibration Management Plan (CNVMP) would be prepared and implemented in accordance with the requirements of the Transport for NSW <i>Construction Noise Strategy</i> and the <i>Interim Construction Noise Guideline</i>. The CNVMP would include all reasonable and feasible mitigation options to manage the noise emissions from the site and also any complaints which may occur due to the construction activity noise. The CNVMP would include the following:</p> <ul style="list-style-type: none"> <li>- Identification of nearby residences, other sensitive land uses (e.g places of worship) and businesses (e.g retailers).</li> <li>- Description of approved hours of work.</li> <li>- Description and identification of all construction activities, including work areas, equipment and duration.</li> <li>- Description of work practices (generic and specific) to be applied to minimise noise and vibration.</li> <li>- Details of any necessary out-of-hours work required would form part of the CNVMP.</li> <li>- A complaints handling process.</li> <li>- Noise and vibration monitoring procedures.</li> </ul>
2	<p>All receivers impacted by noise from the proposed works which are expected to exceed the construction NMLs would be consulted about the project prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works.</p> <p>The information provided to the receivers would include:</p> <ul style="list-style-type: none"> <li>- Programmed times and locations of construction work.</li> <li>- The hours of proposed works.</li> <li>- Construction noise and vibration impact predictions.</li> <li>- Construction noise and vibration mitigation measures being implemented on site.</li> </ul> <p>Consultation would be consistent with the requirements of TfNSW <i>Construction Noise Strategy</i>. The highest consideration would be given to receivers that are predicted to be most affected as a result of the works.</p> <p>Complaints during construction would be managed in accordance with Transport for NSW's <i>Community Engagement Policy</i>. The construction response line (1800 775 465) would be available during construction.</p>
3	<p>Induction and training would be provided to relevant staff and sub-contractors outlining their responsibilities with regard to noise. Construction workers would be briefed in order to create an awareness of the locality, the location of sensitive receivers and noise mitigation measures.</p>
4	<p>Particularly noisy activities should be scheduled for times when they would have the least impact where feasible and reasonable</p> <p>Where there is potential for continued elevated noise levels (including structure-borne noise), consultation with affected retailers, other businesses premises and Sydney Trains personnel would be undertaken to complete noise or vibration intensive activities outside retail business hours, during periods of low retail activities and low passenger numbers, where reasonable and feasible. This would result in additional works being</p>

Identification number	Mitigation and management measure
	<p>undertaken outside standard construction hours. Undertaking works outside of standard working hours is advantageous as it reduces the impact on retail premises and Sydney Trains' staff and passengers.</p> <p>Negotiations should be undertaken with retail premises within and around the station to determine if periods of respite are appropriate.</p>
5	Activities which may need to be conducted outside of standard construction hours, and have not been assessed in this report, would be subject to out-of-hours approval as identified in the TfNSW <i>Construction Noise Strategy</i> .
6	The selection of plant and equipment can have a significant impact on construction noise (including structure-borne levels). Appropriate plant would be selected for each task to minimise the noise contributions.
7	Alternative works methods would be considered and implemented where feasible and reasonable (e.g. saw cutting instead of impact hammering would reduce structure-borne noise). The use of alternative machines that perform the same function e.g. electric/hydraulic in place of diesel; rubber wheeled in place of steel tracked plant) would be considered.
8	Equipment would be regularly inspected and maintained to ensure it is in good working order.
9	At Wynyard Park compound, noisy equipment would be orientated away from residential and hotel receivers and/or shielded behind structures where feasible and reasonable.
10	Where possible noisy construction works should be conducted behind hoardings subject to the final construction staging strategy. The hoardings should be full height and be constructed from ≥10 mm plywood or similar.
11	Truck drivers would be advised of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (i.e. minimising the use of engine brakes, and no extended periods of engine idling).
12	Construction sites would be arranged to limit the need for reversing associated with regular / repeatable movements (e.g. trucks transporting spoil) to minimise the use of reversing alarms. Where feasible and reasonable, non-tonal reversing alarms would be used (particularly for vehicles reversing down York Lane), taking into account the requirements of the Workplace Health and Safety legislation.
13	<p>A noise monitoring program would be considered and implemented to assist in confirming and controlling the site specific potential for disturbance at particularly sensitive receivers, at the commencement of activities identified as having the potential to result in exceedances and periodically during the construction program as the works progress. Measurements would also be undertaken in response to complaints. The results would be reviewed to determine if additional mitigation measures are required. All measurements would be undertaken in accordance with Australian Standard 1055.1-1997 – Acoustics – Description and measurement of environmental noise, Part 1: General procedures.</p> <p>A noise monitoring program would be presented in the CNVMP</p>