Noise Impact Assessment

East Hills Station Upgrade

NE30047

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Contact Information

Cardno QLD Pty Ltd Trading as Cardno ABN 57 051 074 992

L11 Green Square North Tower 515 St Pauls Terrace Fortitude Valley QLD 4006

Telephone: 07 3369 822 Facsimile: 07 3369 9722 International: +61 7 3369 9822

Julie.mcdonagh@cardno.com.au www.cardno.com

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Executive Summary

This noise impact assessment was conducted on behalf of Transport for NSW (TfNSW), for inclusion in the Review of Environmental Factors prepared for the proposed East Hills Station upgrade.

Proposal Description

The Proposal involves an upgrade of East Hills Station as part of the Transport Access Program (TAP) which would improve accessibility and amenities for customers. The Proposal would include the following key elements:

- > construction of two new lifts to provide access between the existing station underpass and the platforms
- > upgrade of the existing station entrance on Park Road including:
 - floor regrading and modifications to the entrance with readjustments to bollards and bicycle hoops
 - upgrade of the existing entry ramp and stairs, including upgrade of handrails, stair nosings and tactiles to be compliant with Australian standards and guidelines
- > modifications to the commuter carpark along Park Road to allow for the upgrade of the two accessible parking spaces
- > provision of a new kiss and ride space along Park Road adjacent to the taxi zone
- > upgrades of the existing station entrance on Thompson Lane including:
 - provision of an accessible pathway between the station underpass, Thompson Lane and Maclaurin Avenue by regrading and modifications to the existing path
 - provision of a new rest area along the accessible pathway
- > internal station building works including:
 - reconfiguration of the existing customer toilet facilities to provide one new unisex Family Accessible Toilet (FAT), one new male ambulant toilet and one new female ambulant toilet
- other minor building modifications that may be required to accommodate new or upgraded electrical equipment including a main switchboard, new or upgraded station communications equipment and other station services
- ancillary work including adjustments to lighting, relocation or replacement of existing customer facilities (platform seating, bins, payphone, Opal card readers, fencing) and improvement to station systems including additional CCTV cameras, hearing loops and wayfinding signage.

Assessment Objectives

This assessment has been carried out to determine the predicted noise and vibration impacts associated with the construction of the proposed East Hills Station upgrade on nearby sensitive receivers.

Assessment Methodology

In undertaking the assessment, unattended noise monitoring was conducted to measure the existing ambient noise levels at two locations in close proximity to the proposal. The monitoring sites were located to the north and south of the proposed site. The measured data was used to calculate rating background noise levels for each location, and to determine appropriate noise criteria for the residential sensitive receivers in proximity to the site in accordance with the *NSW Noise Policy for Industry* (NPI).

The assessment footprint of a 500 metres radius was divided into noise catchment areas (NCAs) for similar sensitive receiver types. These included residential, commercial, educational and passive recreational receivers.

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3D noise modelling software (SoundPLAN 8.2) was used to create a noise model of the existing scenario. The 3D model was then used to predict construction noise levels associated with the proposed works impacting on nearby sensitive receivers by adopting the appropriate construction stages.

Relevant Noise and Vibration Guidelines

This assessment has considered the following policies and guidelines:

- > NSW Interim Construction Noise Guideline (DECC 2009) (ICNG)
- > NSW Assessing Vibration: A Technical Guideline (DEC 2006) (AV:ATG)
- > Transport for NSW Construction Noise and Vibration Strategy (TfNSW 2018) (CNVS)
- > NSW Road Noise Policy (RTA 2011) (RNP)
- > NSW Noise Policy for Industry (EPA 2017) (NPI)
- The Transit Noise and Vibration Impact Assessment (TNVIA) (US Federal Transit Administration (FTA), 2006).

Assessed Construction Activities and Timing

The following construction stages are proposed for the station upgrade:

Table E-1	Construction stages and hours	
Stage No.	Stage	Hours
1	Site establishment and enabling work	Standard hours
2a1	Lift 1 works	Standard hours, night works & 48 hour rail possessions
2a2	Lift 2 works Thompson Lane	Standard hours, night works & 48 hour rail possessions
2b1	Platform works – services	Standard hours, night works & 48 hour rail possessions
2b2	Platform works – services (worst case)	Standard hours, night works & 48 hour rail possessions
3	Station building works	Standard hours, night works & 48 hour rail possessions
4a	Station building works – ramps and stairs	Standard hours, night works & 48 hour rail possessions
4b	Park Road parking, kiss and ride and pedestrian work	Standard hours, night works & 48 hour rail possessions
4c	Maclaurin Avenue footpath works	Standard hours
4d	Site demobilisation	Standard hours

To provide an indicative assessment of construction noise impact, based on the provided plant, a noise model was created for each of the above construction stages, and assessed against the relevant criteria, references from the ICNG for each of the adopted NCAs.

Assessment Conclusions

The assessment identified the following conclusions:

- Construction noise levels are predicted to exceed the NSW ICNG NML for "standard" hours at all NCAs, except Kelso Beach Reserve and the East Hills Girls High School playing fields for standard construction hours for all construction stages
- Construction noise levels are predicted to exceed management levels for "out of hours work" (OOHW) hours of operation for Stages 2a, 2b, 3, 4a and 4b at the nearby residential receivers in both residential NCAs (1 and 2), particularly for receivers located on Thompson Lane and directly south of the station. This is due to the proximity of receivers to the construction works
- Predicted levels are expected to be very highly intrusive at a number of residential receivers in NCA 1 and 2 for Stages 2a, 2b,3, 4a and 4b for works during OOH1 and OOH2 time periods. Construction noise is likely to have a higher impact on and cause sleep disturbance at sensitive receivers located on Park

Road and around Thompson Lane due to their proximity to the proposed work site. However, the modelled noise levels reflect the worst case scenario where all plant is operating simultaneously which is very unlikely to occur in practice due to safety and space constraints within the site. Continuous noise levels are likely to be lower for most of the works

- Highly intrusive noise levels were predicted for the commercial receivers in NCA 3 for Stages 1, 2A and 4D
- > Highly intrusive noise levels were not predicted for any receivers in NCA 4 to 9 for any of the construction stages
- > It is generally expected that sleep disturbance criteria are likely to be exceeded unless the proposed number and type of plant are reduced for out of hours works
- > A detailed construction noise and vibration management plan should be prepared for the project prior to construction commencement to incorporate the recommendations detailed in Section 9 and updated to reflect the proposed staging and plant to be adopted for the project.

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Technical Terms

Technical Term	Definition
Adverse Weather	Weather effects that enhance noise (that is, wind and rain) that occur at a site for a significant period of time (that is, wind exceeding 5 m/s and rain exceeding 0.5 mm per hour during any measurement period).
A-weighted Level	As per dB(A) defined below.
Ambient Sound	Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far.
Background Sound Level	The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted external ambient noise sources.
dB(A)	Unit of acoustic measurement electronically weighted to approximate the sensitivity of human hearing to sound frequency.
Decibel, dB	Unit of acoustic measurement. Measurements of power, pressure and intensity may be expressed in dB relative to standard reference levels.
L90, L10 etc.	A statistical measurement giving the sound pressure level which is exceeded for the given percentile of an observation period, i.e. L90 is the level which is exceeded for 90 percent of an observation period. L90 is commonly referred to as a basis for measuring the background sound level.
LAbg, T	The A-weighted background sound level measured over a time interval T.
LAeq, T	Equivalent continuous A-weighted sound pressure level. This is the value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound.
Sensitive Receiver	A sensitive receiver may refer to persons, facilities, structures or organisms that can be impacted by noise and/or vibration such as residents, students, specialist medical equipment, heritage structures and marine mammals etc.
Sound Pressure Level, SPL, dB, of a sound	A measurement obtained directly obtained using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure of 20 microPascals.
Sound Power Level, SWL, dB of a source	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power level is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt.

Abbreviations

Abbreviations	Definition
AV:ATG	New South Wales Office of Environment and Heritage Assessing Vibration: A Technical Guide (DEC 2006)
BOM	Bureau of Meteorology
CBD	Central business district
CCTV	Closed-circuit television
CNVMP	Construction Noise and Vibration Management Plan
CNVS	Construction Noise and Vibration Strategy (TfNSW 2018)
CoRTN	Calculation of Road Traffic Noise, HMSO 1988
DDA	Disability Discrimination Act 1992 (Commonwealth)
DEC	NSW Department of Environment and Conservation, now known as the NSW Office of Environment and Heritage
DECC	NSW Department of Environment and Climate Change, now known as the NSW Office of Environment and Heritage
DECCW	NSW Department of Environment and Climate Change and Water, now known as the NSW Office of Environment and Heritage
ECRTN	New South Wales superseded Office of Environment and Heritage Environmental Criteria for Road Traffic Noise (EPA 1999)
ENMM	The New South Wales Department of Roads and Maritime Safety Environmental Noise Management Manual (RTA 2001)
EPA	New South Wales Environmental Protection Authority
FAT	Family Accessible Toilet
FTA	US Federal Transit Administration
ICNG	New South Wales Office of Environment and Heritage Interim Construction Noise Guideline (DECC 1999)
INP	New South Wales Office of Environment and Heritage Industrial Noise Policy (EPA 2000)
NCA	Noise catchment areas
NML	Noise Management Level as defined by the NSW EPA and in compliance with the ICNG
NPI	NSW Noise Policy for Industry (EPA 2017)
NSW	New South Wales
OEH	formerly NSW Office of Environment and Heritage
ООНЖ	"Out-of-Hours Work" referring to construction activities outside of the Standard Construction Hours
PPV	"Peak Particle Velocity" a parameter used to express the level of vibration. It is evaluated at the building footings and used to assess the risk of damage to structures
RBL	Rating Background Level
rms	Root mean square
RNP	New South Wales Office of Environment and Heritage Road Noise Policy (DECCW 2011)
RTA	NSW Roads and Traffic Authority, now known as the NSW Department of Transport, Roads and Maritime Services
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the

Abbreviations	Definition
	measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
ТАР	Transport Access Program
TfNSW	Transport for NSW
TNVIA	Transit Noise and Vibration Impact Assessment (FTA, 2006)
VDV	Vibration Dose Value
VML	Vibration Management Levels

1 Introduction

This noise impact assessment was conducted on behalf of Transport for NSW (TfNSW), for inclusion in the Review of Environmental Factors prepared for the proposed East Hills Station upgrade.

East Hills Station is serviced by the T8 – Airport and South Line. The station is approximately 26 kilometres south-west of Sydney CBD and is within the local government area of Canterbury Bankstown Council. As an elevated station with an island and side platform (for three tracks) pedestrian access is via an underpass which links Park Road with a council parking area off Thompson Lane. This underpass is located through the centre of the station. The station is surrounded by a range of sensitive receivers, including residential, educational, commercial and recreational land uses within the assessment area.

Noise modelling has been carried out to determine the predicted noise impacts associated with the construction of the proposed East Hills Station upgrade.

This assessment has been prepared with reference to the following documents:

- > NSW Interim Construction Noise Guideline (DECC 2009) (ICNG)
- > NSW Assessing Vibration: A Technical Guideline (DEC 2006) (AV:ATG)
- > Transport for NSW Construction Noise and Vibration Strategy (TfNSW 2018) (CNVS)
- > NSW Road Noise Policy (RTA 2011) (RNP)
- > NSW Noise Policy for Industry (EPA 2017) (NPI)
- The Transit Noise and Vibration Impact Assessment (TNVIA) (US Federal Transit Administration (FTA), 2006).

In undertaking the assessment, unattended noise monitoring was conducted to measure the existing ambient noise levels at two sensitive locations in close proximity to the proposal. The monitoring sites were located to the north and south of the proposed site.

3D noise modelling software (SoundPLAN 8.2) was used to create a noise model of the existing scenario. The 3D model was then used to predict construction noise levels associated with the proposed works impacting on nearby sensitive receivers by adopting the appropriate construction stages.

1.1 Assessment Objectives

The assessment objectives are to determine the predicted levels of construction noise and vibration impact on sensitive receivers in the vicinity of the proposal, and to provide impact mitigation and management in accordance with the current NSW policy and guidelines.

2 **Proposal Description**

2.1 Proposal Description

The Proposal involves an upgrade of East Hills Station as part of the TAP which would improve accessibility and amenities for customers. The Proposal below would include the following key elements:

- > construction of two new lifts to provide access between, the existing station underpass and the platforms
- > upgrade of the station entrance on Park Road including:
 - floor regrading and modifications to the entrance with readjustments to bollards and bicycle hoops
 - upgrade of the existing entry ramp and stairs including upgrade of handrails, stair nosings and tactiles to be compliant with Australian standards and guidelines
- > modifications to the commuter carpark along Park Road to allow for the upgrade of the two accessible parking spaces
- > provision of a new kiss and ride space along Park Road adjacent to the taxi zone
- > upgrades of the existing station entrance on Thompson Lane including:
 - provision of an accessible pathway between the station underpass, Thompson Lane and Maclaurin Avenue by regrading and modifications to the existing path
 - provision of a new rest area along the accessible pathway
- > internal station building works including:
 - reconfiguration of the existing customer toilet facilities to provide one new unisex Family Accessible Toilet (FAT), one new male ambulant toilet and one new female ambulant toilet
- other minor building modifications that may be required to accommodate new or upgraded electrical equipment including a main switchboard, new or upgraded station communications equipment and other station services
- > ancillary works including adjustments to lighting, relocation or replacement of existing customer facilities (platform seating, bins, payphone, Opal card readers, fencing) and improvement to station systems including additional CCTV cameras, hearing loops and wayfinding signage.

Figure 2-1 shows the key features of the proposal.

Noise and Vibration Impact Assessment East Hills Station Upgrade

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Figure 2-1 Key features of the proposal

2.2 Sensitive Receivers

The existing station is surrounded by a range of sensitive receivers, predominantly residential and commercial premises. Non-residential receivers include recreational areas such as East Hills Park, Monash Reserve and Kelso Beach Reserve and educational facilities such as East Hills Girls High School and Bright Futures Early Learning Centre.

Identified sensitive receiver types surrounding the proposal are shown in Figure 2-2 and associated land uses are listed in Table 2-1.



Figure 2-2 Site location and surrounding sensitive receivers

Table 2-1 Land uses surrounding the proposal

Description	Land Use	Minimum Distance to Proposal (metres)
Residential properties to the northwest of the station on Park Road	Residential	20
Residential properties to the southeast on Thompson Lane and Broe Avenue	Residential	5
Businesses along Maclaurin Avenue	Commercial	15
East Hill Girls High School - Classrooms	Educational	580
East Hills Girls High School Playing Fields	Active Recreation	460
Bright Futures Early Learning Centre	Educational	325
East Hills Baptist Church	Place of Worship	130
Monash Reserve	Passive Recreation	250
East Hills Park	Passive Recreation	165
Kelso Beach Reserve	Passive Recreation	440

Table 2.2

2.3 **Proposed Construction Activities**

Subject to approval, construction is expected to commence in 2021 and take around 18 months to complete. The construction methodology would be further developed during the detailed design of the Proposal by the nominated Construction Contractor in consultation with TfNSW. The proposed construction activities for the Proposal are identified in Table 2-2. This staging is indicative and is based on the current concept design and may change once the detailed design methodology is finalised. The staging of the proposal would be dependent on the Contractor's preferred methodology, program and sequencing of work.

The proposal generally comprises the construction stages, onsite activities and timing listed in Table 2-2.

Table 2-2	Construction stages		
Stage No.	Stage	Activities	Timing
1	Site establishment and enabling work	 site investigations and survey establish site compounds (erect fencing, tree protection zones, site offices, amenities, plant and material storage areas) removal and trimming of trees to allow for the site compound, footpath works and lift construction relocate or upgrade utility / services where required establish crane and piling rig install safety barriers, lighting, hoarding around nominated work areas establish traffic control measures 	Standard construction hours (7am to 6pm Monday to Friday and 8am to 1pm Saturday)
2a	Lift work	 establish lift construction areas on platforms and in the underpass excavate lift foundations piling, waterproofing (as required), installation of reinforcement, formwork and concrete to form the lift pit construction of lift shaft structures, construction of new landing between Lift 2 and Platform 3 installation of cantilevered awnings to Lift 2 lift installation and commissioning 	Standard hours, night works and 48 hour rail possessions during Sydney Trains planned maintenance weekends
2b	Platform work	 install new yellow line and tactiles along platforms relocation of platform furniture including seats, rubbish bins, and planter boxes upgrade drinking fountain on platform 2 for accessibility ancillary work including adjustment to lighting, electrical upgrades, improvement to station communications systems (including CCTV cameras), public address, hearing loops, and wayfinding signage 	Standard hours, and 48 hour rail possessions during Sydney Trains planned maintenance weekends
3, 4a	Station building work	 reconfiguration of existing male and female toilets to provide a FAT, one male ambulant and one female ambulant toilet upgrade the stairs and handrails to the platforms and entrances install footings for ramp and bike hoops at the Park Road station entrance upgrade ramp at park road station entrance relocate bike racks 	Standard hours, and 48 hour rail possessions during Sydney Trains planned maintenance weekends
4b	Park Road parking, kiss and ride and pedestrian work	 construction of <i>Disability Discrimination Act 1992</i> (Commonwealth) (DDA) compliant car spaces construction of pathways to link car park and station entrance 	Standard hours, and 48 hour rail possessions during Sydney Trains planned

Stage No.	Stage	Activities	Timing
		 construction of a new pedestrian ramp between the commuter car park and station entrance 	maintenance weekends
4c	Maclaurin Avenue footpath	 demolition/excavation of existing non-compliant footpath construction and regrading of footpath area to tie into existing footpath 	Standard construction hours
4d	Site demobilisation	 civil / lighting work test and commission CCTV cameras / station systems installation test and commission new lifts / open to the public finishing work including landscaping, fencing and wayfinding reinstatement of platform furniture clearing of site 	Standard construction hours

3 Existing Noise Environment

The existing acoustic environment is generally dominated by road traffic noise on local roads, noise from train pass-bys and horns on the nearby T8 rail corridor, and at the station, and local traffic in the station carparks.

3.1 Unattended Noise Monitoring Methodology

Unattended noise monitors were installed at the following two locations to measure ambient (i.e. background) noise levels for a period of seven days to determine the ambient background noise levels. Noise monitors were configured to measure 15 minute statistics, between 9 and 17 September 2020.

The unattended noise monitors were configured to measure noise levels as follows:

- > 'A' weighting
- > 'Fast' response
- > 15 minute statistical intervals
- > Measurement descriptors LAMax, LAeq, LA1, LA10, LA90.

The noise loggers were deployed at the following locations (Figure 3-1):

- Logger 1 was located on TfNSW land to the south east of the station, on land parcel boundary adjacent to 3 Thompson Lane and approximately 15 metres from East Hills Station
- Logger 2 was located at 92 Park Road, East Hills approximately 30 metres north west from East Hills Station.



Figure 3-1 Noise monitoring locations

Unattended noise monitoring was carried out using the equipment listed in Table 3-1.

Table 3-1 Nois	e monitoring equipment	
Location	Logger Type	Serial Number
Logger 1	ARL EL-316	16-207-030
Logger 2	ARL EL-316	16-207-037

3.1.2 Potentially Altered Noise Environment

It should be noted that the background noise monitoring was conducted during COVID 19 and may represent non-typical background noise levels on this basis. Background noise levels are likely to be quieter the pre-COVID levels and therefore this assessment can be considered conservative.

3.2 Equipment Calibration

Calibration of the sound monitoring equipment was conducted before and after the measurement period, with a variance of less than ± 0.1 dB recorded.

3.3 Metrological Monitoring Conditions

A summary of the environmental conditions noted during the measurement period were as follows (source: Bureau of Meteorology (BOM) weather station located at Bankstown):

Conditions: Mostly Fine with some showers on 9 September

Wind: 0 - 14 m/s predominantly from a west south west (WSW) direction

Humidity: 24 - 97 per cent (%)

Temperature: 7 – 31 °C

Detailed weather information recorded for the site during the monitoring period is detailed in Appendix A along with the noise monitoring data. Data was excluded for rain periods during the monitoring period.

Elevated winds occurred intermittently during the monitoring period. This data has been removed as shown on the weekly logger charts included in Appendix A. However, it should be noted that Bureau of Meteorology wind speed was recorded at 7 metres above the ground and that the ground level wind speed is significantly less. Removal of the data did not affect the monitored rating background level (RBL) noise levels on-site.

3.4 Measurement parameters

As environmental noise varies with time, the use of statistical descriptors is necessary to understand and describe these variations. For road traffic noise these descriptors are further classified for day time (7am - 10pm) and night time (10pm - 7am).

For environmental noise, the assessment period for day time is further split into day (7am - 6pm) and evening (6pm - 10pm). A-weighted statistical levels are used to describe ambient noise levels. The common descriptors used to describe environmental noise are described as follows:

L _{Amax:}	the A-weighted maximum noise level measured during the measurement period
L _{A1} :	the A-weighted noise level exceeded for 1 per cent (%) of the measurement period
L _{A10} :	the noise A-weighted level exceeded for 10 per cent (%) of the measurement period, generally referred to as the average maximum sound pressure level
LA90:	the A-weighted noise level exceeded for 90 per cent (%) of the measurement period, generally referred to as the background noise level (refer AS 1055.1 – 1997)
L _{Aeq} :	the equivalent continuous noise level over the measurement period, generally referred to as the energetical average sound pressure level over the measurement period.

3.5 Measured noise levels

Measured noise levels at each logger location were observed to be affected by the following:

Table 3-2	Observed existing holse environment	
Logger	Location	Observed Noise Environment
1	3 Thompson Lane	The primary sources of noise were from intermittent traffic along Thompson Lane, birds and general noise from trains passing by and trains leaving and entering the station.
2	92 Park Road	The primary sources of noise were from local traffic along Park Road, trains passing by, and trains leaving and entering the station.

 Table 3-2
 Observed existing noise environment

3.5.2 Rating background noise level

The Rating Background Level (RBL) for each site was determined in accordance with the *Noise Policy for Industry* (EPA, 2017). The RBL is defined as follows:

"Rating background level (RBL) - the overall single figure median background level representing each assessment period (day / evening / night) over the whole monitoring period (as opposed to over each 24-hour period used for the assessment background level). The rating background level is the level used for assessment purposes. Where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A)."

The weather affected data (due to wind or rain) was excluded from the analysis in accordance with the NPI requirements. The RBL applicable to each site is detailed below in Table 3-3.

Measurement		Measured Rating Background Noise Level, dB(A)		
Logger	Location	07:00-18:00	18:00-22:00	22:00-07:00
1	3 Thompson Lane, East Hills	40	41	32
2	92 Park Road, East Hills	38	36	31

 Table 3-3
 Rating background noise level

The measured RBLs from Table 3-3 have been used to formulate the noise objectives for construction noise impacts as detailed in Section 5.1.

Typical measured noise levels, averaged from measured data, are shown below in Figure 3-2 for Logger 1 and Figure 3-3 for Logger 2. Full noise charts are displayed in Appendix A.

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Figure 3-3 Averaged measured noise levels – logger 2

4 Statutory Noise and Vibration Criteria

4.1 Construction Noise Criteria

4.1.1 Transport for NSW Construction Noise and Vibration Strategy (CNVS)

The TfNSW *Construction Noise* & *Vibration Strategy* (TfNSW 2018) (CNVS) provides a framework for the assessment of noise during the construction phase of the project. The CNVS references the following documents to provide the criteria for the assessment of construction noise and vibration impacts:

- > EPA Interim Construction Noise Guideline
- > EPA Assessing Vibration Technical Guideline
- > EPA Road Noise Policy (RNP).

4.1.1.1. Construction Hours

The CNVS prescribes the following construction hours assessment periods:

Standard hours:	Monday to Friday, 7am to 6pm
OOHW1:	Monday to Friday 6pm to 10pm
	Saturday 7am to 8am, 1pm to 10pm
	Sunday, Public Holidays, 8am to 6 pm
OOHW2:	Monday to Saturday, 12am to 7am, 10pm to 12 am
	Sunday / Public Holiday, 12am to 8am, 6pm to 12am

4.1.2 Interim Construction Noise Guideline

Airborne Construction Noise - Residential Receivers

NSW Office of Environment & Heritage (OEH) provides guidance for assessing construction noise impacts in the *Interim Construction Noise Guideline* (DECC, 2009) (NSW ICNG).

The level of noise impact and the requirement for mitigation measures is generally determined by the timing and duration of the noise emissions and the perceived impact of the noise above existing background noise levels.

It is important to note that the guideline distinguishes between qualitative and quantitative noise assessments based on the type and duration of construction activities. For example, a qualitative assessment is warranted for road maintenance type works of short duration, whereas a quantitative assessment is preferred for major infrastructure works.

Section 4 of the guideline outlines the quantitative assessment method, which establishes noise management levels and assessment requirements for proposed construction activities over three weeks duration.

The noise management level for potentially affected residential properties, as taken from Section 4.2 of the ICNG, is detailed in Table 4-1.

Time of day	Management level L _{Aeq (15 min)*}	How to apply
Recommended standard hours:	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise.
Monday to Friday: 7am to 6pm		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.

Table 4-1 Residential noise management levels at residences (Source: INCG (DECC, 2009))

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Time of day	Management level L _{Aeq} (15 min)*	How to apply
Saturday 8am to 1pm: No work on Sundays or public holidays		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.

Notes:

- (1) For Residential receivers Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.
- (2) Other sensitive use receivers Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most affected point within 50 metres of the area boundary

A strong justification would typically be required for works outside the recommended standard hours (see Table 4-1). The proponent should apply all feasible and reasonable work practices to meet the noise affected level. The definition of feasible and reasonable work practices is outlined in Section 1.4 of the NSW ICNG, with the following excerpts providing a brief description:

"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."

"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."

A number of factors may be considered in selecting reasonable measures, including the level of impact, the number of people affected, and the order of treatments applied to previous, similar projects. Where all feasible and reasonable practices have been applied and noise remains more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community on suitable mitigation measures. For guidance on negotiating agreements see section 7.2.2 of the NSW ICNG.

Airborne Construction Noise - Non-Residential Sensitive Receivers

Non-residential sensitive land uses are also located within the study area. These include East Hills Girls High School, outdoor recreational areas, and commercial properties. The ICNG provides noise management levels (NMLs) for these receivers as shown below in Table 4-2.

Non-Residential Receiver	Applicable Dessiver	Noise Management Level (when in use)		
		Internal L _{Aeq (15} min)*	External L _{Aeq (15} min)*	
Classrooms	East Hills Girls High School	45	*55	
Childcare Centres	Bright Futures Early Learning Centre	**40	*50	
Places of Worship	East Hills Baptist Church	45	*55	
Active recreation areas	East Hills Girls High School Playing Fields	-	*65	
Passive Recreation Areas	East Hills Park Monash Reserve Kelso Beach Reserve	-	*60	
Commercial	Shops & Businesses (including a hotel) to the south of the station upgrade worksite.	-	70	

 Table 4-2
 Noise management levels for non-residential sensitive receivers (Source: INCG (DECC, 2009))

Notes:

*Based on an inside to outside nose reduction of 10 dB(A) where ICNG noise levels have been specified as internal only.

**Referenced for teaching spaces from Australian Standard AS 2107 - Acoustics – Recommended design sound levels and reverberation times for building interiors

Sleep Disturbance

Section 4.3 of the NSW ICNG defines the assessment of sleep disturbance as follows:

"Where construction works are planned to extend over more than two consecutive nights, and a quantitative assessment method is used, the analysis should cover the maximum noise level, and the extent and the number of times that the maximum noise level exceeds the RBL. Some guidance indicating the potential for sleep disturbance is in the now superseded NSW Environmental Criteria for Road Traffic Noise (EPA 1999)."

The NSW Environmental Criteria for Road Traffic Noise (EPA, 1999) (NSW ECRTN) discusses a number of methodologies with respects to sleep disturbance. In general, the methodologies address sleep disturbance due to continuous noise (expressed in terms of a $L_{Aeq, T}$) and the affect multiple short duration noise events (expressed as a L_{AMax}).

In addition to the night time noise criteria specified in Table 4-1 (which addresses the continuous noise component generated by construction activities), the application of a noise criteria addressing the maximum noise level from construction activities is appropriate when works are planned to extend over more than two consecutive nights. The NSW ECRTN draws the following conclusions with respects to noise limits for sleep disturbance:

"Considering all of the foregoing information the following conclusions can be drawn:

- Maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions.
- > One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly."

The NSW EPA confirm that a sleep disturbance criterion of $L_{A1,1min} \le L_{A90,15min} + 15 \text{ dB}(A)$, is used for initial assessment for the purpose of this Review of Environmental Factors (REF). It should only be used as a first

step guide and where the criteria is not met, more detailed analysis is required to be incorporated into the detailed design and Construction Noise and Vibration Management Plan.

On this basis, a sleep disturbance criteria of RBL+15 dB(A) has been adopted for this assessment.

4.1.3 EPA Road Noise Policy

The NSW EPA Road Noise Policy (RNP) application notes state that for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB(A) above that of the corresponding 'no build' option. This limit applies to either the relevant day or night noise assessment criterion.

Therefore, if the road traffic noise levels increase by more than 2 dB(A) as a result of the proposed construction, traffic mitigation options should be considered.

Where an increase of more than 2 dB(A) is predicted, the RNP target criteria can be applied to traffic generated by construction activities to provide a benchmark for mitigation measures. On this basis, target criteria applicable to road traffic noise from construction vehicles is detailed below in Table 4-3:

 Table 4-3
 Construction traffic noise criteria (Source: RNP, 2011)

	Construction Traffic Noise Criteria dB(A)		
Road Type	L _{Aeq} Day	L _{Aeq} Night	
Arterial / Sub Arterial /Collector Road	60 (15 hour)	55 (9 hour)	
Local Road	55 (1 hour)	50 (1 hour)	

In addition, the CNVS states that If the heavy vehicle movements occur during the 10 pm to 7 am night-time period, guidance on assessing the potential for sleep disturbance is taken from the RNP, which refers to Practice Note 3 of the 'Environmental Noise Management Manual' (ENMM) (Roads and Traffic Authority of NSW, 2001). The ENMM Practice Note 3 outlines the following protocol for assessing and reporting on existing maximum noise levels and to assist in assessing the potential for sleep disturbance of a road project:

- Determine the number of L_{Amax} noise levels greater than 65 dB(A) where L_{Amax}- L_{Aeq} exceeds 15 dB(A)
- 2. The number and distribution should be determined on an hourly basis between 10 pm and 7 am;
- 3. Evaluate whether the number of maximum noise impacts will reduce or increase as a result of the project
- 4. Based on this evaluation, take account of maximum noise levels when prioritising, selecting and designing noise control measures.

Whilst this protocol applies specifically to road projects, it is appropriate to use in the assessment of noise from construction traffic on existing roads associated with the project.

4.2 Operational Noise Criteria

Rail noise impacts are not expected to change as a result of the project. However the following criteria referenced from the NPI will apply to any plant noise emissions from the upgraded station.

4.2.1 NSW Noise Policy for Industry 2017 (NSW NPI)

The noise criteria for industrial noise emissions are set by the NSW NPI. There are two objectives in the NSW NPI, including protection against noise intrusion and preservation of acoustic amenity in relation to sensitive receivers.

Noise intrusion is controlled by limiting the amount by which new development or significant plant items can increase noise levels above the existing Rating Background Levels (i.e. the RBL).

To protect amenity of a given area, the existing noise from industrial sources is compared against acceptable levels for a particular land use. If the current industry noise emissions are approaching these acceptable levels, then a downward adjustment to the criteria may apply.

During an assessment it is identified whether the intrusive criterion or the amenity criterion is more stringent. The most stringent becomes the project noise trigger level within each time period.

Separate criteria are defined for the daytime (7 am to 6 pm), evening (6 pm to 10 pm) and night-time (10 pm to 7 am) assessment periods to reflect the change in ambient noise levels within a 24 hour period.

Intrusive Noise Criteria

The intrusive criteria are established from the ambient L_{A90} background noise level (in the absence of the noise source to be assessed) at the nearest sensitive receivers. The result of statistical analysis of background noise levels, as required by the NSW NPI is termed the Rating Background Level (RBL). The intrusive criterion is then determined by adding 5 dB(A) to the RBL level for the day, evening, and night periods.

Amenity Criteria

The amenity criteria are based upon the surrounding land uses and associated activities, and are expressed as a L_{Aeq} averaged over specified time periods. The amenity criteria are set out in full in Table 2.1 of the NSW NPI. In accordance with the NSW NPI, the nearest receivers would be classified as "suburban", as the acoustic environment is generally dominated by local traffic with intermittent flows and some limited commerce or industry. In the evening, it is generally dominated by the natural environment and infrequent human activity.

Note that the land use classification may not relate to Council planning definitions of land use. These are separate definitions within the NSW NPI that relate to the acoustic environment. The applicable amenity noise goals during the day, evening and night-time periods for residential receivers near the site are taken from Table 2.2 of the NSW NPI and are reproduced in Table 4-4.

Receiver	Noise amenity area	Time of day	Recommended amenity noise level, L _{Aeq} , dB(A)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Industrial premises	All	When in use	70

Table 4-4 NSW NPI recommended amenity criteria

Notes:

The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Low Frequency Noise

Adjustments for low frequency noise content in the predicted noise levels should be applied in accordance with the NSW NPI as follows:

- Measure/assess source contribution C- and A-weighted L_{eq,T} levels over same time period. Correction to be applied where the C minus A level is 15 dB or more.
- Where any of the 1/3 octave noise levels in Table 4-5 are exceeded by up to 5 dB and cannot be mitigated, a 2 dB(A) positive adjustment to measured/predicted A weighted levels applies for the evening/night period.
- 3. Where any of the 1/3 octave noise levels in Table 4-5 are exceeded by more than 5 dB and cannot be mitigated, a 5 dB(A) positive adjustment to measured/predicted A weighted levels applies for the evening/night period and a 2 dB positive adjustment applies for the daytime period.

Hz/dB(Z)		One-third octave Lzeq,15min threshold level											
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Table 4-5 NSW NPI low frequency thresholds

4.3 Construction Vibration Criteria

4.3.1 Transport for NSW Construction Noise Strategy (CNVS)

The CNVS Addendum V4 (TfNSW 2019) provides recommended minimum separation distances between vibration intensive plant and sensitive receivers for minimising the risk of cosmetic damage. The CNVS further states that the minimum working distance for cosmetic damage must be complied with at all times, unless otherwise approved by TfNSW or under the environmental licence as relevant. The minimum working distances are summarised below and in Section 8.1.1.

Summary of Minimum Working Distances for Vibration Intensive Plant

Table 4-6 provides a summary of the minimum working distance for different types of sensitive receivers referenced from the CNVS.

		Minimum Working Distance			
Plant Item	Rating / Description	Cosmetic Damage (BS 7385) (metres)	Human Response (OEH Vibration Guideline) (metres)		
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5	15 to 20		
	< 100 kN (Typically 2-4 tonnes)	6	20		
	< 200 kN (Typically 4-6 tonnes)	12	40		
	< 300 kN (Typically 7-13 tonnes)	15	100		
	> 300 kN (Typically 13-18 tonnes)	20	100		
	> 300 kN (> 18 tonnes)	25	100		
Small Hydraulic Hammer	(300 kg - 5 to 12 t excavator)	2	7		
Medium Hydraulic Hammer	(900 kg – 12 to 18 t excavator)	7	23		
Large Hydraulic Hammer	(1600 kg – 18 to 34 t excavator)	22	73		
Pile Driver - Vibratory	Sheet Piles	2 to 20	20		
Piling Rig - Bored	≤ 800 mm	2 (nominal)	N/A		
Piling Rig – Hammer	12 t down force	15	50		
Jackhammer	Hand Held	1 (nominal)	Avoid contact with structure		

 Table 4-6
 Recommended minimum working distances for vibration intensive plant from sensitive receivers

The minimum working distances are indicative and will vary depending on the particular item of plant, local geotechnical conditions and the dominant frequency of the construction vibration levels. They apply to cosmetic damage of typical light-framed residential buildings and heritage/fragile buildings and assume that construction vibration could include low frequency content with associated increased risk of cosmetic damage.

Vibration monitoring is recommended to confirm the minimum working distances at specific sites. Additionally, further detailed analysis based on the frequency dependent guideline vibration levels in BS 7385-2:1993 and DIN 4150-3:2016 may be utilised in conjunction with site-specific measurements to derive alternative cosmetic damage objectives and minimum working distances.

4.3.2 Assessing Vibration: A Technical Guideline

Vibration from activities associated with the project could potentially impact on the amenity of the occupants of dwellings or buildings located close to the site. Generally, vibration impact can be summarised into two categories:

- > Effect on human comfort
- > Structural or cosmetic damage to buildings.

Human comfort vibration criteria is addressed in the NSW ICNG and refers to Section 2.5 of the document Assessing Vibration: A Technical Guideline (NSW AV:ATG) issued by DEC (2006).

The NSW AV:ATG outlines vibration limits in relation to human comfort. Criteria in this guideline are based on the British Standard BS 6472-1992 evaluation of human exposure to vibration in buildings (1-80 Hz).

Vibration sources are defined as continuous, impulsive or intermittent. Table 4-7 provides a definition and examples of each type of vibration.

Type of Vibration	Definition	Examples
Continuous	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.	Infrequent: activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Table 4-7 Types of vibration

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

"Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472)."

When applying the criteria, it is important to note that vibration may enter the body along different orthogonal axes, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). The three axes are referenced to the human body. Thus, vibration measured in the horizontal plane should be compared with x-and y-axis criteria if the concern is for people in an upright position, or with the y and z- axis criteria if the concern is for people in an upright position, or with the y and z- axis criteria if the vibration are defined in Table 2.2 of the guideline and are reproduced below in Section 5 of this report.

4.3.3 German Standard DIN 4150 (Building Damage)

In relation to structural damage, there is currently no Australian Standard that provides criteria for the assessment of structural damage to buildings. However, the German Standard DIN 4150-3 : 1999-02 - 'Structural vibration - Effects of vibration on structures', provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard also presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

These criteria are summarised below in Section 5.

4.4 Australian Standards

The following Australian Standards provide criteria and methodologies that have been adopted in this assessment.

- > Australian Standard AS 1055: Acoustics Description and measurement of environmental noise
- > Australian Standard AS 2107: Acoustics Recommended design sound levels and reverberation times for building interiors.

5 Design Benchmarks

5.1 Construction Noise

The proposal area has been divided into noise catchment areas (NCA) where ambient noise levels are likely to be similar to assess the potential construction noise impacts on surrounding receivers. These catchment areas are shown in Figure 6-1.

Works may be carried out, outside of standard hours due to the nature of the project. For this reason noise management levels (NMLs) have been calculated for both standard and non-standard hours. The NMLs are detailed below in Table 5-1.

Table 5-1 Construction noise management levels – residential receivers (NCA 1 & 2)

		Noise Management Level,				
Noise Catchment Area	Logger Label	Standard Hours (RBL + 10 dB(A))	andard Hours Outside Standard Hours BL + 10 dB(A)) (RBL + 5 dB(A)		*Sleep Disturbance	
		Day	Evening	Night		
1 & 2	1	49	44	37	60	

Notes:

*Sleep disturbance criteria has been calculated based on an assumed typical internal night time L_{A90} noise level of 35 dB(A) referenced from Australian Standard AS:2107 and corrected with a typical inside to outside noise reduction of 10 dB(A)+15 dB(A).

Taking into consideration the measured RBLs in Section 3.5.2 and the criteria from Section 4.1, the applicable construction noise management levels for standard and non-standard hours for the project are shown in Table 5-1.

A summary of the adopted NMLs for non-residential receviers is shown below in Table 5-2.

Noise Catchment Area	Non-Residential Sensitive Receiver	External Noise Management Level, dB(A)
3	Shops & Businesses to the south of the Work Site	70
4	Monash Reserve	60
5	East Hills Park	60
6	Kelso Beach Reserve	60
7a	East Hills Girls High School Classrooms	55
7b	East Hills Girls High School Playing Fields	65
8	Bright Futures Early Learning Centre	50
9	East Hills Baptist Church	55

Table 5-2 Construction noise management levels – Non-Residential Receivers (NCA 3 to 7)

5.2 Construction Vibration

5.2.1 Human Comfort Criteria

The vibration criteria for human comfort listed in Table 5-3 apply to this proposal.

 Table 5-3
 Preferred and maximum levels for human comfort

Location		Accessment period	Preferred Va	lues	Maximum Values	
Location		Assessment period	z-axis	x and y axis	z-axis	x and y axis
Continuo	ous vibration ³ (Weigh	nted RMS Acceleration, m	/s², 1-80 Hz)			
Critical ar	reas ²	Day- or night-time	0.005	0.0036	0.010	0.0072
Decidence		Daytime	0.010	0.0071	0.020	0.014
Residend	es.	Night-time	0.007	0.005	0.014	0.010
Offices, s institutior worship	schools, educational ns and places of	Day- or night-time	0.020	0.014	0.040	0.028
Worksho	ps	Day- or night-time	0.04	0.029	0.080	0.058
Impulsiv	e vibration ³ (Weighte	d RMS Acceleration, m/s	², 1-80 Hz)			
Critical ar	reas ²	Day- or night-time	0.005	0.0036	0.010	0.0072
Decidona		Daytime	0.30	0.21	0.60	0.42
Residend	es.	Night-time	0.10	0.071	0.20	0.14
Offices, s institution worship	schools, educational as and places of	Day- or night-time	0.64	0.46	1.28	0.92
Workshops		Day- or night-time	0.64	0.46	1.28	0.92
Intermitt	ent vibration⁴ (Vibrat	ion Dose Values, VDV, m	s ^{1.75} , 1-80 Hz)		·	
Critical ar	reas ²	Day- or night-time	0.10	0.20	-	-
Decidona		Daytime	0.20	0.40	-	-
Residend	es.	Night-time	0.13	0.26	-	-
Offices, schools, educational institutions and places of worship		Day- or night-time	0.40	0.80	-	-
 Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am 2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. 3. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-2008 4. For continuous and impulsive vibration the preferred and maximum values are weighted acceleration rms values (m/s²) 5. For intermittent vibration the preferred and maximum values are vibration dose values (VDVs), based on the weighted acceleration values (m/s^{1.75}) 						

5.2.2 Building Damage Criteria

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings are presented in DIN 4150.3 is provided in Table 5-4.

Table 5-4 DIN 4150-3 structural damage cr	teria
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		Vibration Velocity, mm/s					
Group	Type of Structure	At Foundatio	Plane of Floor uppermost Storey				
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	All Frequencies		
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 - 40	40 - 50	40		
2	Dwellings and buildings of similar design and/or use	5	5 - 15	15 - 20	15		
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3 - 8	8 - 10	8		
Notes:	At frequencies above 100 Hz, the values given in this column may be used as minimum values						

6 **Construction Noise Impact Assessment**

6.1 Construction Noise Assessment Methodology

An assessment on the potential level of construction noise impact has been carried out to determine whether mitigation will be required, and to determine appropriate management controls.

Details of proposed plant to be used for each construction stage was provided by TfNSW. Sound power levels for various items of plant and equipment were adopted based upon construction plant noise data provided in Table 19 of the TfNSW Construction Noise and Vibration Strategy (CNVS). Plant noise levels were also sourced from AS2436 – Guide to Noise Control on Construction, Maintenance and Demolition Sites and measured library data where applicable.

This assessment has been prepared based on construction staging provided by TfNSW. A further assessment may be required to prepare a Construction Noise and Vibration Management Plan (CNVMP) once final construction staging detail becomes available during the next phase of the proposal.

The proposed works, with the potential to generate noise, are detailed below in Section 6.6. To provide an indicative assessment of construction noise impact, a noise model was created for each of the construction stages (Section 6.3).

6.2 Noise Modelling Inputs And Assumptions

6.2.1 General Modelling Input Data

The modelling inputs and asumptions made for the modelling are shown in Table 6-1.

5 1	
Modelling Element	Input / Assumption (Source Reference)
Ground Elevation Geometry	Provided by the NSW Spatial Exchange (Sixmaps)
Receiver Locations	Nearmap & Google Earth / Street View
Ground Absorption	50% over soft ground 0% over hard ground
Assessment Standard	ISO 9613-2:1996 – Acoustics – Attenuation of Sound During Propagation Outdoors (Part 2: General Method of Calculation)
Weather Conditions	Receiver is downwind of the source, as per the assumptions of ISO 9613.
Receiver Height	Assumed to be 1.4 metres above ground level for noise logger microphone heights for the verification model and 1.5 metres above ground for prediction models for ground floor. Subsequent floor level receiver heights have been modelled at + 3 metres above the floor below.

Table 6-1 Modelling assumptions

6.3 Modelled Construction Stages

The construction stages in Table 6-2 have been modelled for the proposed station upgrade.

Table 6-2	Modelled construction stages
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Stage No.	Construction Stage Description
1	Site establishment and enabling work – (standard hours)
2a	Lift 1 works - (standard hours, night works & 48 hour rail possessions)
2a	Lift 2 works Thompson Lane - (standard hours, night works & 48 hour rail possessions)
2b	Platform Works – services - (standard hours, night works & 48 hour rail possessions)
2b	Platform works – services (worst case) - (standard hours, night works & 48 hour rail possessions)
3	Station building works - (standard hours, night works & 48 hour rail possessions)
4a	Station building works - ramps & stairs - (standard hours, night works & 48 hour rail possessions)

Stage No.	Construction Stage Description
4b	Park Road parking, kiss and ride and pedestrian work - (standard hours, night works & 48 hour rail possessions)
4c	Maclaurin Avenue footpath works - (standard hours)
4d	Site demobilization - (standard hours)

To provide an indicative assessment of construction noise impact, a noise model was created for each of the above construction stages.

6.4 Noise Catchment Areas

Noise modelling was conducted to determine the predicted level of noise impact at sensitive locations surrounding the project. Works associated with the modelled stages are likely to remain within a finite work area. Therefore, construction works have been modelled as a number of point sources operating simultaneously for each construction stage to provide the worst case predicted noise levels at each sensitive location. Sensitive areas have been grouped into noise catchment areas as shown below in Figure 6-1.



Figure 6-1 Noise catchment areas

Noise contour maps showing the predicted noise levels for the modelled construction works are detailed in Appendix C.

6.5 Construction Timing

We understand that some construction works are likely to be proposed for outside of standard hours as well as during standard hours during rail possessions for safety reasons. All night work would be undertaken in accordance with CNVS where feasible, or in consultation with the adjacent community.

6.6 Construction Plant and Equipment

The construction plant included in the modelled stages are presented in Table 6-3. The equipment sound power levels were sourced from the TfNSW CNVS, AS2436 and Cardno's measurement library.

Table 6-3	Construction	plant sound	power	levels

Plant	Duration	Number of Plant	Sound Power Level, L _{Aeq} ,dB(A)
Stage 1 –Site Establishment & Enabling Work		Total L _{Aeq}	119
Ute	_	4	103
Medium Rigid Truck	2-3 Months	1	103
Chainsaw		1	114
Crane Establishment		1	98
Piling Rig Establishment (Truck Source Only)		1	110
Hand Tools		1	94
Generator		1	103
Mulcher		1	116
Stage 2A – Lift 1 - Work		Total L _{Aeq}	119
Excavator 30t		1	110
Generator		1	103
Piling (small rotary bored)		1	112
Hand Tools	8 Months	1	94
Mobile Crane		1	113
Truck & Dog		1	108
Dump Truck		1	110
EWP		1	97
Concrete Truck		1	109
Concrete Pump	-	1	109
Stage 2A – Lift 2 - Work Thompson Lane		Total L _{Aeq}	119
Excavator 30t		1	110
Generator		1	103
Piling (small rotary bored)	- 8 Months	1	112
Hand Tools		1	94
Mobile Crane		1	113
Truck & Dog		1	108
Dump Truck		1	110
EWP		1	97
Concrete Truck		1	109
Concrete Pump		1	109
Stage 2B – Platform Works - Services		Total L _{Aeq}	119
Franna		1	98
Power Tools	1_3 Months	1	106
EWP		1	97
Hand Tools		1	94
Plant	Duration	Number of Plant	Sound Power Level, L _{Aeq} ,dB(A)
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Stage 2B – Platform Works - Services Worst Case		Total L _{Aeq}	118
Concrete Saw		1	118
Power Tools		1	106
Franna	1 10 chifte	1	98
Hand Tools		1	94
EWP		1	97
Generator		1	103
Stage 3 – Station Building Works		Total L _{Aeq}	116
Hand Tools		1	94
Generator		1	103
Franna		1	98
Pneumatic Drill	3-5 Months	1	115
Power Tools		1	106
Fork Lift		1	106
Medium Rigid Truck	-	1	103
Stage 4A – Station Building Works - Ramps & Stairs		Total LAeq	121
Hand Tools		1	94
Power Tools	-	1	106
Generator		1	103
Franna		1	98
Concrete Saw	1-3 Months	1	118
Concrete Truck	-	1	109
Concrete Pump		1	109
Pneumatic Drill	-	1	115
Medium Rigid Truck	-	1	103
Stage 4B – Park Road parking, kiss and ride and pedestrian work		Total L _{Aeq}	124
Mobile Crane		1	113
Excavator with Hydraulic Hammer		1	122
Concrete Truck		1	109
Concrete Pump		1	109
Hand Tools	2.4 Months	1	94
Bobcat (Use 2t Skidsteer)	2-4 Monuns	1	107
Power Tools		1	106
Road Saw (Use concrete saw)		1	118
Compactor]	1	106
Asphalt Paver		1	106
Stage 4C – Maclaurin Avenue footpath		Total L _{Aeq}	120
Demolition Saw	1.2 Martha	1	118
Excavator 6t		1	100

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Plant	Duration	Number of Plant	Sound Power Level, L _{Aeq} ,dB(A)
Dump Truck		1	110
Bobcat		1	107
Concrete Truck		1	109
Concrete Pump		1	109
Stage 4D – Site demobilization		Total L _{Aeq}	117
Bobcat		1	107
EWP		1	97
Power Tools		1	106
Hand Tools		1	94
Medium Rigid Truck	1.2 Months	1	103
Ute		1	103
Truck & Dog		1	108
Generator		1	103
Excavator 30t		1	110
Mobile Crane		1	113

Notes:

- (1) All timeframes are indicative and subject to change during detailed design.
- (2) The modelling represents the worst case scenario, where all plant is operating simultaneously. However, in practice, all activities / plant within each stage are very unlikely to operate at the same time. The modelling results should therefore be considered conservative.

6.7 Predicted Construction Noise Levels

The predicted noise impact from construction activities in the form of noise contour maps is presented in Appendix C with predicted levels at. Predicted construction noise levels at the wrost case location in each modelled NCA for each stage are shown below in Table 6-4 and Table 6-5. The levels below represent the worst case predicted noise impact at the most affected receivers (closest to the works) in each NCA. Noise levels as a result of construction activities are predicted to be lower than these levels for the remaining receivers within each associated NCA.

Noise Levels have been coloured according to their expected level of subjective impact as defined in Table 9 of the CNVS V4 Addendum (Nov 2019).



Table 6-4Predicted construction noise	levels –	propose	d activities d	luring sta	ndard working hours						
Most Affected	Obj	Eleor	Facade		Predicted Construction	ICNG Noise M dB(A)	/lanagement Lo	evels (NMLs),	Predicted V of ICNG NN	d Worst Case Exceedance NMLs	
Receivers	No.	FIOOI	Facing		Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours¹	OOHW2 Hours ²	Std. Hours	OOHW1. Hours	OOHW2 Hours
Noticeable (NML-5 to NML)											
Clearly audible (NML to NML+10)											
Moderately intrusive (NML+10 to NML	+20)										
Highly intrusive / Highly noise affected	(>NML	+20 or	>75 dB(A)	for reside	ential receivers)						
Stage 1 –Site Establishment & Enab	ling W	ork– St	andard W	orking H	lours						
92 Park Road	27	GF	SE	1	66	49	-	-	17	-	-
3 Thompson Lane	38	GF	NW	2	98	49	-	-	49	-	-
Commercial	72	GF	NE	3	84	70	-	-	14	-	-
Monash Reserve	71	GF	-	4	51	60	-	-	4	-	-
East Hills Park	70	GF	-	5	53	60	-	-	-	-	-
Kelso Beach Reserve	69	GF	-	6	44	60	-	-	-	-	-
East Hills Girls High School	73	GF	W	7a	51	55	-	-	-	-	-
East Hills Girls High School Playing Fields	74	GF	SE	7b	52	65	-	-	-	-	-
Bright Futures Early Learning Centre	76	GF	W	8	53	50	-	-	3	-	-
East Hills Baptist Church	75	GF	SW	9	64	55	-	-	9	-	-
Stage 2a1 – Lift 1 - Work– Standard	Workir	ng Hou	rs								
92 Park Road	27	GF	SE	1	83	49	-	-	34	-	-
3 Thompson Lane	38	GF	NW	2	60	49	-	-	11	-	-
Commercial	72	GF	NE	3	58	70	-	-	-	-	-
Monash Reserve	71	GF	-	4	42	60	-	-	-	-	-
East Hills Park	70	GF	-	5	45	60	-	-	-	-	-
Kelso Beach Reserve	69	GF	-	6	54	60	-	-	-	-	-
East Hills Girls High School	73	GF	W	7a	39	55	-	-	-	-	-
East Hills Girls High School Playing Fields	74	GF	SE	7b	45	65	-	-	-	-	-
Bright Futures Early Learning Centre	76	GF	W	8	42	50	-	-	-	-	-



			1								
Most Affected	Obj	-	Facade		Predicted Construction	ICNG Noise N dB(A)	lanagement Lev	els (NMLs),	Predicted Worst Case Exceedance of ICNG NMLs		
Receivers	No.	FIOOF	Facing		Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours ¹	OOHW2 Hours ²	Std. Hours	OOHW1. Hours	OOHW2 Hours
Noticeable (NML-5 to NML)											
Clearly audible (NML to NML+10)											
Moderately intrusive (NML+10 to NML	+20)										
Highly intrusive / Highly noise affected	(>NML	+20 or 3	>75 dB(A)	for reside	ential receivers)						
East Hills Baptist Church	75	GF	SW	9	50	55	-	-	-	-	-
Stage 2a2 – Lift 2 – Work – Thompso	on Lan	e– Stan	dard Wor	king Hou	urs						
92 Park Road	27	GF	SE	1	54	49	-	-	5	-	-
3 Thompson Lane	38	GF	NW	2	94	49	-	-	45	-	-
Commercial	72	GF	NE	3	88	70	-	-	18	-	-
Monash Reserve	71	GF	-	4	52	60	-	-	-	-	-
East Hills Park	70	GF	-	5	53	60	-	-	-	-	-
Kelso Beach Reserve	69	GF	-	6	36	60	-	-	-	-	-
East Hills Girls High School	73	GF	W	7a	49	55	-	-	6	-	-
East Hills Girls High School Playing Fields	74	GF	SE	7b	51	65	-	-	-	-	-
Bright Futures Early Learning Centre	76	GF	W	8	49	50	-	-	-	-	-
East Hills Baptist Church	75	GF	SW	9	56	55	-	-	1	-	-
Stage 2b1 – Platform Works - Servic	æs–Sta	ndard	Hours								
92 Park Road	27	GF	SE	1	65	49	-	-	16	-	-
3 Thompson Lane	38	GF	NW	2	62	49	-	-	13	-	-
Commercial	72	GF	NE	3	62	70	-	-	-	-	-
Monash Reserve	71	GF	-	4	49	60	-	-	-	-	-
East Hills Park	70	GF	-	5	50	60	-	-	-	-	-
Kelso Beach Reserve	69	GF	-	6	42	60	-	-	-	-	-
East Hills Girls High School	73	GF	W	7a	42	55	-	-	-	-	-
East Hills Girls High School Playing Fields	74	GF	SE	7b	44	65	-	-	-	-	-
Bright Futures Early Learning Centre	76	GF	W	8	47	50	-	-	-	-	-



Most Affected	Obi	-	Facade		Predicted Construction	dB(A)	ianagement Lev	eis (NMLS),	of ICNG NMLs			
Receivers	No.	Floor	Facing		Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours ¹	OOHW2 Hours ²	Std. Hours	OOHW1. Hours	OOHW2 Hours	
Noticeable (NML-5 to NML)												
Clearly audible (NML to NML+10)												
Moderately intrusive (NML+10 to NML	+20)											
Highly intrusive / Highly noise affected	(>NML	+20 or 3	>75 dB(A)	for reside	ential receivers)							
East Hills Baptist Church	75	GF	SW	9	47	55	-	-	-	-	-	
Stage 2b2 – Platform Works Worst C	Case - S	Service	s–Standar	d Hours	;	·						
92 Park Road	27	GF	SE	1	72	49	-	-	23	-	-	
3 Thompson Lane	38	GF	NW	2	84	49	-	-	35	-	-	
Commercial	72	GF	NE	3	79	70	-	-	9	-	-	
Monash Reserve	71	GF		4	62	60	-	-	2	-	-	
East Hills Park	70	GF		5	63	60	-	-	3	-	-	
Kelso Beach Reserve	69	GF		6	54	60	-	-	-	-	-	
East Hills Girls High School	73	GF	W	7a	54	55	-	-	-	-	-	
East Hills Girls High School Playing Fields	74	GF	SE	7b	56	65	-	-	-	-	-	
Bright Futures Early Learning Centre	76	GF	W	8	59	50	-	-	9	-	-	
East Hills Baptist Church	75	GF	SW	9	59	55	-	-	4	-	-	
Stage 3 – Station Building WorksS	Standar	d Hour	s									
92 Park Road	27	GF	SE	1	82	49	-	-	33	-	-	
3 Thompson Lane	38	GF	NW	2	56	49	-	-	7	-	-	
Commercial	72	GF	NE	3	54	70	-	-	-	-	-	
Monash Reserve	71	GF		4	39	60	-	-	-	-	-	
East Hills Park	70	GF		5	40	60	-	-	-	-	-	
Kelso Beach Reserve	69	GF		6	54	60	-	-	-	-	-	
East Hills Girls High School	73	GF	W	7a	34	55	-	-	-	-	-	
East Hills Girls High School Playing Fields	74	GF	SE	7b	40	65	-	-	-	-	-	
Bright Futures Early Learning Centre	76	GF	W	8	59	50	-	-	9	-	-	



Most Affected			Facade		Predicted ICN CA Construction Noise Level	ICNG Noise M dB(A)	lanagement Lev	els (NMLs),	Predicted Worst Case Exceedance of ICNG NMLs			
Receivers	No.	Floor	Facing		Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours ¹	OOHW2 Hours ²	Std. Hours	OOHW1. Hours	OOHW2 Hours	
Noticeable (NML-5 to NML)												
Clearly audible (NML to NML+10)												
Moderately intrusive (NML+10 to NML	+20)											
Highly intrusive / Highly noise affected	(>NML	+20 or 3	>75 dB(A)	for reside	ential receivers)							
East Hills Baptist Church	75	GF	SW	9	59	55	-	-	4	-	-	
Stage 4a – Station Building Works -	Ramps	s & Stai	rsStand	ard Hou	rs							
92 Park Road	27	GF	SE	1	86	49	-	-	37	-	-	
3 Thompson Lane	38	GF	NW	2	84	49	-	-	35	-	-	
Commercial	72	GF	NE	3	84	70	-	-	14	-	-	
Monash Reserve	71	GF		4	51	60	-	-	-	-	-	
East Hills Park	70	GF		5	52	60	-	-	-	-	-	
Kelso Beach Reserve	69	GF		6	57	60	-	-	-	-	-	
East Hills Girls High School	73	GF	W	7a	49	55	-	-	-	-	-	
East Hills Girls High School Playing Fields	74	GF	SE	7b	51	65	-	-	-	-	-	
Bright Futures Early Learning Centre	76	GF	W	8	44	50	-	-	-	-	-	
East Hills Baptist Church	75	GF	SW	9	54	55	-	-	-	-	-	
Stage 4b – Park Road parking, kiss	and rid	e and p	pedestrian	work	Standard Hours							
92 Park Road	27	GF	SE	1	90	49	-	-	41	-	-	
3 Thompson Lane	38	GF	NW	2	62	49	-	-	13	-	-	
Commercial	72	GF	NE	3	59	70	-	-	-	-	-	
Monash Reserve	71	GF		4	47	60	-	-	-	-	-	
East Hills Park	70	GF		5	48	60	-	-	-	-	-	
Kelso Beach Reserve	69	GF		6	59	60	-	-	-	-	-	
East Hills Girls High School	73	GF	W	7a	45	55	-	-	-	-	-	
East Hills Girls High School Playing Fields	74	GF	SE	7b	53	65	-	-	-	-	-	
Bright Futures Early Learning Centre	76	GF	W	8	46	50	-	-	-	-	-	



						ICNC Noise N	lanagamantiay		Predicted Worst Case Exceedance			
Most Affected	Ohi		Facado		Predicted Construction	dB(A)	ianagement Lev	eis (INIVILS),	of ICNG NN	ILs	xceedance	
Receivers	No.	Floor	Facing	NCA	Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours ¹	OOHW2 Hours²	Std. Hours	OOHW1. Hours	OOHW2 Hours	
Noticeable (NML-5 to NML)												
Clearly audible (NML to NML+10)												
Moderately intrusive (NML+10 to NML	+20)											
Highly intrusive / Highly noise affected	(>NML	+20 or 3	>75 dB(A)	for reside	ential receivers)							
East Hills Baptist Church	75	GF	SW	9	54	55	-	-	-	-	-	
Stage 4c – Maclaurin footpath works	sStar	ndard H	ours			-						
92 Park Road	27	GF	SE	1	56	49	-	-	7	-	-	
3 Thompson Lane	38	GF	NW	2	88	49	-	-	39	-	-	
Commercial	72	GF	NE	3	93	70	-	-	23	-	-	
Monash Reserve	71	GF		4	55	60	-	-	-	-	-	
East Hills Park	70	GF		5	52	60	-	-	-	-	-	
Kelso Beach Reserve	69	GF		6	39	60	-	-	-	-	-	
East Hills Girls High School	73	GF	W	7a	52	55	-	-	-	-	-	
East Hills Girls High School Playing Fields	74	GF	SE	7b	51	65	-	-	-	-	-	
Bright Futures Early Learning Centre	76	GF	W	8	53	50	-	-	3	-	-	
East Hills Baptist Church	75	GF	SW	9	56	55	-	-	1	-	-	
Stage 4d - Site demobilization-Star	ndard H	Hours										
92 Park Road	27	GF	SE	1	79	49	-	-	30	-	-	
3 Thompson Lane	38	GF	NW	2	84	49	-	-	35	-	-	
Commercial	72	GF	NE	3	92	70	-	-	22	-	-	
Monash Reserve	71	GF		4	52	60	-	-	-	-	-	
East Hills Park	70	GF		5	50	60	-	-	-	-	-	
Kelso Beach Reserve	69	GF		6	47	60	-	-	-	-	-	
East Hills Girls High School	73	GF	W	7a	49	55	-	-	-	-	-	
East Hills Girls High School Playing Fields	74	GF	SE	7b	48	65	-	-	-	-	-	
Bright Futures Early Learning Centre	76	GF	W	8	50	50	-	-	-	-	-	



Most Affected	Obj	Elect	Facade		Predicted Construction	ICNG Noise N dB(A)	lanagement Lev	rels (NMLs),	Predicted W of ICNG NM	/orst Case E Ls	xceedance
Receivers	No.		Facing	NCA	Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours¹	OOHW2 Hours ²	Std. Hours	OOHW1. Hours	OOHW2 Hours
Noticeable (NML-5 to NML)											
Clearly audible (NML to NML+10)											
Moderately intrusive (NML+10 to NML	+20)										
Highly intrusive / Highly noise affected	(>NML	+20 or :	>75 dB(A)	for reside	ential receivers)						
East Hills Baptist Church	75	GF	SW	9	51	55	-	-	-	-	-

Notes:

¹Out of Hours Work, Period 1 (OOWH1): Monday to Friday 6pm to 10pm, Saturday 7am to 8am, 1pm to 10pm, and Sunday/Public Holidays 8am to 6 pm.

²Out of Hours Work, Period 2 (OOWH2): Monday to Saturday, 12am to 7am, 10pm to 12 am, and Sunday / Public Holiday 12am to 8am, 6pm to 12am.

Table 6-5 Predicted construction noise	levels –	propose	d activities d	uring out	of working hours (O	OHW)					
Most Affected	Obj	Elect	Facade		Predicted Construction	ICNG Noise M dB(A)	Management Le	vels (NMLs),	Predicted V of ICNG NN	Vorst Case I ILs	Exceedance
Receivers	No.		Facing	acing NCA	Noise Level dB(A), L _{Aeq 15hr}	Std. Hours	OOHW1. Hours ¹	OOHW2 Hours ²	Std. Hours	OOHW1. Hours	OOHW2 Hours
Noticeable (NML-5 to NML+5)											
Clearly audible (NML+5 to NML+15)											
Moderately intrusive (NML+15 dB(A) to	NML +	+25 dB((A))								
Highly intrusive / Highly noise affected	(>NML	+25 dB	(A))								
Stage 2a1 – Lift 1 – Work – OOHW1	& 2 Wo	orking H	lours								
92 Park Road	27	GF	SE	1	83	-	44	37	-	39	46
3 Thompson Lane	38	GF	NW	2	60	-	44	37	-	16	23
Stage 2a2 – Lift 2 – Work – Thompson	on Lane	e – OO	HW1 & 2 V	/orking	Hours						
92 Park Road	27	GF	SE	1	54	-	44	37	-	10	17
3 Thompson Lane	38	GF	NW	2	94	-	44	37	-	50	57
Stage 2b1 – Platform Works - Servic	:es – 0	OHW1	& 2 Worki	ng Hour	'S						
92 Park Road	27	GF	SE	1	65	-	44	37	-	21	28
3 Thompson Lane	38	GF	NW	2	62	-	44	37	-	18	25
Stage 2b2 – Platform Works Worst 0	Case –	оонw	1 & 2 Worl	king Ho	urs						
92 Park Road	27	GF	SE	1	72	-	44	37	-	28	35
3 Thompson Lane	38	GF	NW	2	84	-	44	37	-	40	47
Stage 3 – Station Building Works-	оонw	1 & 2 W	Vorking Ho	ours							
92 Park Road	27	GF	SE	1	82	-	44	37	-	38	45
3 Thompson Lane	38	GF	NW	2	56	-	44	37	-	12	19
Stage 4a – Station Building Works -	оонw	/1 & 2 V	Norking H	ours							
92 Park Road	27	GF	SE	1	86	-	44	37	-	42	49
3 Thompson Lane	38	GF	NW	2	84	-	44	37	-	40	47
Stage 4b – Park Road parking, kiss	and rid	e and p	pedestrian	work	OOHW1 & 2 Wor	king Hours					
92 Park Road	27	GF	SE	1	90	-	44	37	-	36	43
3 Thompson Lane	38	GF	NW	2	62	-	44	37	-	18	25

¹Out of Hours Work, Period 1 (OOWH1): Monday to Friday 6pm to 10pm, Saturday 7am to 8am, 1pm to 10pm, and Sunday/Public Holidays 8am to 6 pm.

²Out of Hours Work, Period 2 (OOWH2): Monday to Saturday, 12am to 7am, 10pm to 12 am, and Sunday / Public Holiday 12am to 8am, 6pm to 12am.

6.8 Construction Noise Results Summary

A summary of the predicted impacts is described below for each proposed construction stage. It should be noted that this assessment has endeavoured to carry out "worst case" noise modelling, and noise levels are predicted based on all sources operating simultaneously within the worksite.

However in practice, all activities/plant within each stage are very unlikely to operate at the same time.

For example, for stage 1, the noise predictions have been based on eight different types of plant and equipment (refer toTable 6-3) being used concurrently, which has led to a noise prediction of 98dB for the nearest receiver in Thompson Lane. However, given that the size of the proposed construction compound is 140 square metres, it is unlikely that all machinery types could operate simultaneously.

The 98dB noise prediction is largely influenced by the operation of a mulcher during vegetation clearance work. The model assumes the maximum noise level of the mulcher would occur continuously (ie. when tree branches are being fed into the machine). In practice, branches would be fed intermittently into the mulcher and the equipment would be idling at a substantially lower noise level. Additionally the mulcher is only expected to be used for up to one day in total during the construction period, as there are only 3 trees to be removed. The noise from the removal of one tree would occur for up two hours at NCA 2 and the removal of two trees for up to four hours at NCA 1.

Similarly, the activities undertaken within each scenario (e.g. installation of site sheds, vegetation removal, connection of water and electrical services) would occur sequentially, not concurrently.

Therefore, while the predicted noise levels identified in Table 6-4 and Table 6-5 above show exceedances to the applicable NMLs, these represents the worst case scenarios and in practice noise experienced by nearby receivers is likely to be substantially lower than the noise model predictions.

6.8.1 Stage 1 –Site Establishment and Enabling Work

The above results for Stage 1, indicate moderately and highly intrusive noise levels during the day at nearby residences, and commercial premises and exceedances of the ICNG noise management levels for the day period for NCAs 1 to 3 to varying extents. Properties located on Thompson Lane, closest to the worksites, will experience the highest exceedances when the works are closest to them for short periods of time. Exceedances of the daytime NMLs, and clearly audible noise levels are also predicted for the childcare centre and church in NCAs 8 and 9 respectively. OOHW works are not proposed for this stage.

6.8.2 Stage 2a1 – Lift 1 Work

The above results for Stage 2a1, indicate moderately and highly intrusive noise levels during the day at nearby residences, with no predicted exceedances of the ICNG noise management levels for the day period for other assessed NCAs. Properties located on Park Road, closest to the worksites, will experience the highest exceedances.

OOHW works are also proposed for this Stage. Moderately and highly intrusive noise levels are also predicted during the evening and night period, with higher levels expected to the north of the rail corridor. Given the high predicted level of impacts, reduced operations are recommended and careful planning will be required for proposed works for all time periods to manage potential impacts.

6.8.3 Stage 2a2 – Lift 2 Work – Thompson Lane

The above results for Stage 2a2, indicate clearly audible noise level to the north of the corridor and highly intrusive noise levels to the south during the day at nearby residences and commercial premises, with no predicted exceedances of the ICNG noise management levels for the day period for the school and surrounding parks, but noticeable and clearly audible noise levels for the childcare centre and church respectively. Properties located on Thompson Lane, closest to the worksites, will experience the highest exceedances.

OOHW works are also proposed for this Stage. Moderately and very highly intrusive noise levels (Thompson Lane) are also predicted during the evening and night period, with higher levels expected to the south of the rail corridor. Given the high predicted level of impacts, reduced operations are recommended and careful planning will be required for proposed works for all time periods to manage potential impacts.

6.8.4 Stage 2b1 – Platform Works - Services

The above results for Stage 2a2, indicate moderately intrusive noise levels during the day at nearby residences, with no predicted exceedances of the ICNG noise management levels for the day period for other assessed NCAs. Properties located on Park Road, closest to the worksites, will experience the highest exceedances.

OOHW works are also proposed for this Stage. Moderately (OOHW1 period) and very highly intrusive (OOHW2 period) noise levels are also predicted at nearby residences during the evening and night period, with similar levels expected on both sides of the rail corridor. Given the high predicted level of impacts, reduced operations are recommended and careful planning will be required for proposed works for all time periods to manage potential impacts.

6.8.5 Stage 2b2 – Platform Works Worst Case - Services

The above results for Stage 2b2, indicate highly intrusive noise levels during the day at nearby residences, with predicted exceedances of the ICNG noise management levels for the day period for all other NCAs except Kelso Beach Reserve and the East Hills Girls High School playing fields. Properties located on Thompson Lane, closest to the worksites, will experience the highest exceedances.

OOHW works are also proposed for this Stage. Very highly intrusive noise levels are also predicted during both the evening and night period, with the highest levels expected on the southern side of the rail corridor.

6.8.6 Stage 3 – Station Building Works

The above results for Stage 3, indicate highly intrusive noise levels during the day at nearby residences, to the north of the station and clearly audible noise levels to the south, with no predicted exceedances of the ICNG noise management levels for the school or parks during the day. Exceedances of the daytime NMLs, and clearly audible noise levels are predicted for the childcare centre and church in NCAs 8 and 9 respectively.

OOHW works are also proposed for this Stage. Very highly intrusive noise levels are predicted during both the evening and night period in NCA 2, with the highest levels expected on the northern side of the rail corridor.

6.8.7 Stage 4a – Station Building Works - Ramps & Stairs

The above results for Stage 4a, indicate highly intrusive noise levels during the day at nearby residences, to the north and south of the station in NCA 1 and 2, with moderately intrusive exceedances of the ICNG noise management levels predicted at commercial premises in NCA 3, and no exceedances for the remainder of the NCAs during the day.

OOHW works are also proposed for this Stage. Very highly intrusive noise levels are predicted during both the evening and night period for NCA 1 and 2, with the highest levels expected on the northern side of the rail corridor.

6.8.8 Stage 4b – Park Road parking, kiss and ride and pedestrian work

The above results for Stage 4b, indicate highly intrusive noise levels during the day at nearby residences, to the north and south of the station in NCA 1 and 2, with moderately intrusive exceedances of the ICNG noise management levels predicted at commercial premises in NCA 3, and no exceedances for the remainder of the NCAs during the day.

OOHW works are also proposed for this Stage. Very highly intrusive noise levels are predicted during both the evening and night period for NCA 1, and clearly audible levels predicted for NCA 2. The highest levels are expected on the northern side of the rail corridor.

6.8.9 Stage 4c – Maclaurin footpath works

The above results for Stage 4c, indicate clearly audible noise levels at NCA 1 and highly intrusive noise levels at NCA 2 and 3 during the day at nearby residences, and commercial premises and exceedances of the ICNG noise management levels for the day period for NCAs 1 to 3 and NCA 8 & 9 to varying extents. Properties located on Thompson Lane, closest to the worksites will experience the highest exceedances.

Exceedances are not predicted for the other NCAs for this Stage. OOHW works are not proposed for this Stage.

6.8.10 Stage 4d – Site demobilization

The above results for Stage 4d, indicate highly intrusive noise levels during the day at nearby residences, and commercial premises and exceedances of the ICNG noise management levels for the day period for NCAs 1 to 3 to varying extents. Properties located on Thompson Lane, and the commercial premises in NCA 3 closest to the worksites, will experience the highest exceedances. OOHW works are not proposed for this Stage.

6.9 Sleep Disturbance

Stages 2a, 2b, 3, 4a & 4b

Night works are proposed close to residential receivers and may extend over two consecutive nights, therefore, an assessment of potential sleep disturbance is provided below.

The most likely source of potential sleep disturbance from outside of construction hours works will be from concrete sawing, hammering, piling, and drilling.

Maximum noise levels have been predicted to the nearest affected residential receivers to allow a review of the potential for sleep disturbance from construction activities at night. Typical construction source L_{Amax} noise levels were assumed to be 10 dB(A) above the predicted L_{Aeq} noise levels, on the basis of measurements from previous projects. On this basis, the receivers where the sleep disturbance criteria is likely to be exceeded are summarised in Table 6-6.

Receiver	Obj No.	Floor	Facade	NCA	Constructio dB(A), L _{AMa}	on Noise Leve ×	el					Criteria, dB(A)
, i i i i i i i i i i i i i i i i i i i			Facility		Stage 2a1	Stage 2a2	Stage 2b1	Stage 2b2	Stage 3	Stage 4a	Stage 4b	
92 Park Road	28	GF	W	1	93	54	65	72	82	86	90	60
3 Thompson Lane	28	F 9	W	1	70	94	62	84	56	84	62	60

Table 6-6 Predicted construction maximum (LAMax) noise levels – stages 2a, 2b, 3, 4a & 4b

The predicted L_{Amax} results detailed above indicate that maximum construction noise levels at NCA 1 & 2 are likely to exceed the sleep disturbance criteria for all "outside of standard hours" construction stages, when construction works are located nearby. For this reason it is recommended that activities with potentially high maximum levels such as the use of pneumatic tools, piling, drilling and concrete sawing are minimised at these locations during the quietest periods of the overall night-time period.

7 Operational Noise Assessment

7.1 Rail noise

Operational noise from train movements has not been assessed as noise from train operation is not expected to differ as a result of the proposal.

7.2 Plant Noise

Mechanical plant details are yet to be finalised. It is expected that mechanical noise emissions would not have a significant impact on the surrounding environment, and that the use of standard controls such as quiet plant selection, and duct lining and/or attenuators, would allow mechanical plant noise to be reduced to acceptable levels.

If required, operational noise emissions shall be addressed during the detailed design phase in order to comply with operational noise criteria as per the NPI.

8 Construction Vibration Assessment

8.1 Vibration Limits

Vibration from construction activities associated with the project could potentially impact on the amenity of the occupants of dwellings or buildings located close to the construction works. Generally, vibration impact can be summarised into two categories:

- a Effect on human comfort
- b Structural or cosmetic damage to buildings.

Vibration criteria is addressed in the NSW ICNG and refers to Section 2.5 of the document Assessing Vibration: A Technical Guideline (NSW AV:ATG) issued by DEC (2006). The NSW AV:ATG outlines vibration limits in relation to human comfort. Criteria in this guideline are based on the British Standard BS 6472-1992 Evaluation of human exposure to vibration in buildings (1-80 Hz). A summary of these criteria is detailed in Table 5-3.

In relation to structural damage, there is currently no Australian Standard that provides criteria for the assessment of structural damage to buildings. However, the British Standard BS 7385 Part 2 can be used to assess structural damage to buildings. It defines damage in several categories including, for example, "cosmetic", "minor" and "major" damage. Alternatively, the German Standard DIN 4150 Part 3 provides maximum vibration levels, which are assessed over a frequency range. These criteria are summarised in Table 5-4.

The recommended minimum working distance between vibration intensive plant and sensitive receivers for minimising the risk of cosmetic damage are listed in the TfNSW CNVS and are shown in Table 8-1.

The minimum working distances for cosmetic damage as outlined in Table 8-1 must be adhered to unless otherwise approved by TfNSW.

8.1.1 Vibration Assessment

Building Damage

For the purposes of this assessment, the following proposed plant with the potential to generate the most vibration has been considered:

- > Piling rig
- > Rock hammers
- > Drills
- > Truck movements.

Construction vibration levels vary depending on the distance from the equipment in use, the energy level imparted to the ground by the construction process, and the bedrock type. The most vibration generating sources associated with the construction work will be rock hammers and piling rigs. It is anticipated that no blasting would be required as part of this proposal.

The *Transit Noise and Vibration Impact Assessment* (TNVIA) (US Federal Transit Administration (FTA), 2006) outlines calculation methods for construction equipment vibration levels. These levels are expressed in terms of Peak Particle Velocity (PPV, mm/s), with vibration levels provided for a number of plant items. The TNVIA specifies that:

"It should be noted that there is a considerable variation in reported ground vibration levels from construction sites. The data provides a reasonable estimate for a wide range of soil conditions."

The data provided by the TNVIA results in a graph as shown in Figure 8-1.

Depending on the actual ground conditions (i.e. greater density of rock) vibration levels may increase and affect residents to a greater extent subjectively.



Note: The predicted vibration levels in the figure above include a safety margin for carrying ground types.

Figure 8-1 Estimates of vibration levels generated by common construction activities / equipment at various distances (Source: FTA 2006)

Construction works including bored piling and drilling may be undertaken with a minimum separation distance of 15 metres from the nearest residential buildings (Thompson Lane) on the southern side of the rail corridor and 45 metres from sensitive receiver buildings on the northern side, for the project. Existing station buildings are also located in close proximity to the proposed works.

The CNVS provides guidance on safe minimum working distances for vibration generating works. Table 8-1 below details the minimum safe working distances between construction activities and sensitive receivers to reduce vibration to within levels unlikely to cause building damage.

Minimum Working Distance (TfNSW CNVS)

The minimum working distance for vibration intensive plant from sensitive receivers is listed in Table 20 of the CNVS. Table 8-1 below presents these recommended minimum working distances for specific construction activities.

		Minimum Working Distance					
Plant Item	Approx. Size / Weight / Model	Cosmetic Damage (BS 7385) (metres)	Human Response (OEH Vibration Guideline) (metres)				
	1-2 tonne	5	15 to 20				
	2-4 tonne	6	20				
Vibratory Roller	4-6 tonne	12	40				
	7-13 tonne	15	100				
	13-18 tonne	20	100				

Table 8-1 Recommended minimum working distances for vibration intensive plant from sensitive receivers (CNVS)

		Minimum Working Distance					
Plant Item	Approx. Size / Weight / Model	Cosmetic Damage (BS 7385) (metres)	Human Response (OEH Vibration Guideline) (metres)				
	> 18 tonne	25	100				
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2	7				
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7	23				
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22	73				
Pile Driver - Vibratory	Sheet Piles	2 to 20	20				
Piling Rig - Bored	≤ 800 mm	2 (nominal)	N/A				
Piling Rig – Hammer	12 t down force	15	50				
Jackhammer	Hand Held	1 (nominal)	Avoid contact with structure				

Thompson Lane residences are located in close proximity (approximately 15 metres) to the south of the proposed piling works. Rock hammering is proposed approximately 45 metres from Park Road residences Both of these items are likely to be outside of the safe working limits recommended above for both standard buildings, and predicted vibration levels of > 2.5 mm/s are not expected at any of the closest residences.

However, works are proposed within safe working distances for existing station infrastructure and services and therefore, should be reviewed in more detail during detailed design. In addition, there are no heritage buildings in the vicinity of the proposal.

Where works are proposed within the safe working limits, specialist advice should be sought from an appropriately qualified structural engineer.

In addition, test vibration measurements of piling and other vibration intensive plant at the work location closest to the structure should be carried out prior to works commencing to determine the level of vibration at the sensitive structure. If vibration levels exceed the building damage limits detailed in Table 5-4, alternative work methods should be sought.

9 **Recommended Mitigation Measures**

9.1 Reasonable and Feasible Mitigation Measures

9.1.1 General Mitigation Measures

The best practice construction noise and vibration mitigation measures outlined in Table 9-1 are based on recommendations provided within the CNVS, ICNG and Australian Standard AS 2436-1981: Guide to Noise Control on Construction, Maintenance and Demolition Sites.

Table 9-1 Noise and vibration safeguards and management measures				
Environmental Safeguards	Details			
Construction Noise & Vibration Management Plan Preparation	Preparation of a construction noise and vibration management plan (CNVMP) based on recommendations provided within the NSW ICNG and Australian Standard AS 2436-1981: Guide to Noise Control on Construction, Maintenance and Demolition Sites. This is to include but not be limited to, plant controls, behavioural management, management of construction hours and provision of noise and vibration monitoring program where construction noise is predicted to exceed the NMLs.			
Plant controls	Reasonable and feasible noise mitigation measures which would be considered include:			
	Use of noise attenuating controls at the source, such as mufflers, acoustic screens, etc.			
	Plant and equipment would be in good working order to prevent excess noise generation.			
	Locating static sources of noise such as the generators as remotely as possible from sensitive receivers			
	• Use of broadband reversing alarms, or "quackers", on mobile equipment in accordance with the relevant health and safety regulations			
	 Use of temporary noise barriers where practical. The height and location of these barriers would be determined during preparation of the construction noise and vibration management plan when more information regarding the proposed plant to be used for each construction stage is available. 			
	 Investigate whether "at plant" mitigation or muffled plant is available for plant with high source noise levels such as rock hammers and piling rigs, and plant emitting continuous noise such as generators. 			
	 Acoustic curtains (generally loaded vinyl based products) attached to wire construction fencing or laid over steel scaffold can also provide practical temporary noise barriers. We recommend that this is investigated for stationary plant within the worksites once a detailed schedule of works and plant is available. 			
	 Provision of a solid 2 metre high anti-gawk barrier along the site work area boundaries may provide some reduction to nearby receivers, however this is only expected to benefit the lower levels of the nearby receivers. Local barriers will have minimal effects on noise reduction for receivers with multiple levels as there will still be a clear line of sight from the works to the receivers. Inclusion of an angled return at the top of the barrier (if this is practical to construct) may provide increased benefit to multiple story receivers when the plant is located close to the barrier and is generally stationery. We recommend that this is further investigated once a detailed schedule of works and plant is available. 			
Management and	Reasonable and feasible noise mitigation options which would be considered include:			
denavioural controis	• Ensure that managers effectively communicate acceptable and unacceptable work practices for the site, through staff site inductions, notice boards, and prestart meetings.			
	Avoid the need for reversing in the construction area by creating a loop road or similar.			
	Avoid dropping materials from height.			
	Workers should avoid shouting, minimise talking loudly, and avoid slamming vehicle doors.			
	Allowing construction to occur only during approved construction hours, unless otherwise required as a condition of TfNSW safety requirements			
	 Conducting noise monitoring during all construction stages considering the potential exceedances for the purposes of assisting in noise mitigation and to verify the findings of this noise assessment. 			
	Implementing a procedure for dealing with complaints to ensure that all complaints are registered and dealt with appropriately.			
	• Conducting additional monitoring if complaints are received or proposed activities and number of plant exceed those assumed in this assessment.			

Environmental Safeguards	Details		
	Modification of work activities where noise or vibration is found to cause unacceptable impact.		
	Application of respite periods for noise activities.		
Management of Construction Hours	 Carrying out works within standard daytime hours as follows: 7:00 am to 6:00 pm Monday to Friday 0:00 am to 4:00 pm Qaturdaya magnetic as Quadratic helidaya 		
	 8:00 am to 1:00 pm Saturdays, no work on Sundays or public holidays. Do not carry out operations during evening or night time hours, unless required for safety reasons under track possessions. 		
	 Do not carry out operations during evening of high-time hours, diffess required for safety reasons under track possessions. Should operations be required outside standard hours, all reasonable and feasible efforts should be undertaken to ensure noise levels would not exceed the ICNG noise management levels stated in Section 5.1 of this assessment by carrying out night-works with reduced numbers of plant for example. 		
	 Avoid the use of noisiest plant such as concrete saw and piling during quietest part of the night where possible. 		
	 Provide respite periods where noise levels are highly intrusive. Noise with special audible characteristics and vibration generating activities (including jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling) may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block. 		
	 'Continuous' includes any period during which there is less than a 1 hour respite between ceasing and recommencing any of the work. No more than two consecutive nights of noise with special audible characteristics and/or vibration generating work may be undertaken in the same NCA over any 7-day period, unless otherwise approved by the relevant authority. 		
Notification	• Notification of potentially affected receivers detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the work (where applicable) and contact telephone number.		
	Notification should be a minimum of seven calendar days prior to the start of work.		
	A contact telephone number and email address will be available for community feedback		
Site Specific Mitigation Measures	 Provision of temporary noise barriers is not likely to be practical for most of this site given the elevated nature of the surrounding receivers. However, provision of temporary noise barriers along the rear of the Thompson Lane construction compound with no gaps, and around specific activities may provide some screening to the closest ground level receivers, and should be investigated further as part of the project CNVMP assessment. 		
	 Provision of scaffolding and mobile noise curtains/blankets immediately around higher noise generating plant should be investigated further as part of the project CNVMP assessment. 		
	Carry out Stage 2b "Platform works – services (worst case)" during standard hours only, where possible.		
	 Given the high predicted level of impacts, reduced operations are recommended during night-works and careful planning will be required for proposed works for all time periods to manage potential impacts. 		
Construction Noise Monitoring	• Consider conducting short term background noise monitoring prior to construction to confirm the ambient noise levels presented in this report, if ambient conditions (the level of background activity) are considered to have changed as a result of changes to COVID response.		
Provision of Dilapidation Surveys	• Where buildings are located within the safe working distance zone, dilapidation surveys should be carried out prior to construction.		

Environmental Safeguards	Details
Construction Vibration Monitoring	• Where receivers are located within the safe work distance zones, vibration monitoring should be carried out to ensure compliance with the required criteria. If exceedances are recorded, works should be modified accordingly to reduce vibration levels.

9.2 Transport for NSW Construction Noise and Vibration Guideline Management Recommendations for Residual Impacts

Where all reasonable and feasible standard mitigation measures have been applied and exceedances are still predicted to occur, the CNVS provides guidance on additional mitigation measures to be implemented for each receiver depending on level of exceedance for the predicted noise level above the NML. Additional mitigation measures are outlined in Appendix B.

Identification of where additional mitigation measures may be required is outlined below in Table 9-2.

Predicted airborne L _{Aeq(15min)} noise level at receiver							
Perception	dB(A) above RBL	dB(A) above NML	Additional Mitigation Measures				
Standard Hours: Mon - Fri (7 am – 6 pm), Sat (8 am – 1 pm), Sun/Pub Hol (Nil)							
Noticeable	5 to 10	0	-				
Clearly audible	> 10 to 20	< 10	-				
Moderately intrusive	> 20 to 30	10 to 20	PN, V				
Highly intrusive	> 30	> 20	PN, V				
75 dB(A) or greater	N/A	N/A	PN, V, SN				
OOHW Period 1: Mon - Fri (6 pm – 10 pm), Sat (7 am – 8 am & 1 pm – 10 pm), Sun/Pub Hol (8 am – 6 pm)							
Noticeable	5 to 10	< 5	-				
Clearly audible	> 10 to 20	5 to 15	PN				
Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO				
Highly intrusive	> 30	> 25	PN, V, SN, RO, RP [#] , DR [#]				
OOHW Period 2: Mon - Fri (10 pm – 7 am), Sat (10 pm – 8 am), Sun/Pub Hol (6 am – 7 am)							
Noticeable	0 to 10	< 5	PN				
Clearly audible	> 10 to 20	5 to 15	PN, V				
Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RP, DR				
Highly intrusive	> 30	> 25	PN, V, SN, AA, RP, DR				
Notes:							
AA = Alternative Accommodation		RP = Respite Period	1				
V = Verification Monitoring		SN = Specific Notification, Individual Briefings, Telephone call					
IB = Individual Briefings		DR = Duration Reduction					
PN = Notification	PN = Notification		Perception = relates to level above RBL				
NML = Noise Management Level		vel					
		HA = Highly Affected (> 75 dB	(A) - applies to residences only)				

 Table 9-2
 Triggers for additional mitigation measures – airborne noise

[#] Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6 am-7 am & 1 pm-6 pm, Sundays / Public Holidays 8 am-6 pm)

Additional mitigation measures are outlined in Appendix B.

10 Conclusions

This assessment has determined the following conclusions:

- In accordance with the noise management levels stipulated in Section 5.1, dwellings exposed to levels of construction noise above 75 dB(A) are considered highly noise affected, with dwellings exposed to levels above the daytime RBL +10 dB(A) considered noise affected
- Construction noise levels are predicted to exceed the NSW ICNG noise management levels (NML) for "standard" hours at all NCAs except Kelso Beach Reserve and the East Hills Girls High School playing fields for standard construction hours for all construction stages
- Construction noise levels are predicted to exceed management levels for "OOHW" hours of operation for Stages 2a, 2b, 3, 4a and 4b at the nearby residential receivers in both residential NCAs (1 and 2), particularly for receivers located on Thompson Lane and directly south of the station. This is due to the proximity of receivers to the construction works
- Predicted levels are expected to be very highly intrusive at a number of receivers in NCA 1 and 2 for Stages 2a, 2b,3, 4a and 4b for works during OOH1 and OOH2 time periods. Construction noise is likely to have a higher impact on and cause sleep disturbance at sensitive receivers located on Park Road and around Thompson Lane due to their proximity to the proposed work site. However, the modelled noise levels reflect the worst case scenario where all plant is operating simultaneously which is very unlikely to occur in practice due to safety and space constraints within the site. Continuous noise levels are likely to be lower for most of the works. The results should therefore be considered on this basis.
- Highly intrusive noise levels were predicted for the commercial receivers in NCA 3 for Stages 1, 2A and 4D
- > Highly intrusive noise levels were not predicted for any receivers in NCA 4 to 9 for any of the construction stages
- > It should be noted that this assessment has endeavoured to carry out "worst case" noise modelling, and noise levels are predicted based on all modelled sources operating simultaneously.
- > The predicted exceedances are generally a result of works being located in close proximity to the adjacent receivers. This modelling has been carried out to provide a worst case scenario and it may be possible to reduce the number of plant operating simultaneously, particularly at night, once detailed construction schedules are known
- > It is generally expected that sleep disturbance criteria are likely to be exceeded unless the proposed number and type of plant are reduced for out of hours works
- > A detailed construction noise and vibration management plan should be prepared for the project prior to construction commencement to incorporate the recommendations detailed in Section 9 and updated to reflect the proposed staging and plant to be adopted for the project.

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APPENDIX A NOISE MONITORING CHARTS











Figure A1 Ambient Noise Levels Measured between 9 and 17 September 2020 at Logger Location 1





A2 Ambient Noise Levels Measured Between 9 and 17 September 2020 at Logger Location 2

Figure

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APPENDIX B ADDITIONAL MITIGATION MEASURES





The range of additional mitigation measures detailed in the CNVS, are itemised below.

Periodic Notification (PN)

A notification entitled 'Project Update' or 'Construction Update' is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website (www.transport.nsw.gov.au).

Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g. traffic changes or noisy works) can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them.

Verification (V)

Routine checks of noise levels or following reasonable complaints. This verification should include measurement of the background noise level and construction noise. Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e. for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e. for specific periods of construction noise).

The purpose of monitoring is to confirm that:

- construction noise and vibration from the project are consistent with the predictions in the noise assessment
- mitigation and management of construction noise and vibration is appropriate for receivers affected by the works

Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended. Refer to Section 8.4 for more details.

Specific notifications (SN)

Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing.

- Letters may be letterbox dropped or hand distributed
- Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs
- Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.

Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.

Respite Offers (RO)

The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre- purchased movie tickets, bowling

activities, meal vouchers or similar offer. This measure is determined on a case-by-case basis, and may not be applicable to all projects.

Alternative Accommodation (AA)

Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.

Alternative Construction Methodology (AC)

Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the works, the proponent will need to consider alternative construction options that achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws.

Respite Period (RP)

OOHW during evening and night periods will be restricted so that receivers are impacted for no more than 3 consecutive evenings and no more than 2 consecutive nights in the same NCA in any one week. A minimum respite period of 4 evenings/5 nights shall be implemented between periods of consecutive evening and/or night works. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol (refer CNVS Section 6). Note; this management measure does not apply to OOHW Period 1 – Days (See Table 1).

Duration Reduction (DR)

Where Respite Periods (see management measure above) are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by-project basis, and may not be applicable to all projects.

Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with IP Community Engagement Representatives.

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APPENDIX C

PREDICTED CONSTRUCTION NOISE IMPACTS – NOISE CONTOUR MAPS







Figure C1 Predicted Construction Noise Stage 1 - Site Establishment & Enabling Work, Ground Level - Standard Hours

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Figure C2 Predicted Construction Noise Stage 2A – Lift 1 - Work, Ground Level – Standard Hours





Figure C3 Predicted Construction Noise Stage 2A – Lift 1 - Work, Ground Level – (OOWH1) Evening



Figure C4 Predicted Construction Noise Stage 2A - Lift 1 - Work, Ground Level - (OOHW2) Night





Figure C5 Predicted Construction Noise Stage 2A - Lift 2 - Work Thompson Lane, Ground Level - Standard Hours





Figure C6 Predicted Construction Noise Stage 2A - Lift 2 - Work Thompson Lane, Ground Level - (OOWH1) Evening




Figure C7 Predicted Construction Noise Stage 2A - Lift 2 - Work Thompson Lane, Ground Level - (OOHW2) Night





Figure C8 Predicted Construction Noise Stage 2B - Platform Works Services, Ground Level - Standard Hours



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Figure C9 Predicted Construction Noise Stage 2B - Platform Works Services, Ground Level - (OOWH1) Evening





Figure C10 Predicted Construction Noise Stage 2B - Platform Works Services, Ground Level - (OOWH2) Night



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Figure C11 Predicted Construction Noise Stage 2B - Platform Works Services Worst Case, Ground Level - Standard Hours





Figure C12 Predicted Construction Noise Stage 2B - Platform Works Services Worst Case, Ground Level - (OOWH1) Evening



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Figure C13 Predicted Construction Noise Stage 2B - Platform Works Services Worst Case, Ground Level - (OOWH2) Night



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Figure C14 Predicted Construction Noise Stage 3 - Station Building Works, Ground Level - Standard Hours



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Figure C15 Predicted Construction Noise Stage 3 - Station Building Works, Ground Level - (OOWH1) Evening



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Figure C16 Predicted Construction Noise Stage 3 - Station Building Works, Ground Level - (OOWH2) Night



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Figure C17 Predicted Construction Noise Stage 4A - Station Building Works - Ramps & Stairs, Ground Level - Standard Hours



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Figure C18 Predicted Construction Noise Stage 4A - Station Building Works - Ramps & Stairs, Ground Level - (OOWH1) Evening



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Figure C19 Predicted Construction Noise Stage 4A - Station Building Works - Ramps & Stairs, Ground Level - (OOWH2) Night



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Figure C20 Predicted Construction Noise Stage 4B - Park Road parking, kiss and ride and pedestrian work, Ground Level - Standard Hours





Figure C21 Predicted Construction Noise Stage 4B - Park Road parking, kiss and ride and pedestrian work, Ground Level - (OOWH1) Evening



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Figure C22 Predicted Construction Noise Stage 4B - Park Road parking, kiss and ride and pedestrian work, Ground Level - (OOWH2) Night



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Figure C23 Predicted Construction Noise Stage 4C - Maclaurin footpath work, Ground Level - Standard Hours



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Figure C24 Predicted Construction Noise Stage 4D – Site demobilization, Ground Level – Standard Hours

