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Edgecliff Station Upgrade
Transport for New South Wales
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Edgecliff Station Upgrade Noise and Vibration Impact Assessment

Edgecliff Station Upgrade

Noise and Vibration Impact Assessment

Client: Transport for New South Wales

ABN: 18 804 239 602

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A	9-Oct-2017	Draft for review	Frank Ciancio Associate Director, Design + Planning	
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Executive Summary

AECOM has been commissioned by Transport for New South Wales (TfNSW) to undertake a Noise and Vibration Impact Assessment of the proposed Edgecliff Station Upgrade (the Proposal) Nearby noise and vibration sensitive receivers were identified and unattended noise measurements were completed to characterise the existing noise environment. The measured noise levels were used to establish construction noise management levels.

Construction noise and vibration

The construction noise assessment was conducted in accordance with NSW Environment Protection Authority's (EPA) *Interim Construction Noise Guideline* (ICNG). Typical worst case construction scenarios have been considered. Construction activities would occur during the day and the night. Worst case construction scenarios in the following areas have been considered:

- works behind hoardings within the station concourse and platform areas
- works in open areas in the bus interchange and near the New McLean Street ramp.

The noise assessment associated with the Proposal indicates some exceedances of the ICNG noise management levels at the nearest residential, educational, retail and commercial receivers. Measures have been recommended to mitigate the construction noise impact at adjacent receivers. These measures include:

- completion of a Construction Noise and Vibration Management Plan (CNVMP)
- community consultation
- appropriate selection and maintenance of equipment
- use of hoardings
- scheduling of work for less sensitive time periods, where feasible
- situating plant in less noise sensitive locations
- induction and training of construction site workers
- construction traffic management
- noise monitoring.

The construction vibration assessment indicates some exceedances of the structure-borne noise management levels at the nearest retail and commercial receivers. These exceedances are considered typical worst case scenarios. The mitigation measures recommended to control airborne construction noise are also considered appropriate to control regenerated construction noise.

No exceedances of the construction human comfort management levels are predicted.

Construction road traffic noise

The road traffic noise associated with construction activities was assessed in accordance with EPA's NSW *Road Noise Policy* (RNP) guidelines.

The road traffic noise assessment associated with construction indicates compliance with the NSW RNP acoustic criteria as the noise increase on construction routes is predicted to be negligible, i.e. less than 1 dB.

Operational impacts

Noise impacts upon nearby sensitive receivers due to the plant associated with the Proposal would be minimal.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) has been commissioned by Transport for New South Wales (TfNSW) to undertake a Noise and Vibration Impact Assessment of the proposed Edgecliff Station Upgrade (the Proposal). The upgrade forms part of the Transport Access Program (TAP). TAP is an initiative to provide a better experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure.

The key features of the proposal are summarised as follows:

- installation of a new lift (Lift 1) inside the paid station concourse area to provide access between the paid station concourse and the station platform
- installation of a new lift (Lift 2) outside the paid station concourse area to provide access between the station concourse and the bus interchange
- replacement of the existing four escalators that provide access between the paid station concourse and station platform with new escalators
- provision of new fire stairs to provide access between the paid station concourse and the station platform
- relocation of the existing ticket gate line to increase circulation space in the paid station concourse
- partial demolition of the existing platform buildings to provide pedestrian passing bays
- installation of new pedestrian crossings and pram ramps at the bus interchange to provide an accessible path of travel from the new lift to the existing bus stands
- extension of the existing canopy over the new pedestrian crossings at the bus interchange and installation wind breaks for weather protection
- relocation of the existing bicycle shed at the bus interchange
- provision of three new kiss and ride spaces on New McLean Street and installation of a new undercover bicycle rack
- new pedestrian access ramp on New McLean Street to provide an accessible path of travel from the station concourse to the new interchange facilities
- ancillary works including adjustments to lighting, electrical upgrades, minor drainage works, new seating, improvement to station communications systems (including CCTV cameras) and wayfinding signage, and installation of TGSIs.

Subject to approval, construction is expected to commence in early 2018 and take around 18 months to complete. Works would be undertaken during standard daytime construction hours and also out-of-hours.

1.1 Background information

This Noise and Vibration Impact Assessment has been prepared in support of a Review of Environmental Factors report, which has been prepared to assess the environmental impacts associated with the construction and operation of the Proposal under the provisions of Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

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
- *Rail Infrastructure Noise Guideline* (RING), NSW Environmental Protection Authority (EPA), 2013
- *Noise Policy for Industry* (NPfI), Environment Protection Authority (EPA), 2017
- *Construction Noise Strategy* (CNS), TfNSW, 2016
- DIN Standard 4150: *Part 3 1999 Structural Vibration in Buildings - Effects on Structures*, 1999
- British Standard 6472: Part 1 2008 *Evaluation of Human Exposure to Vibration in Buildings*, 2008
- Australian Standard AS 2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites*, 2010
- Australian Standard AS 1055.1-1997 – *Acoustics – Description and measurement of environmental noise, Part 1: General procedures*, 1997
- UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*, 2006.

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

1.2 Scope

The scope of this Noise and Vibration Impact Assessment is to:

- establish the existing background noise levels in the vicinity of the Proposal
- establish construction noise management levels and vibration limits which would apply to the Proposal
- predict construction noise and vibration levels at nearby residential and other sensitive receivers due to the Proposal
- predict noise impacts from additional off-site construction traffic generated by the Proposal
- recommend mitigation measures where necessary to reduce and manage noise and vibration impacts from the Proposal
- consider operational noise levels at nearby residential and other sensitive receivers due to the Proposal.

1.3 Proposed works

The Proposal would include the following key elements:

- site establishment and enabling works
- lift works
- escalator replacement works
- new staircase construction
- ticket gate replacement works
- upgrades to the bus interchange
- electrical upgrades
- platform modification works
- new garbage room construction.

1.4 Site description

Edgecliff station is located at the intersection of New South Head Road and Ocean Street. A mix of residential, commercial and retail receivers surround the station. In addition a number of retail and medical spaces are located within the station building. A multi-storey residential building (180 Ocean Street, Edgecliff) is located above the station building. New South Head Road is considered an arterial road, as per the categories within the Environment Protection Authority's (EPA) *NSW Road Noise Policy*.

1.5 Receivers

1.5.1 Noise catchment areas

To assist in determining noise criteria for the receivers surrounding the Proposal, noise catchment areas (NCA) were identified. The noise environment at each of the residential receivers within each NCA is considered to be comparable and the existing noise levels can be used to develop assessment / management criteria for similar existing environments. A description of these NCA is provided in Table 1 and their location is shown in Figure 1.

Table 1 Noise catchment areas

NCA	Description
1	Residences in the vicinity and north of New South Head Road
2	Residences to the south of Edgecliff Station

Figure 1 Representative receiver locations and noise catchment areas (NCAs)

Figure 2 Representative receiver locations

1.5.2 Representative receivers

In order to simplify the assessment methodology, three representative residential receivers were selected to describe the noise impacts. These residential receivers are expected to be the most impacted by noise from the works and are listed in Table 2.

Five representative non-residential receivers which are expected to be impacted during the works have also been selected. These receivers are listed in Table 2.

The locations of the residential receivers identified for use in the assessment are presented in Figure 1 and Figure 2.

Table 2 Representative receivers

Receiver ID	Receiver address	Type	NCA	Distance to Proposal (metres)
R1	172 - 180 New South Head Road, Edgecliff	Residential	1	33
R2	180 Ocean Street, Edgecliff	Residential	1	25
R3	27 Cameron Street,	Residential	2	30
R4	Aldi – Concourse level	Retail	-	-
R5	Newsagency – Concourse level	Retail	-	-
R6	Precise Dental Surgery - Concourse level	Medical	-	-
R7	Shopping Centre - Gallery level	Retail	-	-

Receiver ID	Receiver address	Type	NCA	Distance to Proposal (metres)
R8	Edgecliff Medical Centre – Gallery level	Medical	-	-
R9	Ascham School	School	1	60

1.5.3 Heritage items

Edgecliff Station is listed on the Sydney Trains Section 170 Heritage and Conservation Register (SHI No. 4801167) as an item of local significance. It has been identified as being of historical, social, technical, research and representative significance. Its aesthetic, research and representative significance is linked to the 1970s design, embodied in the terrazzo flooring, moulded plywood ceilings and blue tiled columns, which remain intact. Other heritage features across the station which are of significance include the tri-level signage, long escalators, barrier box, ticketing windows, drinking fountains and telephone booths.

There are a series of other local heritage items nearby, including the Ascham school precinct (LHR239), the Former Post Office and interiors (LHR240), and House and interiors (LHR241).

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2.0 Existing acoustic environment

Long-term unattended measurements were undertaken to establish the existing ambient and background noise environment at potentially affected receivers in the vicinity of the Proposal site.

2.1 Unattended noise monitoring

Long-term unattended noise monitoring was conducted at two locations between 15 September 2017 and 22 September 2017. One noise logger was placed within each NCA at a representative location as shown in Figure 1. NCA descriptions are provided in Section Table 1. The noise loggers were calibrated prior to and after the monitoring period with a drift in calibration not exceeding ± 0.5 dB(A).

2.1.1 Instrumentation

All the acoustic instrumentation employed during the noise measurements comply with the requirements of *AS IEC 61672.1-2004 Electroacoustics - Sound level meters - Specifications* and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

In accordance with the EPA's *Noise Policy for Industry* (NPfI), noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data. The NPfI advises that data may be affected where adverse weather, such as wind speeds higher than five metres per second or rain, occurs. Weather data were acquired from the Bureau of Meteorology's Observatory Hill weather station (station ID 066062).

2.1.2 Noise measurements

The loggers measured noise levels over the sample period and then determined L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} noise levels are the levels exceeded for 1 per cent, 10 per cent and 90 per cent of the measurement period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. 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 L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the NPfI 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 3 and Table 4 present 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 3 and Table 4 also present the existing L_{Aeq} ambient noise levels selected for each day, evening and night-time period, in accordance with the NPfI. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the entire monitoring period.

Table 3 Unattended noise measurement results in dB(A) – NCA 1

Measurement date (2017)	Backgr-ound noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 15 September	-	55	47	-	69	65
Saturday 16 September	-	-	48	-	-	66
Sunday 17 September	57	-	40	69	-	65
Monday 18 September	-	-	41	-	-	64
Tuesday 19 September	-	-	40	-	-	65
Wednesday 20 September	64	-	40	71	-	66
Thursday 21 September	64	56	43	71	69	66
Friday 22 September	-	-	-	-	-	-
Log Average				**70**	**69**	**65**
RBL	**64**	**56**	**41**			

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 & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

Table 4 Unattended noise measurement results in dB(A) – NCA 2

Measurement date (2017)	Backgr-ound noise levels L_{A90} dB(A)			Ambient noise levels L_{Aeq} dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
Friday 15 September		-	43		-	50
Saturday 16 September	-	-	43	-	-	50
Sunday 17 September	49	46	44	58	55	54
Monday 18 September	-	-	43	-	-	51
Tuesday 19 September	-	-	41	-	-	51
Wednesday 20 September	52	45	43	62	58	52
Thursday 21 September	52	47	43	63	57	52
Friday 22 September	-			-		
Log Average				**62**	**57**	**52**
RBL	**52**	**46**	**43**			

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 & Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday & Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays & Public Holidays.

2.2 Site observations

The acoustic environment of NCA 1 is characterised by constant road traffic noise during all periods of the day. This is typical of an urban environment.

NCA 2 is characterised by local traffic noise and constant background noise from New South Head Road during all periods of the day. This is typical of an urban environment.

3.0 Construction noise and vibration criteria

3.1 Construction activity noise criteria

3.1.1 Interim Construction Noise Guideline

The *Interim Construction Noise Guideline* (ICNG) is the principal guideline for the assessment and management of construction noise in NSW. The ICNG recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the Environmental Impact Assessment (EIA) processes'*. Noise levels due to construction activities are predicted at nearby receivers using environmental noise modelling software and 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 practices to minimise the noise impact. The proponent should also inform all potentially impacted residents 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 ICNG 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 the residential and non-residential receivers are detailed in Table 6 and Table 7.

Table 5 ICNG residential noise management levels

Time of day	NML, LAeq,15min, dB(A)1	How to apply
Recommended standard hours: 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. • where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • 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.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • 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: - 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 - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• a strong justification would typically be required for works outside the recommended standard hours • the proponent should apply all feasible and reasonable work practices to meet the noise affected level • 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 • for guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Notes:
1. 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 6 presents the NMLs applicable to residential receivers nearby to the Proposal.

Table 6 Construction noise management levels – Residential receivers

NCA	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
1	Day	64	74	69
	Evening	56	-	61
	Night	41	-	46
2	Day	52	62	57
	Evening	46	-	51

NCA	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
	Night	43	-	48

Table 7 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 7 Construction noise management levels – Other receivers

Land Use	Noise Management Levels, $L_{Aeq,15min}$ (applies when properties are being used)	
	External noise level	Internal noise level
Commercial premises (including offices, retail outlets)	70 dB(A)	60 dB(A)
Medical	55 dB(A)	45 dB(A)
Classrooms at schools and other educational institutions	55 dB(A)	45 dB(A)

3.1.2 Sleep disturbance criteria

The ICNG requires a sleep disturbance analysis to be completed 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), 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 $L_{A1(1\ min)}$, noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ 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 exceeded, 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 to 55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides around 10 dB in noise attenuation from outside to inside, external noise levels of 60 to 65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 8.

Table 8 Sleep disturbance criteria

NCA	Background noise level (L_{A90}), dB(A)	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A)	Awakening reaction $L_{A1(1\ minute)}$, dB(A)
1	41	56	65
2	43	58	65

3.2 Construction traffic noise criteria

Noise from construction traffic on public roads is not covered by the ICNG. However the ICNG does refer to the ECRTN, now superseded by the RNP, for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic, an initial screening test should be undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is equal to or greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion then noise mitigation should be considered for those receivers affected. The RNP does not require assessment of noise impact to commercial or industrial receivers.

3.3 Construction vibration criteria

The relevant standards and guidelines for the assessment of construction vibration are summarised in Table 9.

Table 9 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration)	Assessing Vibration: A Technical Guideline (AVATG)[1]

Notes

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. However 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
- 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.

3.3.1 Structural damage

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

The German Standard (DIN 4150) provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 10. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage. In this assessment of DIN 4150 structural damage safe limits have been adopted for residential, non-residential and heritage structures.

Table 10 Structural damage safe limits (DIN 4150) for building vibration (Vibration peak particle velocity)

Group	Type of structure	At foundation – Less than 10 Hz	At foundation - 10 Hz to 50 Hz	At foundation - 50 Hz to 100 Hz[1]	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
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 (e.g. buildings that are under a preservation order/heritage listed)	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values

3.3.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline A*ssessing Vibration: A Technical Guideline* (AVTG) 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 11. The VDV criteria are based on the likelihood that a person would comment adversely on the level of vibration over the entire assessment period.

Table 11 Preferred and maximum vibration dose values for intermittent vibration (m/s$^{1.75}$) for daytime (7am – 10pm) and night time (10pm – 7am)

Location	Daytime Preferred	Daytime Max	Night time Preferred	Night time Max
Critical areas[1]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops[2]	0.8	1.6	0.8	1.6

Notes:

1. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. Places where sensitive equipment is stored or delicate tasks are undertaken require more stringent criteria than the residential criteria specified above
2. Examples include automotive repair shops, manufacturing or recycling facilities. This includes places where manufacturing, recycling or repair activities are undertaken but do not require sensitive or delicate tasks.

4.0 Operational noise criteria

4.1 Noise Policy for Industry

The *Noise Policy for Industry* (NPfI) provides noise levels for assessing the potential impact of noise from industry, including railway stations, and includes a framework for considering feasible and reasonable noise mitigation measures. The assessment procedure has two components: the project intrusiveness noise level and the project amenity noise level. The project noise trigger level is the lower value of the project intrusiveness noise level and project amenity noise level .

The project noise trigger level is assessed at the boundary of the noise sensitive receiver site, or if the site boundary is more than 30 metres from the noise sensitive building, a distance of 30 metres from the noise sensitive building.

Adjustments to the level of noise predicted at the assessment location should be applied in accordance with Factsheet C of the NPfI to account for the effects of specific noise characteristics including tonality, low frequency content, intermittency, impulsiveness and duration.

4.1.1 Project intrusiveness noise level

The NPfI states that the intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15 minute period, does not exceed the background noise level measured by more than 5 dB. The rating background level (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in Fact Sheet B of the NPfI.

4.1.2 Project amenity noise level

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the acceptable noise levels specified in Table 2.2 of the NPfI. As per the definitions of receiver types within the NPfI, residences within the Proposal area are classified as being in an urban area. For residential receivers, the cumulative amenity criteria are shown in Table 12. Amenity noise levels for other nearby receiver types are also presented in Table 12. The amenity noise level is applied over the entire daytime, evening or night-time period.

The project amenity level for a project is equal to the recommended cumulative amenity level – 5 dB. The project amenity level is then converted to a 15 minute period by adding 3 dB. Therefore relevant noise amenity level from Table 12 is assigned as the project amenity noise level.

A summary of the environmental noise criteria is presented in Table 12 below. These criteria apply to environmental noise emissions from any operational plant installed as part of the Proposal.

Table 12 Summary of environmental noise emission criteria

Location	Time of day	RBL dB(A)	Intrusive Criterion $L_{Aeq(15\ min)}$, dB(A)	Amenity Criterion $L_{Aeq(15\ min)}$, dB(A)	Project-Specific Noise Levels[1] Criterion L_{Aeq}, dB(A)
NCA 1	Day	64	69	58[2,3]	60
	Evening	56	61	57[2,3]	57
	Night	41	46	53[2,3]	46
NCA 2	Day	52	57	58[3]	57
	Evening	46	51	48[3]	48
	Night	43	48	43[3]	43

School classroom	Noisiest 1-hour period when in use	-	-	43[3,4]	43
Commercial premises	When in use	-	-	63[3]	63

Notes:

1. Project-Specific Noise Levels represent the lower of the intrusive and amenity criteria
2. Amenity noise levels have been corrected for high level of existing traffic noise levels. Existing road traffic noise levels are more than 10 dB above the cumulative amenity noise levels and are unlikely to decrease in the future.
3. 3 dB has been added to the amenity levels to convert to a 15 minute noise level.
4. External noise level assuming windows are open for adequate ventilation

5.0 Construction noise assessment

5.1 Construction stages and scheduling

In consultation with TfNSW, a number of construction activities have been assumed to be required. These activities would be confirmed by the construction contractor prior to construction commencing and further assessment would be undertaken if required. The proposed construction staging is described in Table 13. The construction stages that have been modelled (i.e. those that represent worst case scenarios for noise impacts) are highlighted in blue in the table. The proposed timing of the works is also presented in this table.

Table 13 Construction assessment scenarios and scheduling

Construction stage	Activity	Description	Timing
1. Site establishment and enabling works	1A – Establishment of main site compound	Main site compound to be located at the bus interchange level. Activities include erecting fencing, deliveries of site cabins and offices, welfare facilities, service connections, material storage area.	Standard hours and night works
	1B – Establishment of site hoardings and work zones	Erect site hoarding around the different work fronts. Installation of temporary construction lights and power where required.	Night works
2. Lift 1 Works	2A – Platform demolition works	Demolition of existing platform slab, removal of slab infill, demolition of platform foundations/rock base to make space for the Lift 1 pit.	Night works and weekends
	2B – Lift pit concrete works	Installation of waterproofing (as required), reinforcement, formwork and concrete to form the Lift 1 pit on the platform.	Standard hours, night works and weekends
	2C - Penetrations through floor slabs	Local demolition of floor slabs to make space for the new Lift 1 shaft from platform to concourse level (3 penetrations).	Standard hours, night works and weekends

Construction stage	Activity	Description	Timing
	2D – Erection of glass and steel shaft	-	Standard hours and night deliveries
	2E – Lift Installation and commissioning	-	Standard hours and night deliveries
	2F – Architectural fit-out around lift shaft	Make good architectural finishes around lift shaft – reinstate ceiling finishes, make good tiling and floor finishes.	Standard hours
3. Lift 2 Works	3A – Penetrations through floor slabs	Local demolition of floor slabs to make space for the new Lift 2 shaft from concourse to bus interchange level (2 penetrations). Installation of trimming steel to the underside of the slabs before demolition.	Standard hours and night works
	3B – Erection of glass and steel shafts	-	Standard hours and night deliveries
	3C – Lift Installation and commissioning	-	Standard hours and night deliveries
	3D – Architectural fit-out around lift shaft	Make good architectural finishes around lift shaft – reinstate ceiling finishes, make good tiling and floor finishes.	Standard hours
4. Escalators 1 to 4 replacement works	4A – Demolition of existing escalators and motors	Piecemeal demolition of motors and truss by cutting them in small manageable pieces to take off site. New door openings in escalator motor rooms to facilitate logistics.	Night works
	4B – Demolition of top and bottom landings to suit new escalators	Demolition of floor finishes and concrete slabs at top and bottom landings of the escalators.	Night works
	4C – New concrete structural supports	FRP works for the construction of new concrete bearings for the new escalators at the top and bottom landings (concourse and platform levels).	Night works and weekends
	4D – New steel structural supports	Weld new intermediate steel supports for the new escalators.	Standard hours
	4E – Fit-out of escalator void and landings	Make good architectural finishes around the escalators – reinstate ceiling finishes, make good tiling and floor finishes, re-paint and render exposed/damaged walls.	Standard hours

Construction stage	Activity	Description	Timing
	4F – Erection of temporary works for the installation of new escalators	Installation of a guiderail and trolley system to pull sections up the escalator void from the platforms. Install gantries and/or jacking stations at top and bottom of void to allow loading and unloading of escalator units on the rails.	Standard hours and night deliveries
	4G – Installation of new escalators	Deliveries of escalator sections via hi-rail to the platforms, and use of temporary works system to pull the sections up the escalator void to splice them and fix them into place.	Standard hours, weekends and night deliveries
	4H – Commissioning of new escalators	Fit-out of steps and cladding panels, commission escalators	Standard hours and night deliveries
5. New staircase construction	5A – Penetrations through floor slabs	Local demolition of floor slabs to make space for the new staircase from platform to concourse level (3 penetrations).	Standard hours, night works and weekends
	5B – Erect walls and build stairs	Build peripheral walls and concrete staircases using block work and concrete, including reinforcement, formwork and concrete pouring.	Standard hours and night works
	5C – Fit-out of new stairs	Paint walls and floors, install stair nosing, fit-out lights, power points, speakers, CCTV, sprinklers, fire detection, handrails, balustrades and doors.	Standard hours
6. New McLean Street Ramp and Kiss & Ride works	6A – Removal of clashing vegetation	Remove trees and vegetation.	Standard hours
	6B – Install foundations and pre-cast concrete ramps	Install pre-cast concrete ramp during a weekend closure of the New McLean Street entrance..	Weekend Works
7. Ticket gates relocation works	7A – Remove existing gate line and move/install new gates – weekend shutdown	Relocate ticket gates on concourse level, to new location and install new additional gates. Test and commission gates.	Weekend Works
	7B - Floor finishes around new and old gate line	Complete architectural fit-out and make good works at previous gate line location and around newly installed gates.	Weekend Works
8. Bus interchange works	8A – Pedestrian/wheelchair crossings levelling works	Install pedestrian crossings and pram ramps and to Lift 2.	Standard hours

Construction stage	Activity	Description	Timing
	8B – New canopy extension erection	Erect steel frame and roof sheeting for the new extended canopy over the new levelled pedestrian crossings.	Night works and weekends
	8C - Bike shed relocation	Disassemble bike shed and re-assemble at new location.	Standard hours
9. Electrical Upgrades	9A – Penetrations	New penetrations for cables, conduits, cable racks and trays through slabs and walls of Edgecliff station.	Night works
	9B – Builders works in relation	New walls and doors to modified electrical switch rooms. Fit-out and finishes in modified electrical rooms.	Standard hours and night works
	9C – Electrical works	Electrical upgrades including critical electrical works that require switch overs or isolations of station equipment; delivery of new switch boards via hi-rail; cable pulling across platforms.	Standard hours, night works and weekends
10. Platform modifications works	10A – Partial demolition of platform buildings for passing bays	Platform level - Demolition of walls to create passenger passing bays.	Night works and weekends
	10B - Ceilings and walls fit-out to modified platform areas	Ceiling cladding installation, paint walls and floors, fit-out lights, power points, speakers, CCTV, sprinklers, fire detection.	Standard hours
11. New garbage room at concourse level	11A – Build new garbage room at Concourse level, East of new Lift 2	Erect block work wall, minor demolition of existing redundant fittings, fit-out of new room with architectural finishes and safety/security services.	Standard hours

5.2 Construction noise sources

Construction noise sources and their respective L_{Aeq} sound power levels for each scenario are shown in Table 14. These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites* and the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites* noise database and assume equipment is modern and in good working order.

Table 14 Equipment sound power levels per construction scenario

Equipment	Activity	Sound Power Level, dB(A)	
		L_{Aeq}	L_{A1}
Concrete saws	2C, 3A, 4A, 5A, 9A, 10A	110	118
Jack hammers	2C, 3A, 4A, 5A, 8A, 9A, 10A	108	116
Road forklifts and skip trucks	2C, 3A, 4A, 5A	98	106
Hi-rail skip truck and flatbeds	2C, 3A, 4A, 5A, 10A	98	106

Equipment	Activity	Sound Power Level, dB(A)	
		L_{Aeq}	L_{A1}
Standard carpentry tools and power tools	2C, 3A, 4A, 5A, 7B, 8A, 8B, 10A	94	102
Torque wrenches and impact wrenches	2C, 3A, 5A, 8B	105	113
Cold cutting power saws	4A	110	118
Hydraulic shears	4A	94	102
Chainsaws	6A	110	118
Skip trucks	6A	98	106
EWP and boom lifts	6A	87	95
Tile cutting saw	7B	110	118
Mixer for screeding works	7B	89	97
Forklift, pallet jacks and flatbed trucks	7B, 8B	98	106
Concrete mixer truck	8A	89	97
Concrete vibrator poker	8A	97	105
Grinders and bar benders	8A	108	116
Mobile Crane	8B	104	112
Core drills	9A	113	121
Hammer drills	9A	107	115

5.3 Modelling and conditions

In order to assess noise impacts during construction, a noise model was created to represent 'reasonable' worst periods of upgrade works. The construction of the Proposal has been modelled in SoundPLAN Version 7.3 with the following features included in the noise model:

- ground topography (the level and shape of the surrounding land)
- ground absorption and reflection
- buildings (including shielding of noise)
- residential and non-residential receivers (as shown in Table 2)
- construction noise sources for the Proposal (as listed in Table 14).

Noise emissions from the construction sites have been modelled using an implementation of the ISO 9613 propagation algorithm.

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 would also vary as the construction equipment moves around the site.

Construction noise levels at the identified residential receivers have been assessed against the NMLs for standard hours, daytime, evening and night-time out-of-hours (as shown in Table 6 and Table 7). However, the level of impact may change depending on the final construction methodology which would be developed by the contractor, and further assessment would be undertaken if required.

During construction not all equipment would be operating simultaneously at all times and in the one location (as assumed in the modelling), which would result in a reduction in predicted noise levels.

Mitigation measures for receivers have been specified in Section 7.0. These measures are considered to be feasible and reasonable and would reduce the impact of these exceedances.

5.4 Construction airborne noise assessment

Construction noise levels at the identified residential and non-residential receivers have been assessed against the standard hours and out-of-hours night-time NMLs (as shown in Table 15). However, the level of impact may change depending on the final construction methodology which would be developed by the contractor, and further assessment would be undertaken if required.

During construction not all equipment would be operating simultaneously at all times and in the one location (as assumed in the modelling), which would result in a slight reduction in predicted noise levels. Mitigation measures for receivers have been specified in Section 7.0 which would feasibly and reasonably reduce the impact of these exceedances.

Noise results are presented as noise contour layers over aerial maps in Appendix D. For works package 10A the predicted noise levels are below the NMLs therefore no noise contours are shown.

The predicated construction noise levels at residential receivers are shown in Table 15. During work packages 7B and 8B, exceedances of between 10 and 20 dB(A) are predicted at the closest residential receivers. More minor exceedances, less than 10 dB(A), are predicted at residential receivers during work packaged 3A, 4A, 6A, 8A and 9A.

No residential receivers are predicted to be 'highly affected' during the work packages.

Construction noise levels at non-residential receivers during standard hours are shown in Table 15. The non-residential receivers are predicated to experience exceedances of daytime NMLs during standard hours. During work packages 7B and 8B, exceedances of between 10 and 21 dB(A) are predicted. More minor exceedances (less than 10 dB(A)) are anticipated during scenarios 3A, 4A, 6A, 8A and 9A.

The Precise Dental Surgery is predicted to be impacted by exceedances greater than 20 dB(A) during the work packages 3A, 6A, 7B.

The Edgecliff Medical Centre is predicted to be impacted by exceedances greater than 20 dB(A) during the work packages 3A, 7B, 8A.

Key noisy activities during daytime construction works include the use of chainsaws, concrete saws, jack hammers, power saws, tile saws, grinders and core drills.

Table 15 Construction L_{Aeq} airborne noise level results

Worst Affected Receiver	Type	Time[1]	RBL[2], $L_{A90\ 15\ min}$	NML, $L_{Aeq\ 15\ min}$	Predicted, $L_{Aeq\ 15\ min}$ dB(A)	NML exceedance[3]
2C - Lift 1 Penetrations						
176 New South Head Road	Residential	Night	41	46	46	-
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	<40	-
Aldi	Retail	Day	-	70	69	-
Newsagency - Concourse	Retail	Day	-	70	72	2
Precise Dental Surgery	Medical	Day	-	55	65	10
Shopping centre Level 4	Retail	Day	-	70	57	-
Edgecliff Medical Centre	Medical	Day	-	55	57	2

Worst Affected Receiver	Type	Time[1]	RBL[2], $L_{A90\ 15\ min}$	NML, $L_{Aeq\ 15\ min}$	Predicted, $L_{Aeq\ 15\ min}$ dB(A)	NML exceedance[3]
Ascham School	School	Day	-	65	< 40	-
3A - Lift 2 Penetrations						
176 New South Head Road	Residential	Night	41	46	54	8
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	52	4
Aldi	Retail	Day	-	70	81	11
Newsagency - Concourse	Retail	Day	-	70	80	10
Precise Dental Surgery	Medical	Day	-	55	85	30
Shopping centre Level 4	Retail	Day	-	70	83	13
Edgecliff Medical Centre	Medical	Day		55	83	28
Ascham School	School	Day	-	65	47	-
4A Escalator Demolition						
176 New South Head Road	Residential	Night	41	46	49	3
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	<40	-
5A - Staircase Penetrations						
176 New South Head Road	Residential	Night	41	46	46	-
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	<40	-
Aldi	Retail	Day	-	70	69	-
Newsagency - Concourse	Retail	Day	-	70	72	2
Precise Dental Surgery	Medical	Day	-	55	65	10
Shopping centre Level 4	Retail	Day	-	70	57	-
Edgecliff Medical Centre	Medical	Day		55	57	2
Ascham School	School	Day	-	65	46	-
6A McLean Ramp						
176 New South Head Road	Residential	Day	64	74	<40	-
180 Ocean Street	Residential	Day	64	74	58	-
27 Cameron Street	Residential	Day	52	62	69	7
Aldi	Retail	Day	-	70	60	-
Newsagency - Concourse	Retail	Day	-	70	62	-
Precise Dental Surgery	Medical	Day	-	55	77	22
Shopping centre Level 4	Retail	Day	-	70	<40	-
Edgecliff Medical Centre	Medical	Day		55	<40	-
Ascham School	School	Day	-	65	<40	-
7B - Ticket Gate Floor						

Worst Affected Receiver	Type	Time[1]	RBL[2], $L_{A90\ 15\ min}$	NML, $L_{Aeq\ 15\ min}$	Predicted, $L_{Aeq\ 15\ min}$ dB(A)	NML exceedance[3]
176 New South Head Road	Residential	Night	41	46	64	18
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	48	-
Aldi	Retail	Day	-	70	83	13
Newsagency - Concourse	Retail	Day	-	70	89	19
Precise Dental Surgery	Medical	Day	-	55	77	22
Shopping centre Level 4	Retail	Day	-	70	77	7
Edgecliff Medical Centre	Medical	Day		55	77	22
Ascham School	School	Day	-	65	56	-
8A - Bus Interchange Crossing						
176 New South Head Road	Residential	Day	64	74	68	-
180 Ocean Street	Residential	Day	64	74	73	-
27 Cameron Street	Residential	Day	52	62	65	3
Aldi	Retail	Day	-	70	51	-
Newsagency - Concourse	Retail	Day	-	70	57	-
Precise Dental Surgery	Medical	Day	-	55	43	-
Shopping centre Level 4	Retail	Day	-	70	78	8
Edgecliff Medical Centre	Medical	Day		55	78	23
Ascham School	School	Day	-	65	61	-
8B - Bus Interchange Canopy						
176 New South Head Road	Residential	Night	41	46	62	16
180 Ocean Street	Residential	Night	41	46	67	21
27 Cameron Street	Residential	Night	43	48	59	11
9A - Electrical Penetrations						
176 New South Head Road	Residential	Night	41	46	49	3
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	<40	-
10A Platform Demo						
176 New South Head Road	Residential	Night	41	46	<40	-
180 Ocean Street	Residential	Night	41	46	<40	-
27 Cameron Street	Residential	Night	43	48	<40	-
Aldi	Retail	Day	-	70	41	-
Newsagency - Concourse	Retail	Day	-	70	46	-
Precise Dental Surgery	Medical	Day	-	55	<40	-
Shopping centre Level 4	Retail	Day	-	70	<40	-
Edgecliff Medical Centre	Medical	Day		55	<40	-

Worst Affected Receiver	Type	Time[1]	RBL[2], $L_{A90\ 15\ min}$	NML, $L_{Aeq\ 15\ min}$	Predicted, $L_{Aeq\ 15\ min}$ dB(A)	NML exceedance[3]
Ascham School	School	Day	-	65	<40	-

5.5 Sleep disturbance assessment

Table 16 presents the predicted maximum $L_{A1\ (1\ min)}$ noise levels. The predicted $L_{A1(1\ min)}$ noise levels indicate that the awakening reaction criteria may be exceeded during the night-time construction works during work packages 7B and 8B.

Table 16 Construction L_{A1} noise level results

Worst Affected Receiver	Type	Time[1]	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A)	$L_{A1(1\ minute)}$, dB(A) Awakening reaction	Predicted, $L_{A1\ 1\ min}$ dB(A)	Exceedance[3]
2C - Lift 1 Penetrations						
176 New South Head Road	Residential	Night	56	65	54	-
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	48	-
3A - Lift 2 Penetrations						
176 New South Head Road	Residential	Night	56	65	62	-
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	60	-
4A Escalator Demolition						
176 New South Head Road	Residential	Night	56	65	57	-
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	48	-
5A - Staircase Penetrations						
176 New South Head Road	Residential	Night	56	65	54	-
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	48	-
7B - Ticket Gate Floor						
176 New South Head Road	Residential	Night	56	65	72	7
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	56	-
8B - Bus Interchange Canopy						
176 New South Head Road	Residential	Night	56	65	70	5

Worst Affected Receiver	Type	Time[1]	Sleep disturbance screening level $L_{A1(1\ minute)}$, dB(A)	$L_{A1(1\ minute)}$, dB(A) Awakening reaction	Predicted, $L_{A1\ 1\ min}$ dB(A)	Exceed-ance[3]
180 Ocean Street	Residential	Night	56	65	75	10
27 Cameron Street	Residential	Night	58	65	67	2
9A - Electrical Penetrations						
176 New South Head Road	Residential	Night	56	65	57	-
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	48	-
10A Platform Demo						
176 New South Head Road	Residential	Night	56	65	48	-
180 Ocean Street	Residential	Night	56	65	48	-
27 Cameron Street	Residential	Night	58	65	48	-

5.6 Construction traffic assessment

Construction traffic volumes are anticipated to be:

- 1 skip truck per day;
- 2 utes or small vans per day;
- 2 construction staff cars per day;
- 1-2 heavy vehicle deliveries per day supplying plant and equipment.

In order for construction traffic to generate an increase in noise levels of greater than 2 dB, existing traffic levels along construction traffic routes would need to increase by around 60 per cent.

From on-site observations during the deployment of unattended noise measurement equipment, the existing traffic flow is substantially greater than the proposed construction traffic numbers. Based on a Traffic and Transport Impact Assessment prepared by AECOM (AECOM, 2017), additional construction traffic movements would be less than 10 per cent of the existing total daily movements. Therefore, the construction vehicles would have a negligible impact on existing road traffic noise in the area. The traffic generated by the Proposal is considered to comply with the *Road Noise Policy* criteria.

5.7 Construction vibration assessment

5.7.1 Predicted structure-borne noise levels

Structure-borne noise, in addition to airborne noise (refer to Section 5.4), 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 3. 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 re-radiated as noise in a nearby room.

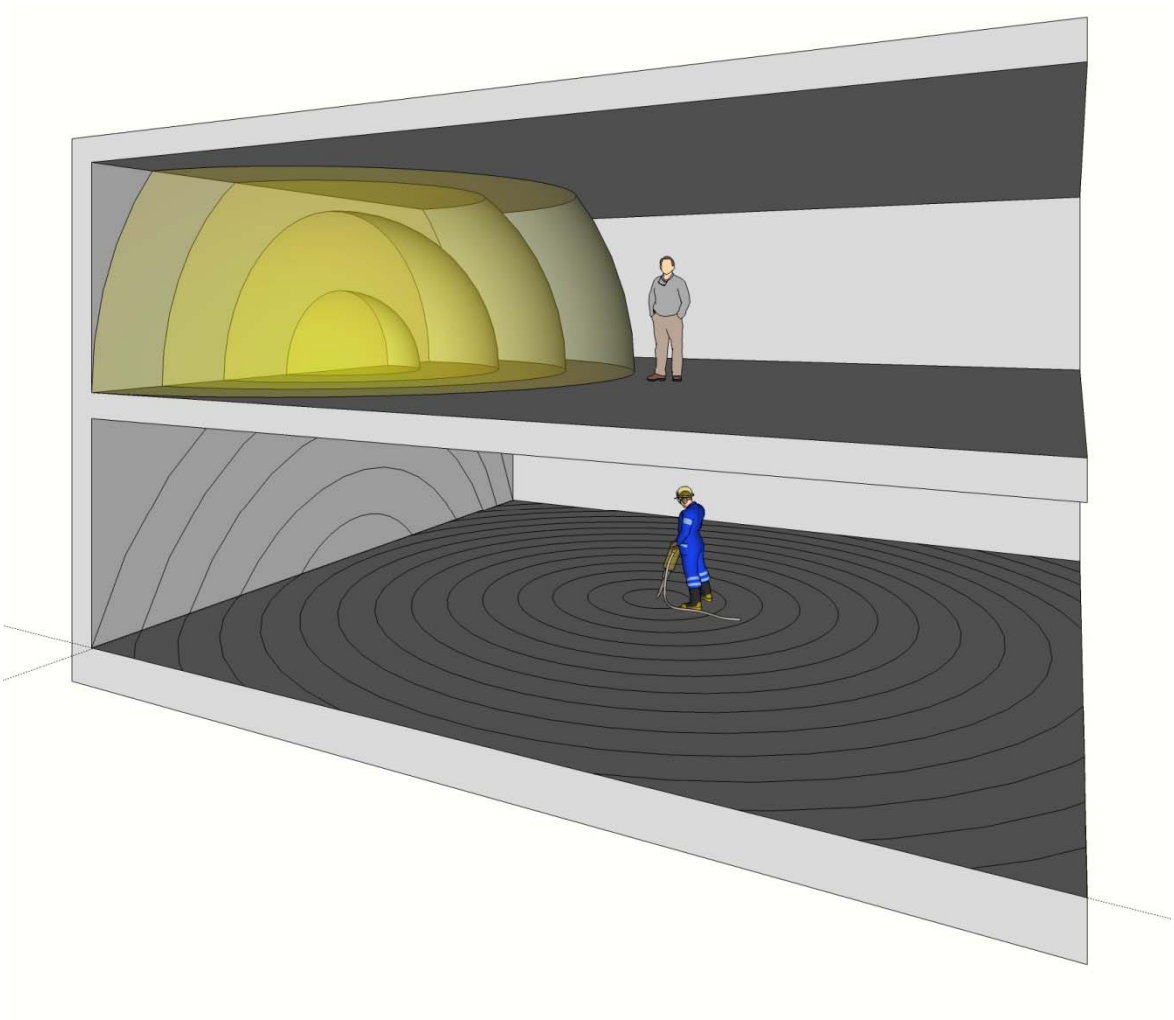

Figure 3 Structure-borne noise path

Vibration levels have been calculated at the nearest sensitive receivers. These results have been based upon:

- Vibration measurements taken by AECOM within Wynyard Station in 2014 of a hammer drill, a hammer drill with a chisel point and an angle grinder; and
- 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 representative receivers are presented in Table 17.

Regenerated noise levels exceedances between 10 and 20 dB(A) are predicted at the Edgecliff Medical Centre (work packages 2C, 3A, 5A, 7B and 8A) and the Precise Dental Surgery (work package 3A). More minor exceedances (less than 10 dB(A)) are also anticipated during scenarios 2C, 3A, 5A, 7B, 8A and 10A.

Table 17 Predicted regenerated noise levels at selected receivers

Worst Affected Receiver	Type	NML, $L_{Aeq\ 15\ min}$ Internal	Predicted structure-borne noise level dB(A)	NML exceed-ance[3]
2C - Lift 1 Penetrations				
180 Ocean Street	Residential	35	<30	-
Aldi	Retail	60	52	-
Newsagency - Concourse	Retail	60	64	4
Precise Dental Surgery	Medical	45	52	7
Shopping centre Level 4	Retail	60	58	-
Edgecliff Medical Centre	Medical	45	58	13
3A - Lift 2 Penetrations				
180 Ocean Street	Residential	35	<30	-
Aldi	Retail	60	64	4
Newsagency - Concourse	Retail	60	64	4
Precise Dental Surgery	Medical	45	64	19
Shopping centre Level 4	Retail	60	58	-
Edgecliff Medical Centre	Medical	45	58	13
5A - Staircase Penetrations				
180 Ocean Street	Residential	35	<30	-
Aldi	Retail	60	52	-
Newsagency - Concourse	Retail	60	64	4
Precise Dental Surgery	Medical	45	52	7
Shopping centre Level 4	Retail	60	58	-
Edgecliff Medical Centre	Medical	45	58	13
7B - Ticket Gate Floor				
180 Ocean Street	Residential	35	<30	-
Aldi	Retail	60	52	-
Newsagency - Concourse	Retail	60	64	4
Precise Dental Surgery	Medical	45	52	7
Shopping centre Level 4	Retail	60	58	-
Edgecliff Medical Centre	Medical	45	58	13
8A - Bus Interchange Crossing				
180 Ocean Street	Residential	35	<30	-
Aldi	Retail	60	53	-
Newsagency - Concourse	Retail	60	53	-
Precise Dental Surgery	Medical	45	53	8
Shopping centre Level 4	Retail	60	64	4

Worst Affected Receiver	Type	NML, $L_{Aeq\ 15\ min}$ Internal	Predicted structure-borne noise level dB(A)	NML exceed-ance[3]
Edgecliff Medical Centre	Medical	45	64	19
10A Platform Demo				
180 Ocean Street	Residential	35	<30	-
Aldi	Retail	60	41	-
Newsagency - Concourse	Retail	60	53	-
Precise Dental Surgery	Medical	45	41	-
Shopping centre Level 4	Retail	60	47	-
Edgecliff Medical Centre	Medical	45	47	2

5.7.2 Predicted vibration – human comfort

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 18. No exceedance of the VDV management level is predicted.

Table 18 Estimated vibration dose values at selected receivers

Worst Affected Receiver	Type	VDV Management Level	Estimated VDVs (m/s$^{1.75}$)	NML exceed-ance[3]
2C - Lift 1 Penetrations				
180 Ocean Street	Residential	0.13	<0.1	-
Aldi	Retail	0.8	0.2	-
Newsagency - Concourse	Retail	0.8	0.4	-
Precise Dental Surgery	Medical	0.8	0.2	-
Shopping centre Level 4	Retail	0.8	0.3	-
Edgecliff Medical Centre	Medical	0.8	0.3	-
3A - Lift 2 Penetrations				
180 Ocean Street	Residential	0.13	<0.1	-
Aldi	Retail	0.8	0.4	-
Newsagency - Concourse	Retail	0.8	0.4	-
Precise Dental Surgery	Medical	0.8	0.4	-
Shopping centre Level 4	Retail	0.8	0.3	-
Edgecliff Medical Centre	Medical	0.8	0.3	-
5A - Staircase Penetrations				

Worst Affected Receiver	Type	VDV Management Level	Estimated VDVs (m/s$^{1.75}$)	NML exceed-ance[3]
180 Ocean Street	Residential	0.13	<0.1	-
Aldi	Retail	0.8	0.2	-
Newsagency - Concourse	Retail	0.8	0.4	-
Precise Dental Surgery	Medical	0.8	0.2	-
Shopping centre Level 4	Retail	0.8	0.3	-
Edgecliff Medical Centre	Medical	0.8	0.3	-
7B - Ticket Gate Floor				
180 Ocean Street	Residential	0.13	<0.1	-
Aldi	Retail	0.8	0.2	-
Newsagency - Concourse	Retail	0.8	0.4	-
Precise Dental Surgery	Medical	0.8	0.2	-
Shopping centre Level 4	Retail	0.8	0.3	-
Edgecliff Medical Centre	Medical	0.8	0.3	-
8A - Bus Interchange Crossing				
Aldi	Retail	0.8	0.3	-
Newsagency - Concourse	Retail	0.8	0.3	-
Precise Dental Surgery	Medical	0.8	0.3	-
Shopping centre Level 4	Retail	0.8	0.5	-
Edgecliff Medical Centre	Medical	0.8	0.5	-
10A Platform Demo				
180 Ocean Street	Residential	0.13	<0.1	-
Aldi	Retail	0.8	0.1	-
Newsagency - Concourse	Retail	0.8	0.3	-
Precise Dental Surgery	Medical	0.8	0.1	-
Shopping Centre Level 4	Retail	0.8	0.2	-
Edgecliff Medical Centre	Medical	0.8	0.2	-

5.7.3 Predicted vibration – cosmetic damage

Vibration-intensive works may include the use of the following items of equipment:

- jack hammers
- hammer drills

The safe working distances of these items of equipment from off-site receivers are shown in Table 19 which is based on recommendations of the TfNSW *Construction Noise Strategy* (CNS) and AECOM's previous project experience. If these safe working distances are complied with no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage. The safe working distance for a hammer drill (hand held) is assumed to be similar to a jack hammer

Based on the indicative construction activities assessed for the Proposal, some works may occur within the safe working distances for heritage features. If vibration-intensive works are required within these safe working distances, mitigation measures to control excessive vibration would be implemented as outlined in Section 7.0.

The heritage features should be demarcated as constraint areas, as far as is practical, during construction to avoid potential impacts from vibration. For vibration-generating activities within the safe working distances, it is recommended that attended measurements are undertaken when work commences, to determine site specific safe working distances.

Table 19 Safe working distances of vibration intensive equipment to be used during the Proposal

Plant	Rating/ Description	Cosmetic damage – residential/commercial	Cosmetic damage - heritage
Jack hammer	Hand-held	1 m (nominal)	1 m (nominal)

6.0 Operational noise assessment

With the exception of the proposed reconfiguration, the operation of the station would remain unchanged as a result of the Proposal. There would be no additional patrons, and no expected change in the frequency or capacity of passenger trains servicing the station.

During the operation of the Proposal, there may be minor changes to the provision of a new kiss and ride area on New McLean Street, however this is not considered to produce significant noise emissions.

Additional operational equipment at the station would include two new lifts, additional ticket gates and the upgrades escalators (including new motors) which would not produce significant noise emissions.

As such, the operational noise environment is expected to remain largely unchanged. Standard noise controls such as appropriate selection of mechanical plant (such as lifts) would reduce any impacts.

If required, operational noise emissions shall be addressed during the detailed design phase in order to comply with Sydney Trains speech intelligibility requirements and operational noise criteria as per the *Noise Policy* for *Industry.* Operational noise criteria are presented in Section 4.0.

7.0 Mitigation measures

It has been identified that potential construction noise impacts at residences within the vicinity of the Proposal may be high, in some cases exceeding the noise management levels by 20 dB or more. It is therefore critical to the success of this Proposal that a Construction Noise and Vibration Management Plan (CNVMP) should be developed and implemented prior to commencement of construction activities. The CNVMP should include all reasonable and feasible safeguards to manage the noise emissions from the site and manage any complaints which may occur due to construction noise. The CNVMP should include, as a minimum, the following:

- identification of nearby residences and other sensitive land uses
- description of approved hours of work
- description and identification of all construction activities, including work areas, equipment and duration
- description of work practices (generic and specific) which would be applied to minimise noise and vibration
- a complaints handling process
- noise and vibration monitoring procedures
- overview of community consultation required for identified high impact works.

Construction works should be planned and carried out during standard construction hours wherever possible. For works which are required to be undertaken out of hours due to the need to retain the operational status of the station, the use of those items of equipment or processes which have been identified in Section 5.2 as generating the highest noise levels should be minimised as far as is possible, and confined to the earlier portions of the evening and night-time periods as far as is practical to minimise the risk of sleep disturbance throughout the night.

Table 20 presents the standard mitigation measures contained within the CNS which should be considered as mitigation measures as part of the CNVMP.

Table 20 TfNSW's *Construction Noise Strategy* standard mitigation measures

Action required	Safeguard details
Management measures	
Implement any project specific mitigation measures required	In addition to the measures set out in this table, any project specific mitigation measures identified in this report.
Implement community consultation measures	Periodic notification (monthly letterbox drop or equivalent), website, Project Infoline, Construction Response Line, email distribution list.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Noise monitoring	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Source controls	

Action required	Safeguard details
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period	High noise and vibration generating activities may only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block.
Equipment selection	Use quieter and less vibration emitting construction methods where feasible and reasonable.
Maximum noise levels	The noise levels of plant and equipment must have operating sound power or sound pressure levels that would meet the predicted noise levels.
Rental plant and equipment	Noise emissions should be considered as part of the selection process.
Use and siting of plant	Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Plant and vehicles to be turned off when not in use. Noise-emitting plant to be directed away from sensitive receivers.
Plan works site and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction related traffic	Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. Limit the speed of vehicles and avoid the use of engine compression brakes. Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.

Action required	Safeguard details
Silencers on Mobile Plant	Where possible reduce noise from mobile plant through additional fittings including: Residential grade mufflers Damped hammers such as “City” Model Rammer Hammers Air Parking brake engagement is silenced
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

In addition to the standard mitigation measures identified in the CNS, the following specific mitigation measures have been developed as a result of the predicted impacts associated with the Proposal, these are detailed in **Table 21**. The mitigation and management measures focus largely on further consultation and mitigation to address predicted exceedances in airborne and structure-borne noise levels at residential, retail, commercial and educational establishments.

Table 21 Mitigation and management measures

Identification number	Mitigation and management measure
2	All receivers impacted by noise levels which are expected to exceed the construction NMLs would be consulted about the proposal 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. The information provided to the receivers would include: • Programmed times and locations of construction work. • The hours of proposed works. • Construction noise and vibration impact predictions. • Construction noise and vibration mitigation measures being implemented on site. • Consultation would be consistent with the requirements of TfNSW *Construction Noise Strategy*. The highest consideration would be given to receivers that are predicted to be most affected as a result of the works. • Complaints during construction would be managed in accordance with Transport for NSW’s *Community Engagement Policy*. The construction response line (1800 775 465) would be available during construction.
3	• 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.
4	Particularly noisy activities should be scheduled for times when they would have the least impact where feasible and reasonable. 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

Identification number	Mitigation and management measure
	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 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. Negotiations should be undertaken with retail premises within and around the station to determine if periods of respite are appropriate.
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 *Construction Noise Strategy*.
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	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.
10	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).
11	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, taking into account the requirements of the Workplace Health and Safety legislation.
12	Where possible material and equipment deliveries and removal shall be undertaken using high-rail vehicles.
13	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. A noise monitoring program would be presented in the CNVMP
14	The Edgecliff Railway Station Upgrade - Statement of Heritage Impact has identified the potential of moderate heritage impacts to parts of the station fabric such as the plywood ceilings, terrazzo floors and areas of blue tile. To mitigate the impact to these fabrics the following should be considered: • the careful removal of plywood panels around lift shafts (for future reinstatement); and • the installation of protective paper or matting to floors and walls around areas of work, as required. This should be undertaken in consultation with a suitability qualified heritage consultant. For vibration-intensive activities which occur within the safe working distance for

Identification number	Mitigation and management measure
	cosmetic damage for other heritage items such as the phone booths, management methods to mitigate these impacts should include, as appropriate, the following: • the use of less vibration-intensive methods of construction or equipment is preferred where practical to reduce the potential for cosmetic damage. All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts • attended vibration measurements are undertaken when work commences, to determine site-specific safe working distances. Vibration intensive work should not proceed within the safe working distances unless a permanent vibration monitoring system is installed around one metre from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective.

7.1.1 Community consultation and complaints handling

All residents and sensitive receivers impacted by noise and vibration from the proposed works which are expected to exceed the NML should be consulted about the Proposal 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.

The information provided to the residents / building occupants should include:

- programmed times and locations of construction work
- the hours of proposed works
- construction noise and vibration impact predictions
- construction noise and vibration mitigation measures being implemented on site.

Community consultation regarding construction noise and vibration should be detailed in a Community Liaison Plan for the construction of the Proposal and should include a 24 hour hotline and complaints management process.

7.1.2 TfNSW's *Construction Noise Strategy* - Additional mitigation measures

Where exceedances in airborne noise are still expected to occur after standard mitigation measures have been applied, T CNS recommends the implementation of additional mitigation measures. These mitigation measures are specified within TfNSW's CNS and presented in Table 22.

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 6.

The following abbreviations have been used (refer to Table 23 for further details):

AA: Alternative accommodation

M: Monitoring

IB: Individual briefings

LB: Letter box drops

RO: Project specific respite offer

PC: Phone calls

SN: Specific notifications.

Table 22 Additional mitigation measures matrix for airborne construction noise

Time period		Mitigation measures			
		$L_{Aeq(15minute)}$	noise level	above the	background
		Qualitative	assessment	of noise	levels[1]
		0 to 10 dBA Noticeable	10 to 20 dBA Clearly audible	20 to 30 dBA Moderately intrusive	>30 dBA Highly intrusive
Standard	Mon-Fri (7am-6pm) Sat (8am-1pm) Sun/Pub Hol (Nil)	-	-	LB, M	LB, M
OOHW[3] Period 1	Mon-Fri (6pm-10pm) Sat (7-8am) & (1pm-10pm) Sun/Pub Hol (8am-6pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN, RO[2]
OOHW[3] Period 2	Mon-Fri (10pm-7am) Sat (10pm-8am) Sun/Pub Hol (6pm-7am)	LB	M, LB, RO[2]	M, IB, LB PC, SN, RO[2]	AA, M, IB, LB, PC, SN, RO

Notes:

1. For some types of construction activities, a qualitative assessment of the potential noise impacts can be undertaken in lieu of detailed noise modelling. For these activities, noise mitigation measures should be evaluated on the basis of the noise levels being noticeable, clearly audible, moderately intrusive or highly intrusive. The qualitative assessment should consider the type of equipment being used, the character of the noise emissions, time of day, the location of the nearest receivers and the noise sensitivity of the nearest receivers. Where a qualitative assessment is being undertaken, this would need to be approved by the Environmental Management Representative.
2. Respite Offers identified in Period 2 for clearly audible (10 to 20dBA) and moderately intrusive (20 to 30dBA) work shall only apply if works are expected to continue for more than 3 consecutive evenings for Period 1 or more than 2 consecutive nights for Period 2.
3. OOH – Outside of standard hours

Table 23 outlines the additional mitigation measures, as outlined in the CNS.

Table 23 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 would 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.

8.0 Conclusions

AECOM has been commissioned by Transport for New South Wales (TfNSW) to undertake a Noise and Vibration Impact Assessment of the proposed Edgecliff Station Upgrade (the Proposal)

The scope of the assessment included noise measurement surveys, establishing noise and vibration criteria, noise and vibration predictions for construction scenarios, a noise and vibration impact assessment relative to appropriate noise management levels and recommendations for noise and vibration control measures where necessary.

The noise and vibration assessment was carried out in accordance with NSW regulatory requirements which results in addressing the assessment as follows:

Construction noise and vibration

The construction noise assessment was conducted in accordance with EPA's ICNG. Typical worst case construction scenarios have been considered. Construction activities would occur during the daytime and the night-time periods. Worst case construction scenarios in the following areas have been considered:

- works behind hoardings within the station concourse and platform areas;
- works in open areas in the bus interchange and near the New McLean Street pedestrian ramp; and

The noise assessment associated with the Proposal indicates some exceedances of the NSW ICNG noise management levels at the nearest residential, educational, retail and commercial receivers. Measures have been recommended to mitigate the construction noise impact at adjacent residential, commercial and educational receivers. The measures include the:

- completion of a CNVMP;
- community consultation;
- appropriate selection and maintenance of equipment;
- use of hoardings;
- scheduling of work for less sensitive time periods, where feasible;
- situating plant in less noise sensitive locations;
- induction and training of construction site workers;
- construction traffic management; and
- noise monitoring.

The construction vibration assessment indicates some exceedances of the structure-borne noise management levels at the nearest retail and commercial receivers. These exceedances are considered typical worst case scenarios. The mitigation measures recommended to control airborne construction noise are also considered appropriate to control regenerated construction noise.

No exceedances of the construction human comfort management levels are predicted.

Construction road traffic noise

The road traffic noise associated with construction activities was assessed in accordance with EPA's NSW RNP guidelines.

The road traffic noise assessment associated with construction indicates compliance with the NSW RNP acoustic criteria as the noise increase on construction routes is predicted to be negligible, i.e. less than 1 dB.

Operational impacts

Noise impacts upon nearby sensitive receivers due to the plant associated with the station upgrade would be minimal.

Appendix A

Acoustic terminology

Appendix A Acoustic terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10 per cent of the measurement period. For 10 per cent of the measurement period it was louder than the L_{10}.

L_{90}	The sound pressure level exceeded for 90 per cent of the measurement period. For 90 per cent of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's *Noise Policy for Industry* and *Road Noise Policy*.

Appendix B

Noise logging locations

Appendix C

Receivers

Appendix D

Noise contour maps