



Transport for NSW
Croydon Station Easy Access Upgrade
Noise and vibration impact assessment

September 2015

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Glossary

Term	Description
Ambient noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Background noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor.
dB	Decibel is the unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dBA	Decibel expressed with the frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at low and high frequencies.
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
EPA	Environment Protection Authority
Groundborne vibration	Groundborne vibration is vibration transmitted from source to receiver via the medium of the ground.
ICNG	<i>Interim Construction Noise Guideline</i> (DECC, 2009).
INP	<i>Industrial Noise Policy</i> (EPA, 2000).
$L_{A90}(\text{period})$	The A-weighted sound pressure level that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90}(15 \text{ min})$.
$L_{Aeq}(\text{period})$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{Amax}(\text{period})$	The maximum sound pressure level over a specified period of time.
Mitigation	Reduction in severity.
Noise sensitive receiver	An area or place potentially affected by noise which includes: <ul style="list-style-type: none"> • a residential dwelling. • an educational institution, library, childcare centre or kindergarten. • a hospital, surgery or other medical institution. • an active (e.g. sports field, golf course) or passive (e.g. national park) recreational area. • commercial or industrial premises. • a place of worship.
Rating Background Level	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes.
RNP	<i>Road Noise Policy</i> (DECCW, 2011).
Tonality	Noise containing a prominent frequency or frequencies characterised by definite pitch.
V_{rms}	The vibration velocity presented as a root mean square value.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

1. Introduction

1.1 Overview

The Transport Access Program (TAP) is an initiative of Transport for NSW (TfNSW) to provide a better experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure where it is needed most.

As part of the program, TfNSW proposes to undertake works at Croydon Station to improve accessibility (Croydon Station Easy Access Upgrade, 'the Proposal'). GHD Pty Ltd (GHD) was commissioned by TfNSW to undertake an operational and construction noise and vibration impact assessment for the Proposal.

Background noise monitoring was undertaken at one location with consideration to the NSW *Industrial Noise Policy* (INP) (EPA, 2000).

The noise and vibration impact assessment has been undertaken with consideration to the following guidelines:

- *Assessing Vibration: a Technical Guideline* (DEC, 2006)
- *Construction Noise Strategy* (CNS) (TfNSW, 2012)
- *Industrial Noise Policy* (INP) (EPA, 2000)
- *Interim Construction Noise Guideline* (ICNG) (DECC, 2009)
- *Road Noise Policy* (RNP) (DECCW, 2011)
- *Sydney Trains Environmental Management System Guide Noise and Vibration from Rail Facilities* (Sydney Trains, 2013).

1.2 Scope

The following tasks were undertaken as part of this noise and vibration impact assessment:

- Site visit to identify surrounding sensitive receivers potentially impacted by construction and operational noise associated with the Croydon Station Easy Access Upgrade
- Assessment of existing background noise levels by undertaking long term noise monitoring at one location representative of the surrounding sensitive receivers for a minimum period of 7 days
- Assessment of potential operational noise impacts in accordance with the INP
- Assessment of potential construction noise impacts in accordance with the ICNG and the CNS
- Assessment of potential construction traffic noise
- Assessment of potential construction vibration
- Providing options for reasonable and feasible noise management measures if required in accordance with the CNS.

2. Existing environment

2.1 Sensitive receivers

Noise and vibration sensitive receivers are defined based on the type of occupancy and the activities performed in the land use. Sensitive noise and vibration receivers could include:

- residences
- educational institutes
- hospitals and medical facilities
- places of worship
- passive and active recreational areas such as parks, sporting fields, golf courses (Note that these recreational areas are only considered sensitive when they are in use or occupied)
- commercial or industrial premises.

The following sensitive receivers and land uses have been identified in close proximity to the Proposal:

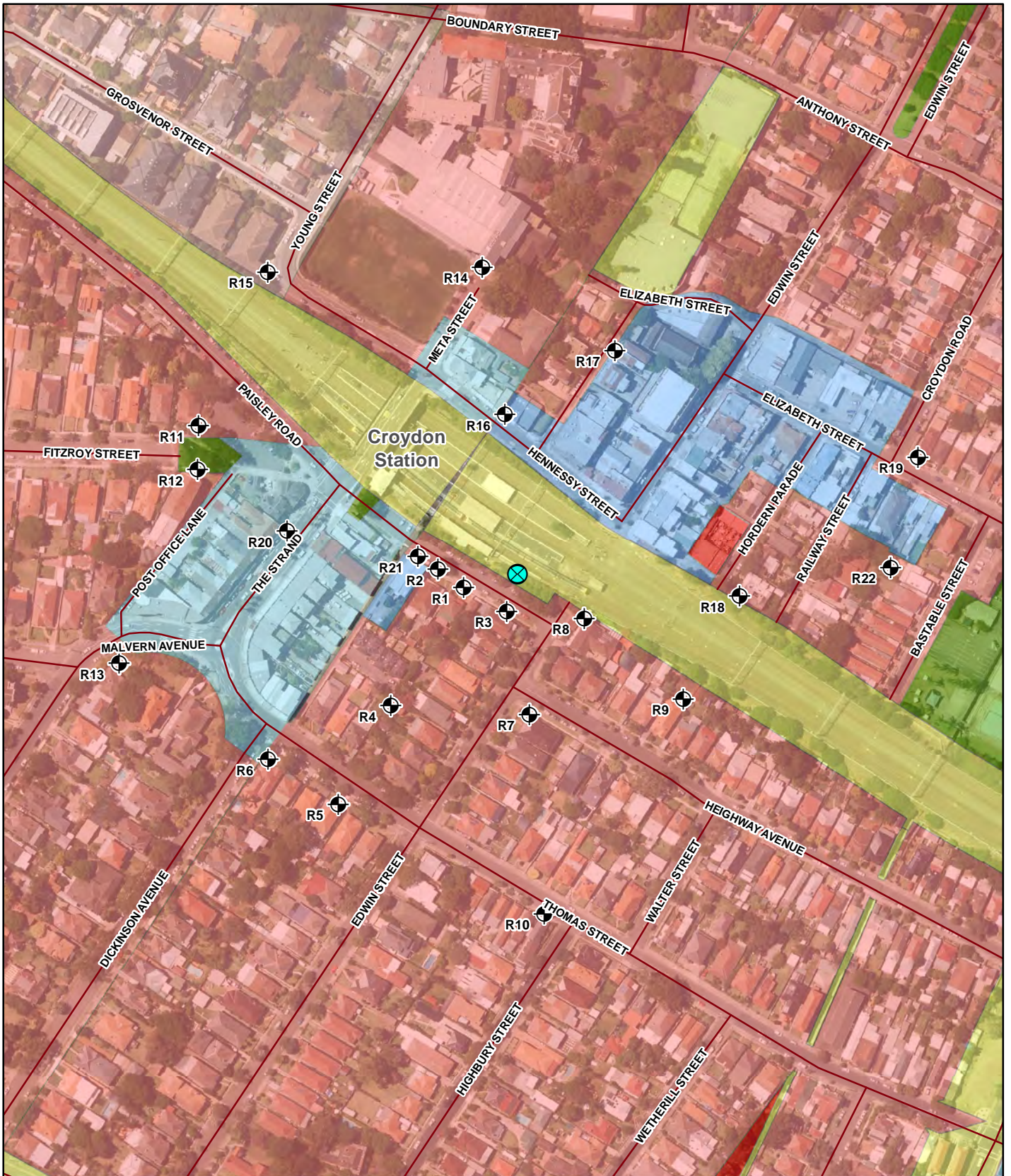
- Residences located along Elizabeth Street, Grosvenor Street, Thomas Street, Malvern Avenue, Fitzroy Street, Paisley Road, Paisley Lane, Edwin Street South, Heighway Avenue, Meta Street, Hennessy Street, College Street, Edwin Street North and Hordern Parade
- The Presbyterian Ladies College north of the site
- The Montessori School at the end of Paisley Road
- The KU Preschool on Railway Parade
- A Croydon Medical Practice located at 8 – 10 Paisley Road and Croydon Medical Centre located at 3 The Strand.

The remaining properties in the area have been identified as commercial premises. Additionally, transient receivers (such as commuters and pedestrians generally transiting along The Strand, Meta Street and Hennessy Street) have the potential to be impacted for short periods from construction noise.









Representative sensitive receivers were selected for modelling and assessment purposes and are detailed in Table 2-1 and shown graphically in Figure 1.

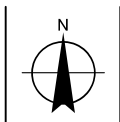
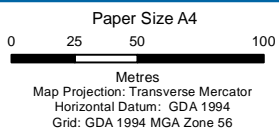
Table 2-1 Representative sensitive receiver locations

Receiver ID	Receiver address	Receiver type
R1	2 Paisley Road	Residential
R2	6 Paisley Road	Residential
R3	48 Edwin Street South	Residential
R4	81 Thomas Street	Residential
R5	110 Thomas Street	Residential
R6	118 Thomas Street	Residential
R7	55 Edwin Street South	Residential
R8	Montessori Academy	Educational institute
R9	85 Heighway Avenue	Residential
R10	94 Thomas Street	Residential
R11	1A Fitzroy Street	Residential
R12	2 Fitzroy Street	Residential
R13	4 Malvern Avenue	Residential
R14	Presbyterian Ladies College	Educational institute
R15	6 Grosvenor Street	Residential
R16	19 Hennessy Street	Residential
R17	15 College Street	Residential
R18	14 Hordern Parade	Residential
R19	213 Elizabeth Street	Residential
R20	Croydon Medical Centre	Health buildings
R21	Croydon Medical Practice	Health buildings
R22	KU Croydon Preschool	Educational institute



Legend

- | | | | | | |
|-------------------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------|--------------------------------|
|  | Sensitive receiver |  | B2, Local Centre |  | R3, Medium Density Residential |
|  | Noise monitoring location |  | R1, General Residential |  | RE1, Public Recreation |
|  | B1, Neighbourhood Centre |  | R2, Low Density Residential |  | SP2, Infrastructure |



Transport for NSW
Croydon Station Easy Access Upgrades

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Noise monitoring location, land use map and representative sensitive receivers

Figure 1

2.2 Background noise monitoring methodology

Noise monitoring was undertaken from 12 November to 19 November 2014 within the railway station boundary (shown in Figure 1), north-west of the corner of Edwin Street South and Paisley Road.

Noise monitoring was undertaken to determine background noise levels for the noise assessment. Monitoring was undertaken at the above location, which was secure from theft and vandalism and considered representative of the ambient environment in the vicinity of the Proposal site.

Noise monitoring was undertaken using a Rion NL-52 environmental noise logger within calibration. The instrument was programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

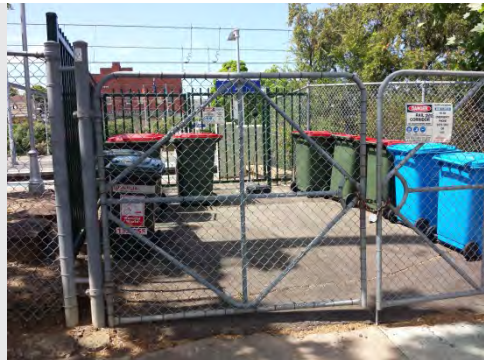
Prior to deployment, a calibration check was performed on the noise monitoring equipment using a sound level calibrator with a sound pressure level of 94 dBA at 1 kHz. At completion of the measurements, the meter's calibration was re-checked to ensure the sensitivity of the noise monitoring equipment had not varied. The noise loggers were found to be within the acceptable tolerance of ± 0.5 dB(A).

The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s, or when rainfall occurred. Meteorological data for the monitoring period was sourced from the nearest Bureau of Meteorology Weather Station to the site, at Canterbury station number 66194, located approximately 3.2 kilometres south of the Proposal site.

2.3 Summary of noise monitoring results

Rating background levels and ambient noise levels are summarised in Table 2-3. Daily noise level charts for the entire monitoring period are presented in Appendix A. A detailed description of the acoustic terms can be found in the glossary at the start of this report.

Table 2-2 Noise monitoring locations and equipment details

Location	Equipment details	Equipment settings	Site photo
Croydon Station on the corner of Edwin Street South and Paisley Road	Rion NL-52 Type 1 SN: 131631	A-weighted Fast time response 15 minute intervals	

The ambient noise levels are typical of an urban area influenced by rail noise. Intermittent noise sources such as rail movements are generally filtered out of the rating background levels as this is described by the 90th percentile $L_{A90(15min)}$.

Table 2-3 Summary of noise monitoring results, **dBA**

Date	Rating background level	90 th percentile	$L_{A90(15min)}$	Ambient noise levels, $L_{Aeq(Period)}$		
	Day	Evening	Night	Day	Evening	Night
Wednesday 12-Nov-2014	47	41	33	61	60	56
Thursday 13-Nov-2014	47	44	35	61	60	56
Friday 14-Nov-2014	44	45	35	61	60	57
Saturday 15-Nov-2014	44	40	34	59	57	65
Sunday 16-Nov-2014	- ¹	41	34	- ¹	57	55
Monday 17-Nov-2014	44	41	31	61	61	56
Tuesday 18-Nov-2014	46	42	33	59	59	56
RBL / Average	45	41	34	61	59	59

Note 1: '-' indicates data excluded due to adverse weather or extraneous conditions

Note 2: INP defines day, evening and night time periods as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.
- Night: the remaining period.

3. Compliance criteria

The noise and vibration compliance criteria during operation and construction of the Proposal are presented in the following section as follows:

- Construction noise criteria (Section 3.1)
- Construction vibration criteria (Section 3.2)
- Operational noise criteria (Section 3.3).

3.1 Construction noise criteria

3.1.1 Construction noise management levels

The ICNG outlines standard hours for construction activities as Monday to Friday: 7 am to 6 pm, Saturday: 8 am to 1 pm and no work on Sundays or public holidays. The ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
- works which maintain noise levels at receivers to below the noise management levels outside of the recommended standard construction hours.

The CNS separates out of hours works (OOHW) into two periods:

- OOHW Period 1: Monday to Friday 6 pm to 10 pm, Saturday 7 am to 8 am and 1 pm to 10 pm and Sunday/Public Holidays 8 am to 6 pm
- OOHW Period 2: Monday to Friday 10 pm to 7 am, Saturday 10 pm to 8 am and Sunday/Public Holidays 6 pm to 7 am.

It is anticipated that some construction activities would be required to be undertaken during OOHW Period 1 and OOHW Period 2. These would be classified as works *where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours* due to the busy nature of the railway station and the limitations of undertaking various construction activities in a live rail environment (i.e. need to undertake works during possession periods for safety and other operational reasons).

Table 3-1 and Table 3-2 detail the ICNG construction noise management levels at sensitive land uses and residences near the Proposal, respectively, where:

- The noise affected noise management level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details

- 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.

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 dBA above the noise affected level, the proponent should consult with the community.

For transient receivers, the external noise level of 75 dBA could be considered acceptable as the receiver would be exposed to the noise source for a short duration.

Table 3-1 Construction noise management levels at residences

Time of day	Management level $L_{Aeq(15min)}$
Recommended standard hours: <ul style="list-style-type: none"> • Monday to Friday 7 am to 6 pm • Saturday 8 am to 1 pm • No work on Sundays or public holidays 	Noise affected Rating background level plus 10 dBA
	Highly noise affected 75 dBA
Outside recommended standard hours	Noise affected Rating background level plus 5 dBA

Table 3-2 Construction noise management levels at sensitive land uses

Land use	Management level, $L_{Aeq(15min)}$ (when in use)
Industrial premises	External noise level 75 dBA
Offices and retail outlets	External noise level 70 dBA
Classrooms at schools and educational institutes	Internal noise level 45 dBA
Health buildings ¹	Internal noise level 45 to 50 dBA

Note 1: Based on AS2107:2000 maximum internal levels for waiting rooms, reception areas and consulting rooms.

3.1.2 Sleep disturbance criteria during construction

The ICNG states that where construction works are planned to extend over more than two consecutive nights, the noise impact assessment should include maximum noise levels and the extent and number of times the maximum exceeds the rating background levels.

The INP application notes regarding sleep disturbance recommend that where the $L_{A1(1min)}$ or L_{Amax} exceeds the $L_{A90(15min)}$ by more than 15 dBA outside the bedroom window, a more detailed analysis is required.

The ICNG also refers to the *Environmental Criteria for Road Traffic Noise* (EPA, 1999) for more guidance on sleep disturbance from maximum noise level events. This guideline has since been superseded by the *Road Noise Policy*. Both guidelines provide a discussion on research into the effects of maximum noise events on sleep disturbance. The results of this research is aimed at limiting the level of sleep disturbance due to environmental noise and concludes that the L_{Amax} or $L_{A1(1min)}$ level of any noise should not exceed the ambient $L_{A90(15min)}$ noise level by more than 15 dB(A). This guideline takes into account the emergence of noise events, but does not directly limit the number of such events or their highest level, which are also found to affect sleep disturbance.

The *Road Noise Policy* provides further guidance, which indicates that:

- maximum internal noise levels below 50–55 dBA are unlikely to cause awakening reactions
- one or two noise events per night with maximum internal noise levels of 65–70 dBA are not likely to significantly affect health and wellbeing.

For this assessment the background level plus 15 dBA has been used as a screening level assessment of sleep disturbance which is consistent with the *Industrial Noise Policy* (application notes and the *Sydney Trains Environmental Management System Guide Noise and Vibration from Rail Facilities* (refer to Table 3-3).

3.1.3 Proposal specific construction noise criteria

The construction noise criteria for the proposed construction activities during recommended standard hours and outside of the recommended standard hours are provided in Table 3-3 for each sensitive receiver and are based on, Table 3-1, Table 3-2 and the *Sydney Trains Environmental Management System Guide Noise and Vibration from Rail Facilities* (Sydney Trains, 2013) guidance on sleep disturbance.

Table 3-3 Proposal specific construction noise criteria, **dBA**

Receiver	Construction,	noise	management	level,	L _{Aeq(15min)}	Sleep disturbance screening test L _{Amax} (external)
	During recommended	standard hours ¹	Outside of hours	standard	recommended	
	7 am to 6 pm Monday to Friday, 8 am to 1 pm Saturday, no work on Sunday or public holidays		Day 7 am to 8 am and 1 pm to 6 pm Saturday, 8 am to 6 pm Sunday & Public Holidays	Evening 6 pm to 10 pm Monday to Sunday & Public Holidays	Night 10 pm to 7 am, Monday to Saturday; 10 pm to 8 am Sunday & Public Holidays	Night 10 pm to 7 am, Monday to Saturday; 10 pm to 8 am Sunday & Public Holidays
	Noise affected	Highly noise affected				
Commercial receivers	70	-	-	-	-	-
Croydon Medical Centre and Croydon Medical Practice ¹	55 – 60					
Classrooms at the Presbyterian Ladies College, Montessori Academy and KU Croydon Preschool ¹	55	-	-	-	-	-

Note 1: A 10 dBA noise reduction is assumed from outside to inside the building

3.1.4 Traffic noise criteria

The application notes for the *Road Noise Policy* (DECCW 2011) 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 above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dBA of, or exceeds, the relevant day or night noise assessment criterion.”

This has been used to identify potential impacts as a result of noise produced by construction traffic and the potential for reasonable and feasible mitigation measures to be applied. If road traffic noise increases as a result of construction work and lies within 2 dBA of current levels then the objectives of the *Road Noise Policy* (DECCW 2011) are considered to be met and no specific mitigation measures would be required.

3.2 Construction vibration criteria

3.2.1 Human comfort

Vibration has been assessed based on the criteria in *Assessing Vibration: a technical guideline. British Standard (BS) 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)* is recognised by the guideline as the preferred standard for assessing the ‘human comfort criteria’.

Typically, construction activities generate ground vibration of an intermittent nature. Intermittent vibration is assessed using the vibration dose value. Acceptable values of vibration dose are presented in Table 3-4 for sensitive receivers.

Whilst the assessment of response to vibration in *BS 6472-1:1992* is based on vibration dose value and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of a peak value, since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in *BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration*, as shown below in Table 3-5.

Table 3-4 Human comfort intermittent vibration limits (BS 6472-1992)

Receiver type	Period ¹	Intermittent vibration dose value (m/s ^{1.75})	
		Preferred value	Maximum value
Residential	Day	0.2	0.4
	Night	0.13	0.26
Educational institutes	When in use	0.4	0.8

Note 1: Day is between 7 am and 10 pm and night is between 10 pm and 7 am

Table 3-5 Guidance on effects of vibration levels for human comfort (BS 5228.2 – 2009)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

3.2.2 Cosmetic damage

The *Construction noise strategy* refers to *BS 7385 Part 2– 1993 Evaluation and measurement for vibration in buildings Part 2* to assess the effects of transient vibration on structures. The BS 7385 values are presented in Table 3-6.

Table 3-6 Transient vibration guide values – minimal risk of cosmetic damage (BS 7385-2)

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings.	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures. Residential or light commercial type buildings.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

The conservative cosmetic damage value of 15 mm/s has been used in this assessment, where data is not provided in the CNS.

Guidance of limiting vibration values for heritage structures, or other structures particularly sensitive to vibration, is attained with reference to German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures* (refer to Table 3-7). The conservative value of 3 mm/s presented in the 1 Hz to 10 Hz range has been used to derive the safe working distances for heritage structures in this assessment. Note that safe working distances are not provided in the CNS for heritage structures.

Table 3-7 Guideline values for short term vibration on structures (DIN 4150-3) used for heritage structures

Type of structure	Guideline values for velocity, (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz ¹
Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy.	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (for example heritage listed buildings).	3	3 to 8	8 to 10

3.3 Operational noise criteria

The INP provides guidance on the assessment of operational noise impacts. The guidelines include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver.

The intrusive noise criteria controls the relative audibility of operational noise compared to the background level at residential receivers. The intrusive criteria are determined by a 5 dBA addition to the measured (or adopted) background level with a minimum of 35 dB(A). The INP recommends that the intrusive noise criteria for the evening period should not exceed the daytime period and the night-time period should not exceed the evening period. The intrusive noise criteria are only applicable to residential receivers.

The amenity criteria limits the total level of extraneous noise for all receiver types. The amenity criteria are determined based on the overall acoustic characteristics of the receiver area, the receiver type and the existing level of noise from commercial or industry in the area. Amenity criteria are also provided for residential receiver areas and other sensitive land uses such as schools, hospitals, places of worship and recreational areas.

Both the intrusive and amenity criteria are calculated and, in the case of continuous noise sources, the lower of the two in each time period (day, evening and night) normally apply.

3.3.1 Proposal specific operational noise criteria

The operational noise criteria for sensitive receivers within proximity to the Proposal are summarised in Table 3-8.

Table 3-8 Proposal specific operational noise criteria

Receiver	Time period ²	Amenity criteria (acceptable noise level) ¹ $L_{Aeq(period)}$	RBL, $L_{Aeq(15min)}$	Intrusive criteria, $L_{Aeq(15min)}$	Proposal specific noise criteria (external)
Residential receivers	Day	60	45	50	50 $L_{Aeq(15min)}$
	Evening	50	41	46	46 $L_{Aeq(evening)}$
	Night	45	34	39	39 $L_{Aeq(night)}$
Commercial receivers	When in use	65	-	-	65 $L_{Aeq(period)}$
School classroom	When in use	35 (internal)	-	-	45³ $L_{Aeq(1hr)}$
Health buildings ⁴	When in use	40 (internal) to 45 internal	-	-	50-55³ $L_{Aeq(period)}$

Note 1: With consideration to the INP, 'noise amenity area' classification, the residential receivers surrounding the Proposal site have been classified as 'urban'.

Note 2: The INP defines day, evening and night time periods as:

Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.

Evening: the period from 6 pm to 10 pm.

Night: the remaining period.

Note 3: A 10 dBA noise reduction is assumed from outside to inside the building for the educational facilities

Note 4: Based on AS2107:2000 maximum internal levels for waiting rooms, reception areas and consulting rooms.

4. Assessment of noise and vibration impacts

4.1 Construction noise

4.1.1 Construction noise modelling methodology

The provided construction stages, proposed equipment and time periods are summarised in Appendix B for indicative construction scenarios S1 to S15. Construction scenarios have been created based on construction equipment likely to be operating for the relevant construction activities. Noise levels for equipment have been obtained from *AS2436 – 2010 Guide to noise and vibration control on construction, demolition and maintenance sites* unless otherwise stated and are provided in Table 4-1. Other equipment than that modelled may be used, however it is anticipated that they would produce similar noise emissions.

It is estimated that the work would take two years and would likely utilise 14-18 weekend track possessions.

For each construction scenario, the noise levels at the modelled sensitive receivers in the vicinity of the Proposal have been predicted.

Noise modelling was undertaken using SoundPlan (v7.3). SoundPlan is a computer program for the calculation, assessment and prognosis of noise exposure. SoundPlan calculates environmental noise propagation according to *ISO 9613-2 'Acoustics – Attenuation of sound during propagation outdoors'*.

The following noise modelling assumptions were made:

- surrounding land was modelled assuming a mixture of hard and soft ground with a ground absorption coefficient of 0.5
- atmospheric absorption was based on an average temperature of 10 °C and an average humidity of 70%
- atmospheric propagation conditions were modelled with noise enhancing wind conditions for noise propagation (downwind conditions) or equivalently a well-developed moderate ground based temperature inversions
- modelled scenarios take into account the shielding effect from surrounding buildings and structures on and adjacent to the site. Attenuation from built up areas was included away from the site
- noise sources were modelled assuming noise propagation in the 500 Hz octave band frequency as per *ISO 9613-2*
- noise sources for each scenario are in some cases modelled at different locations. As such the noise modelling assesses the noise source at multiple locations and takes the maximum L_{Aeq} received noise level
- besides the generators it is assumed that each item of equipment would operate simultaneously on average for 20% of the time during each 15 minute period.

Additionally, the magnitude of off-site noise impact will be dependent upon a number of factors including the intensity and location of activities, the type of equipment used, the background noise levels during the construction period and the prevailing weather conditions.

Table 4-1 Construction equipment noise levels

Equipment	Adopted sound power level, dBA	Data source
Truck	107	AS2436 – 2010
Generator with acoustic enclosure	89	AS2436 – 2010 with acoustic enclosure.
Excavator (small)	100	AS2436 – 2010
Excavator (medium)	107	AS2436 – 2010
Excavator with rock breaker	123 ¹	AS2436 – 2010
Excavator with auger (small)	111	AS2436 – 2010 based on bored piling
Jack hammer	126 ¹	AS2436 – 2010
Concrete saw	122 ¹	AS2436 – 2010
Manitou	106	AS2436 – 2010 based on a forklift
Crane	105	AS2436 – 2010
Scissor lift	105	AS2436 – 2010 based on a cherry picker
Elevated working platform	105	AS2436 – 2010 based on a cherry picker
Concrete pump and truck	108	AS2436 – 2010
Concrete vibrator	103	AS2436 – 2010
Power float (for smoothing concrete)	111	Based on 5.5hp motor
Hand tools (electric)	102	AS2436 – 2010
Hand tools (pneumatic)	116	AS2436 – 2010
Piling rig (bored)	111	AS2436 – 2010
Drill (coring)	113	AS2436 – 2010 based on a hydraulic drill
Under bore drill rig	113	AS2436 – 2010 based on a hydraulic drill
Wacker compactor	113 ¹	Based on Wacker technical data sheet
Roller (vibratory)	108 ¹	AS2436 – 2010
Dump truck (dumping fill)	117	AS2436 – 2010
Mulcher	115	<i>Noise emissions and exposure from mobile woodchippers</i> (HSE, 2008)
Chainsaw	105	Based on 2.5 kW chainsaw

Note 1: The ICNG considers some activities to be particularly annoying to residents, such as jackhammering, concrete sawing, rock breaking, compacting and vibratory rolling. Hence, a +5 dBA modifying factor adjustment has been applied.

4.1.2 Construction noise impacts

Table 4-2 and Table 4-3 outline construction noise levels during standard construction hours and outside of standard construction hours at modelled sensitive receivers for each construction scenario. The cells have been shaded (as per the key) where the noise management levels for each time period are exceeded. Impacts to sensitive receivers have the potential to occur where sensitive receivers experience noise higher than the relevant construction noise management level.

During standard recommended hours the noise affected construction noise management level of 55 dBA is predicted to be exceeded. During standard recommended hours noise levels are predicted to exceed the highly noise affected construction noise management level of 75 dBA at residential receivers on Hennessy Street, Paisley Road and Edwin Street South. This level of noise is mainly attributed to use of the mulcher, jack hammer, concrete saw, rock breaker, compactor or other equipment used in very close proximity to the receiver, such as the road works at the end of Paisley Road.

Noise levels are also predicted to exceed the noise affected construction noise management level of 70 dBA at commercial receivers directly adjacent to the works along Paisley Road and Hennessy Street.

Some activities have the potential to be undertaken outside of standard hours during weekend day / evening possessions (classified by the CNS as out of hours work (OOHW) period 1) and night time possessions (classified by the CNS as out of hours work (OOHW) period 2). Activities during OOHW period 1 and period 2 are predicted to exceed the construction noise management levels. Activities during OOHW period 2 are also likely to exceed the sleep disturbance screening level of 49 dBA. The use of noisy equipment should be minimised during the night time period.

Further details of the recommended noise mitigation measures, and noise management zones to manage these impacts are detailed in Section 5.1.

Table 4-2 Predicted construction noise levels at representative sensitive receivers during standard construction hours, dBA

Exceedence to noise management level cell shading key															
75 dBA highly noise affected level															
55 dBA during standard construction hours															

Receiver ID	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
R1	73	75	58	n/a	n/a	75	65	61	n/a	n/a	n/a	71	60	72	73
R2	69	77	60	n/a	n/a	79	68	63	n/a	n/a	n/a	73	62	79	72
R3	70	77	55	n/a	n/a	72	62	58	n/a	n/a	n/a	68	57	65	73
R4	55	57	54	n/a	n/a	67	57	53	n/a	n/a	n/a	65	50	59	58
R5	50	53	51	n/a	n/a	63	54	50	n/a	n/a	n/a	62	48	54	54
R6	50	52	52	n/a	n/a	63	55	51	n/a	n/a	n/a	62	49	54	54
R7	58	60	52	n/a	n/a	66	57	54	n/a	n/a	n/a	64	52	58	60
R8 ¹	71	66	53	n/a	n/a	69	59	56	n/a	n/a	n/a	66	55	60	66
R9	55	56	49	n/a	n/a	64	54	52	n/a	n/a	n/a	62	42	54	57
R10	49	51	47	n/a	n/a	61	52	49	n/a	n/a	n/a	59	47	51	52
R11	49	53	57	n/a	n/a	68	60	56	n/a	n/a	n/a	68	57	58	58
R12	49	52	58	n/a	n/a	67	60	56	n/a	n/a	n/a	68	54	59	58
R13	48	50	52	n/a	n/a	62	53	50	n/a	n/a	n/a	61	48	54	52
R14 ¹	50	55	54	n/a	n/a	67	60	56	n/a	n/a	n/a	67	56	60	60

Receiver ID	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
R15	48	51	56	n/a	n/a	67	60	56	n/a	n/a	n/a	68	56	56	58
R16	57	71	61	n/a	n/a	76	69	66	n/a	n/a	n/a	74	63	81	79
R17	53	58	52	n/a	n/a	67	58	55	n/a	n/a	n/a	65	54	60	61
R18	55	53	49	n/a	n/a	63	55	52	n/a	n/a	n/a	62	40	55	58
R19	48	47	38	n/a	n/a	49	41	38	n/a	n/a	n/a	49	38	41	50
R20 ¹	54	57	64	n/a	n/a	71	62	61	n/a	n/a	n/a	71	57	65	62
R21 ¹	65	74	62	n/a	n/a	82	69	64	n/a	n/a	n/a	74	63	79	74
R22 ¹	49	49	41	n/a	n/a	49	42	39	n/a	n/a	n/a	51	37	49	51

Note 1: 55 dBA external noise management level applies to receiver R8, R14, R20, R21 and R22 when in use.

Table 4-3 Predicted construction noise levels at representative sensitive receivers outside of standard construction hours, dBA

Exceedence to noise management level cell shading key															
50 dBA during the day time (OOHW) Period 1															
46 dBA during the evening (OOHW) Period 1 and 2															
39 dBA during the night (OOHW) Period 2															

Receiver ID	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
R1	73	n/a	n/a	68	73	75	65	61	59	61	75	71	60	n/a	73
R2	69	n/a	n/a	65	69	79	68	63	61	64	75	73	62	n/a	72
R3	70	n/a	n/a	66	73	72	62	58	56	59	76	68	57	n/a	73
R4	55	n/a	n/a	54	56	67	57	53	53	54	64	65	50	n/a	58
R5	50	n/a	n/a	50	51	63	54	50	50	51	60	62	48	n/a	54
R6	50	n/a	n/a	49	51	63	55	51	51	52	60	62	49	n/a	54
R7	58	n/a	n/a	55	59	66	57	54	52	55	67	64	52	n/a	60
R8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R9	55	n/a	n/a	52	56	64	54	52	50	53	64	62	42	n/a	57
R10	49	n/a	n/a	48	50	61	52	49	48	50	59	59	47	n/a	52
R11	49	n/a	n/a	49	50	68	60	56	57	58	63	68	57	n/a	58
R12	49	n/a	n/a	49	50	67	60	56	57	57	62	68	54	n/a	58
R13	48	n/a	n/a	47	48	62	53	50	51	52	58	61	48	n/a	52

Receiver ID	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
R14	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R15	48	n/a	n/a	48	49	67	60	56	57	58	63	68	56	n/a	58
R16	57	n/a	n/a	62	59	76	69	66	64	67	77	74	63	n/a	79
R17	53	n/a	n/a	55	54	67	58	55	55	56	66	65	54	n/a	61
R18	55	n/a	n/a	52	56	63	55	52	50	53	65	62	40	n/a	58
R19	48	n/a	n/a	46	49	49	41	38	38	39	58	49	38	n/a	50
R20	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R21	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R22	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Note: Where activities are scheduled potentially during both OOHW Period 1 and Period 2, if noise levels are predicted to exceed the Period 1 criteria, they will automatically exceed the OOHW Period 2 criteria.

4.2 Construction traffic

A significant increase in traffic volumes would be needed in order to increase road traffic noise by 2 dBA (a doubling in traffic corresponds to an approximate 3 dBA increase). It is estimated that the daily vehicle movements would not be significant when compared with the existing vehicle numbers in the area. As a result, no impacts from construction traffic movements are expected.

4.3 Construction vibration

Table 4-4 outlines typical vibration levels for vibration generating equipment associated with the Proposal construction. Potential vibration impacts would be limited to the construction period.

Table 4-4 Typical vibration levels – construction equipment

Item	Peak particle velocity	Data source
Vibratory roller (7-13 tonne)	7 to 8 mm/s at 10 m	Calculated based on <i>Construction Noise Strategy</i>
Vibratory roller (4-6 tonnes)	5-6 mm/s at 10 m	Calculated based on <i>Construction Noise Strategy</i>
Vibratory roller (2-4 tonne)	2 to 4 mm/s at 10 m	Calculated based on <i>Construction Noise Strategy</i>
Vibratory roller (1-2 tonne)	1 to 3 mm/s at 10 m	Calculated based on <i>Construction Noise Strategy</i>
Wacker compactor	1 to 3 mm/s at 10 m	No source data available however assumed similar to a small roller
Pavement or rock breaking using a hydraulic hammer (300 kg hydraulic hammer)	1 mm/s at 10 m	Calculated based on <i>Construction Noise Strategy</i>
Jackhammer	0.5 mm/s at 10 m	<i>Environmental Noise Management Manual (RTA, 2001)</i>
Piling (bored)	0.5 mm/s at 10 m	Calculated based on <i>Construction Noise Strategy</i>

4.3.1 Construction vibration impacts

Energy from equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- the efficiency of the energy transfer mechanism of the equipment (i.e impulsive; reciprocating, rolling or rotating equipment)
- the frequency content
- the impact medium stiffness
- the type of wave (surface or body)
- the ground type and topography.

Safe working buffer distances to comply with the human comfort, cosmetic damage and heritage structural damage criteria were calculated for typical vibration values listed in Table 4-4 and are presented in Table 4-5 unless specifically provided in the CNS.

Table 4-5 Vibration safe working buffer distances, m

Activity ¹	Human comfort	Structural damage	
		Heritage building/structure	Standard dwellings
Vibratory roller (7-13 tonnes)	100 m	30 m	15 m
Vibratory roller (4-6 tonnes)	40 m	24 m	12 m
Vibratory roller (2-4 tonnes)	20 m	12 m	6 m
Vibratory roller (1-2 tonnes)	15 m	10 m	5 m
Wacker packer	15 m	10 m	5 m
Small hydraulic hammer	7 m	4 m	2 m
Jackhammer	Avoid contact with structure	2 m (nominal)	1 m (nominal)
Piling (bored) ¹	-	4 m (nominal)	2 m (nominal)

Note 1: These distances have been sourced from the *Construction Noise Strategy* (TfNSW, 2012)

Structural damage

With consideration to the building damage criteria for typical buildings, the expected magnitude of ground vibrations should not be sufficient to cause damage to buildings within 15 metres of the works however will depend on the size of equipment used. If smaller equipment or work methods that don't generate significant vibration emissions are used such as a 2 tonne vibratory roller, non-vibratory rollers, small sized hydraulic hammers or jack hammer then the building damage buffer distance would be reduced significantly.

It is also noted that Croydon Station and the adjacent Meta Street road bridge is heritage listed and the existing buildings within the station area not being demolished should be treated as heritage structures. At this stage of the project equipment selection is not known, however with heritage structures within the Croydon Station site, smaller equipment needs to be considered. It is recommended that smaller equipment (such as vibratory rollers less than 4 tonnes) and work methods that produce lower vibration emissions be considered, where feasible and reasonable, when work is required within the structural damage safe working buffer distances listed in Table 4-5. If no alternative work method is feasible or reasonable then additional mitigation measures as detailed in Section 5.2 should be undertaken which would include attended vibration monitoring, trigger warnings and condition reports.

Human comfort

There is potential for some human comfort impacts at sensitive receivers and would depend on the equipment used.

Human comfort impacts would be limited to commercial properties located adjacent to the station along Hennessy Street and Paisley Road if a 7-13 tonne vibratory roller is used. Human comfort impacts for other equipment are expected to be limited to transient commuters/pedestrians in and around the station.

All potentially impacted receivers within the safe working buffer distances should be informed of the nature of the works, expected vibration levels, duration of works and a method of contact to raise vibration complaints.

4.4 Operational noise

Current operational noise sources on the railway station include:

- Public address systems
- Mechanical plant
- Commuter speech/travel
- Trains accelerating and decelerating into and out of the station.

Additional operational equipment on the station would include the new lifts and a new padmount substation (to replace the existing) which would not produce significant noise emissions. The operational noise environment is expected to remain largely unchanged however it is assumed at detailed design appropriate selection of mechanical plant and adjustments to the PA system should be undertaken to comply with Sydney Trains speech intelligibility requirements and the operational noise criteria provided in Table 3-8.

The car park has been reconfigured and the total number of spaces has been reduced by approximately 3, however a noise assessment has been undertaken to confirm the operation of the car park complies with the operational noise criteria. The proposed at-grade car park will have 8 parking spaces and 3 kiss and ride spaces where vehicles would access via Paisley Road off Meta Street and has been considered in this assessment.

4.4.1 Modelling methodology

Noise modelling was undertaken using CadnaA version 4.3 to predict noise from the re-configured at-grade car park. The following noise modelling assumptions (which vary from the construction noise model) were made:

- noise from the car park has been modelled in accordance with *Recommendations for the calculation of sound emissions of parking areas, motorcar centers and bus stations as well as of multi-storey car parks and underground car parks 6th Edition* (Bavarian Landesamt für Umwelt 2007)
- 8 parking spaces and 3 kiss and ride spaces have been included in the noise model with asphalt surface modelled with a high volume turnover.

4.4.2 Operational noise impacts

Operational noise levels have been predicted for the re-configured car park. The number of parking spaces has been reduced by approximately 3, however a noise assessment has been undertaken to confirm that the operation of the car part complies with the operational noise criteria.

The predicted noise levels are provided in Table 4-6, Figure 2 and Figure 3 for the day and night time period. Note the evening noise contours are the same as the day noise contours. Noise levels are predicted to comply with the operational noise criteria at all time periods at all sensitive receivers.

Additional traffic on the local road network due to the car park would produce an insignificant increase in noise levels (well below 2 dBA). As such additional traffic generation from the Proposal is not expected to impact on nearby sensitive receivers.

Table 4-6 Predicted operational noise levels, **dB(A)**

Receiver ID	Noise criteria (external)	Car park noise levels	
	Day / Evening Night	L _{Aeq} Day / Evening	L _{Aeq} Night
R01	LAeq 50 dBA Day LAeq 46 dBA Evening LAeq 39 dBA Night	29	22
R02		42	35
R03		21	14
R04		0	0
R05		0	0
R06		0	0
R07		2	0
R08		17	10
R09		3	0
R19		0	0
R11		16	9
R12		2	0
R13		0	0
R14		13	6
R15		14	7
R16		20	13
R17		14	7
R18		10	3
R19		1	0
R20		19	12
R21		43	36
R22		6	0

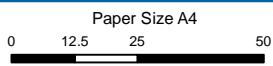
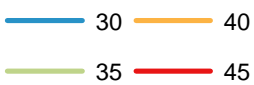
Note : The time periods are defined by the INP as:

- Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
- Evening: the period from 6 pm to 10 pm.

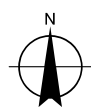
Night: the remaining period.



Sound pressure level, dBA



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



Transport for NSW
Croydon Station Easy Access Upgrade

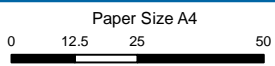
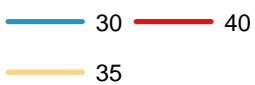
Job Number | 21-24130
Revision | A
Date | 17 Sep 2015

Predicted carpark operational
noise levels, LAeq Day / Evening, dBA

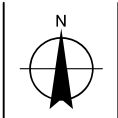
Figure 2



Sound pressure level, dBA



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



Transport for NSW
Croydon Station Easy Access Upgrade

Job Number | 21-24130
Revision | A
Date | 17 Sep 2015

Predicted carpark operational
noise levels, LAeq Night, dBA

Figure 3

5. Mitigation measures

5.1 Construction noise

As discussed in the noise impact assessment (Section 4.1), construction activities have the potential to cause adverse noise impact on surrounding sensitive receivers.

It is recommended that the following CNS standard noise mitigation measures be implemented where feasible and reasonable and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and provided a point of contact.

Table 5-1 Standard mitigation measures for construction noise and vibration

Action required	Details
Management measures	
Implement community consultation measures	<ul style="list-style-type: none"> ▶ periodic notification (letterbox drop or equivalent) ▶ website ▶ project info-line ▶ construction response line ▶ email distribution list ▶ community based forums (if required by approval conditions)
Site inductions	<p>All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include:</p> <ul style="list-style-type: none"> ▶ all relevant project specific and standard noise and vibration mitigation measures ▶ relevant licence and approval conditions ▶ permissible hours of work ▶ any limitations on high noise generating activities ▶ location of nearest sensitive receivers ▶ construction employee parking areas ▶ designated loading/ unloading areas and procedures ▶ construction traffic routes ▶ site opening/closing times (including deliveries) ▶ environmental incident procedures
Behavioural practices	<p>No swearing or unnecessary shouting or loud stereos/radios on site.</p> <p>No dropping of materials from height, throwing of metal items and slamming of doors.</p>
Monitoring	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurement	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Source controls	
Construction hours and scheduling	<p>Where reasonable and feasible, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.</p> <p>Further to this, It is recommended that the use of mulchers, jack hammers, concrete saws, rock breakers, compaction or other equipment used in very close proximity to the receivers should be limited where feasible and reasonable to the standard construction hours.</p>

Action required	Details
Construction respite period	<p>If highly noise affected impacts are predicted high noise and vibration generating activities may only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block.</p> <p>If highly noise affected impacts are predicted no more than four consecutive nights of high noise and/or vibration generating work may be undertaken over any seven day period, unless otherwise approved by the relevant authority.</p>
Equipment selection	Use quieter and less vibration emitting construction methods where reasonable and feasible.
Maximum noise levels	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria listed in Table 2 of the <i>Construction Noise Strategy</i> .
Rental plant and equipment	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 <i>Construction Noise Strategy</i> .
Use and siting of plant	<p>Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided.</p> <p>The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.</p> <p>Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.</p>
Plan worksites and activities to minimise noise and vibration	Plan traffic flow, parking and loading/ unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	<p>Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers.</p> <p>Select site access points and roads as far as possible away from sensitive receivers.</p> <p>Dedicated loading/unloading areas to be shielded if close to sensitive receivers.</p> <p>Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.</p>
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when siting plant.

Due to the highly variable nature of the activities and the potential for work to be undertaken outside the standard construction hours, the Proposal's noise management levels are likely to be exceeded at times. Consultation and cooperation with the neighbours of the site will assist in minimising uncertainty, misconceptions and adverse reactions to noise.

In circumstances where the noise levels are predicted to exceed construction noise management levels after implementation of the general work practices, the relevant additional mitigation measures detailed in Table 5-2 should be considered. Based on the predicted noise levels, additional mitigation measures are likely to be required for works during standard construction hours and any activities outside of standard construction hours. The noise management zones show the additional mitigation measures recommended by the CNS. Noise management zones have been calculated for each scenario showing the recommended additional mitigation measure for each time period. Noise management zones are shown in Figure 4 to Figure 18 and are shown for distances up to 1500 m from the site as it is assumed distances greater than this would not be feasible or reasonable to implement in practice.

Table 5-2 Additional mitigation measures

Criteria	Time period	L _{Aeq(15 min)}	noise level	above rating	background level
		0 to 10 dBA	10 to 20 dBA	20 to 30 dBA	>30 dBA
		Noticeable	Clearly audible	Moderately intrusive	Highly intrusive
Standard	Weekday (7 am– 6 pm)	-	-	LB, M	LB, M
	Saturday (8 am – 1 pm)	-	-	-	-
OOHW Period 1	Weekday (6 pm–10 pm)	-	LB	M, LB	M, IB, LB, PC, SN
	Saturday (1 pm – 10 pm)	-	-	-	-
	Sunday (8 am – 6 pm)	-	-	-	-
OOHW Period 2	Weekday (10 pm–7 am)	LB ¹	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN
	Saturday (10 pm – 8 am)	-	-	-	-
	Sunday (6 pm – 7 am)	-	-	-	-

Monitoring (M): Compliance noise monitoring

Individual Briefings (IB): Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the Proposal.

Letter box drops (LB): Letter box drops or media advertisements.

Phone Calls (PC): Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs.

Specific Notifications (SN): Specific notifications are letterboxed or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications.

Alternative accommodation (AA): Alternative accommodation options would be offered to residents.

Note 1: The minimum level was set at the ICNG background + 5 dBA criteria for determining the noise management zones

Source: *Construction Noise Strategy (Rail Projects)*, (TfNSW, 2012)

5.2 Construction vibration

Where construction is required within the safe working buffer distance and alternative work methods such as smaller equipment should be considered. If no alternative work method is feasible or reasonable then compliance vibration monitoring should be undertaken where works are required within the safe working buffer distances and include:

- Site tests to review of the measured frequency content to determine the structural damage criteria as per Table 3-6 for standard dwellings and Table 3-7 for heritage structures
- Continuous vibration monitoring with a visual alarm installed to warn the equipment operator when the structural damage vibration criteria (considering frequency content) is exceeded
- A dilapidation / condition report before and after construction activities.

5.3 Operational noise

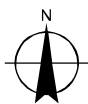
Operational noise levels are expected to remain within the operational noise criteria at all sensitive receivers. No specific operational noise mitigation measures are recommended. However it is recommended appropriate selection of mechanical plant and adjustment to the PA system should be undertaken at detailed design stage to comply with Sydney Trains speech intelligibility requirements and the operational noise criteria provided in Table 3-8.



Noise level contour dBA - Period - Impact - Mitigation measures

- 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]
- 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]
- 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]
- 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

Paper Size A4
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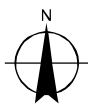
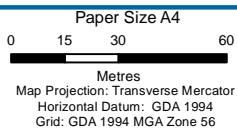
S1 noise management zones

Figure 4



Noise level contour dB(A) - Period - Impact - Mitigation measures

- 65 - Day - Moderately intrusive - [Standard hours (LB, M)]
- 75 - Day - Highly intrusive - [Standard hours (LB, M)]



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Date | 17 Sep 2015

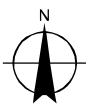
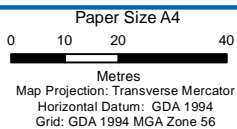
S2 noise management zones

Figure 5



Noise level contour dBA - Period - Impact - Mitigation measures

- 65 - Day - Moderately intrusive - [Standard hours (LB, M)]
- 75 - Day - Highly intrusive - [Standard hours (LB, M)]



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S3 noise management zones

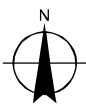
Figure 6



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]

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S4 noise management zones

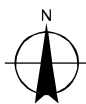
Figure 7



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]

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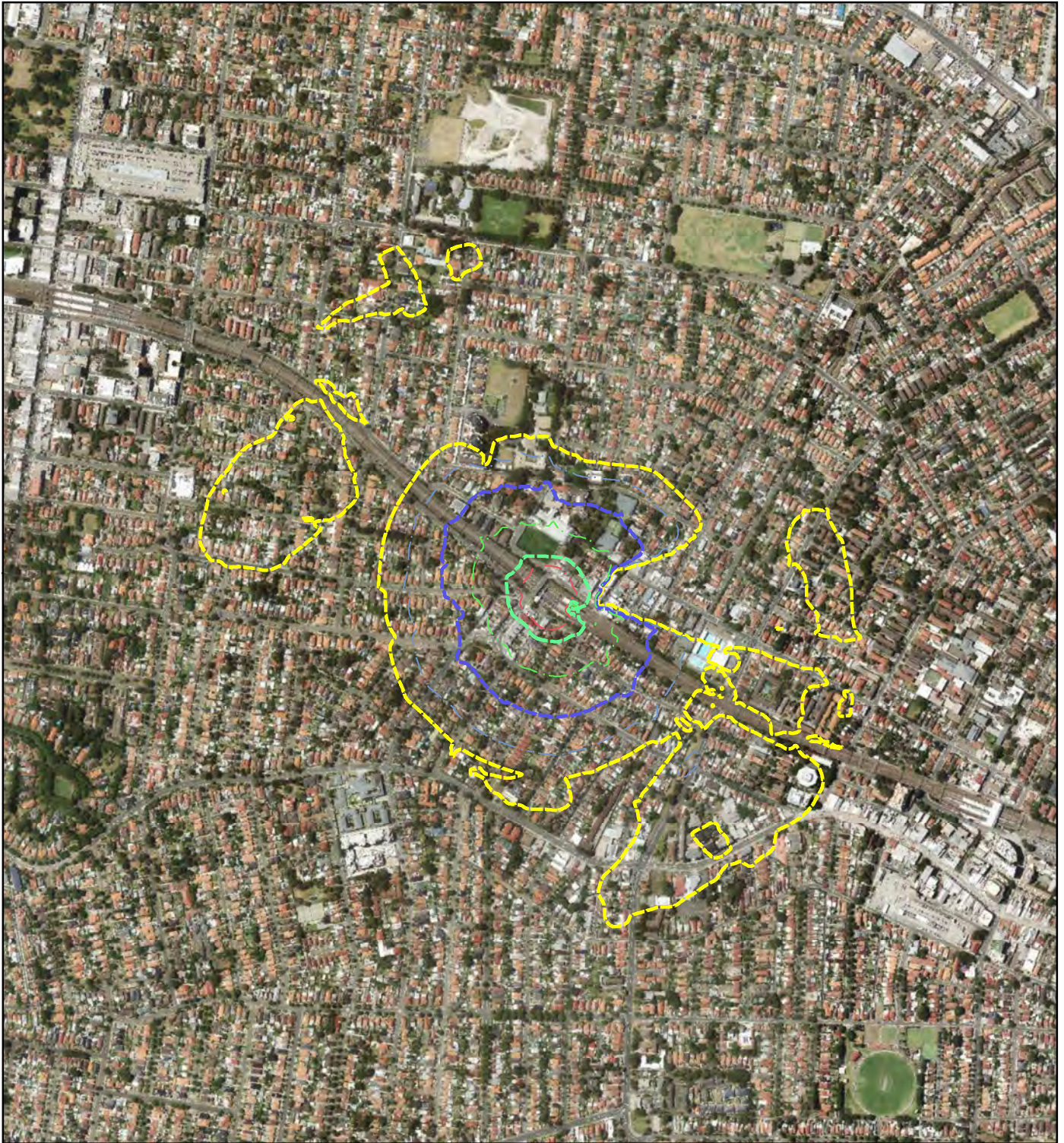


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S5 noise management zones

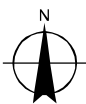
Figure 8



Noise level contour dBA - Period - Impact - Mitigation measures

- 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]
- 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]
- 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]
- 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

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S6 noise management zones

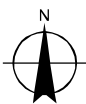
Figure 9



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

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S7 noise management zones

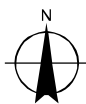
Figure 10



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

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S8 noise management zones

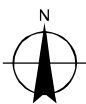
Figure 11



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]

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S9 noise management zones

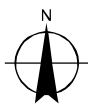
Figure 12



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]

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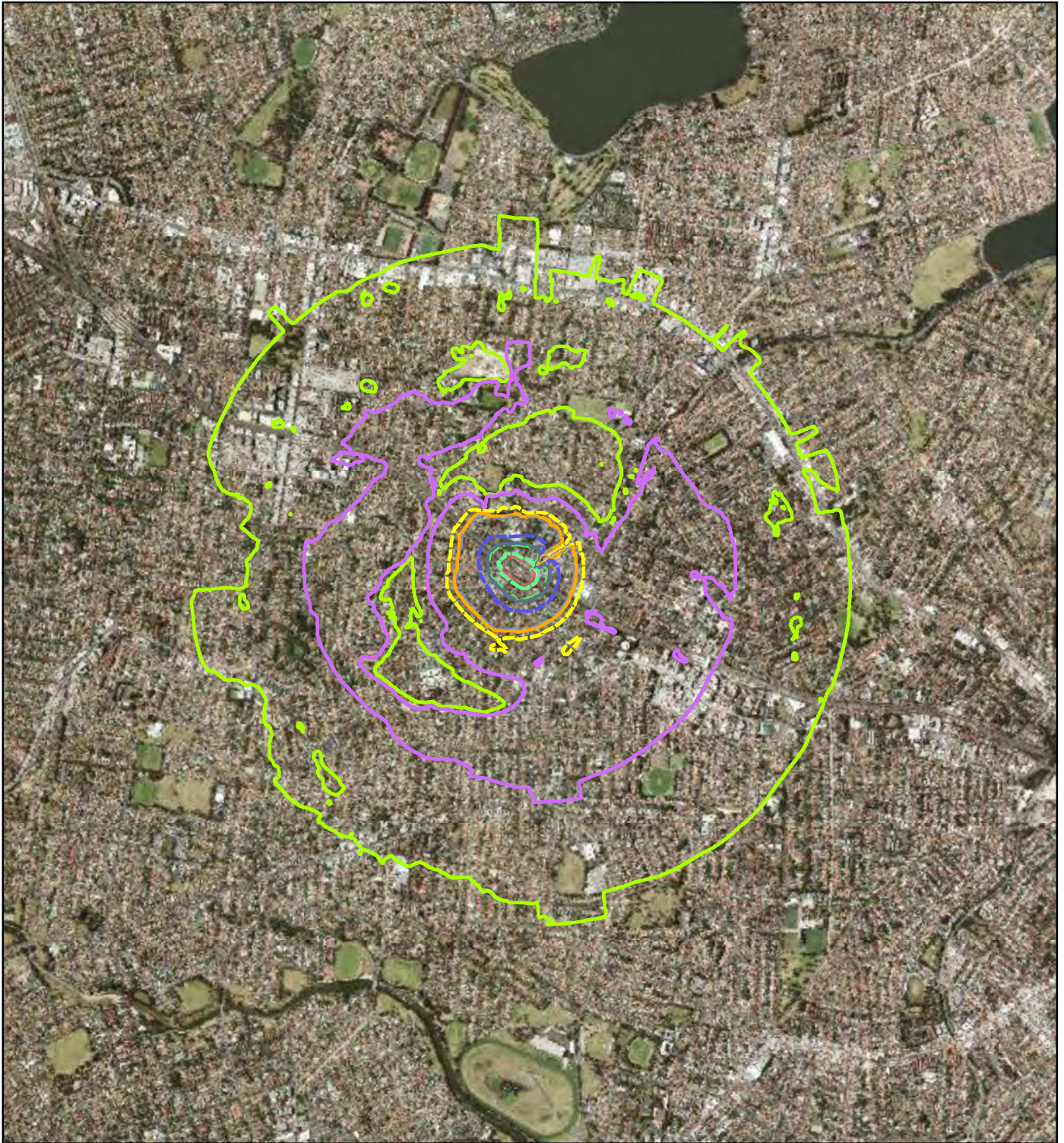


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S10 noise management zones

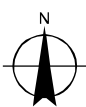
Figure 13



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]

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S11 noise management zones

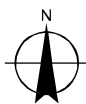
Figure 14



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

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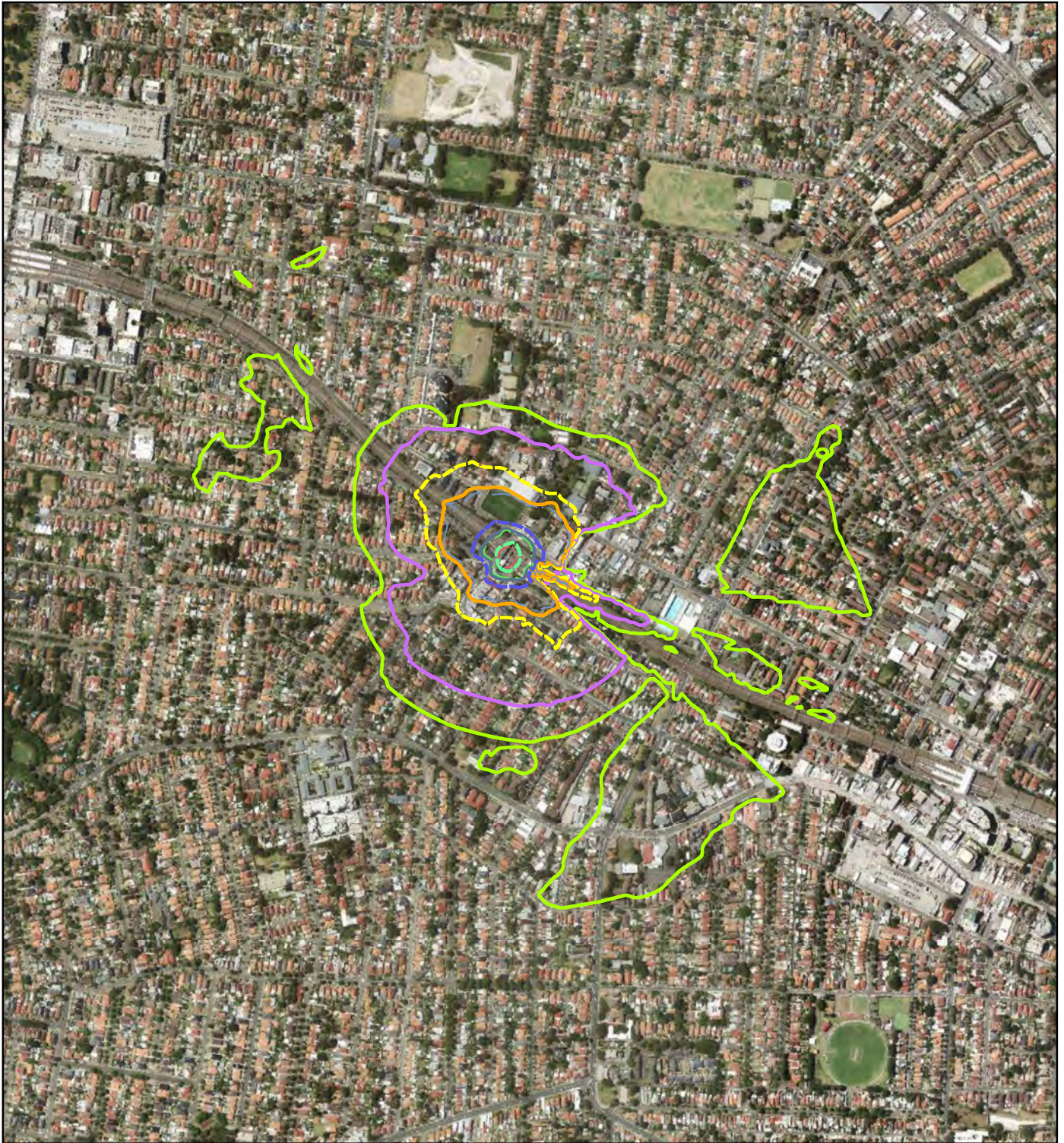


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S12 noise management zones

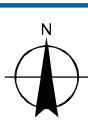
Figure 15



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- - - 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- - - 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

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 Date | 17 Sep 2015

S13 noise management zones

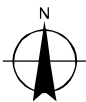
Figure 16



Noise level contour dBA - Period - Impact - Mitigation measures

- 65 - Day - Moderately intrusive - [Standard hours (LB, M)]
- 75 - Day - Highly intrusive - [Standard hours (LB, M)]

Paper Size A4
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S14 noise management zones

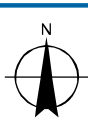
Figure 17



Noise level contour dBA - Period - Impact - Mitigation measures

- 39 - Night - Noticeable - [OOHW Period 2 (LB)]
- 44 - Night - Clearly Audible - [OOHW Period 2 (LB, M)]
- 54 - Night - Moderately intrusive - [OOHW Period 2 (M, IB, LB, PC, SN)]
- 64 - Night - Highly intrusive - [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- - - 51 - Evening - Clearly Audible - [OOHW Period 1 (LB)]; [OOHW Period 2 (LB, M)]
- - - 61 - Evening - Moderately intrusive - [OOHW Period 1 (M, LB)]; [OOHW Period 2 (M, IB, LB, PC, SN)]
- - - 71 - Evening - Highly intrusive - [OOHW Period 1 (M, IB, LB, PC, SN)]; [OOHW Period 2 (AA, M, IB, LB, PC, SN)]
- · - · - 55 - Day - Clearly Audible - [OOHW Period 1 (LB)]
- · - · - 65 - Day - Moderately intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (LB, M)]
- · - · - 75 - Day - Highly intrusive - [Standard hours (LB, M)]; [OOHW Period 1 (M, IB, LB, PC, SN)]

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 Grid: GDA 1994 MGA Zone 56



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S15 noise management zones

Figure 18

6. Conclusions

Operational and construction noise impacts associated with the Croydon Station easy access upgrade have been assessed.

Construction activities during recommended standard construction hours are predicted to exceed the noise affected construction noise management level at sensitive receivers for most construction activities. Reasonable and feasible construction noise and vibration mitigation measures have been recommended, which would minimise noise impacts at potentially affected receivers.

Construction traffic noise is not expected to cause adverse impacts as it would not be significant when compared with the daily existing vehicle numbers in the area. Therefore no construction traffic noise impacts are anticipated at sensitive receivers.

There is potential for some human comfort vibration impacts at sensitive receivers when activities occur within the safe working buffer distances. The human comfort vibration impacts would be short-term in nature and where possible scheduled during standard construction hours.

There is the potential that vibration in the vicinity of Croydon Station heritage structures could exceed the building damage criteria during vibration intensive activities such as compaction and surface breaking. Reasonable and feasible construction vibration mitigation measures for heritage structures have been recommended.

Operational noise from the Proposal is expected to remain unchanged. No operational noise impacts are anticipated.

The Proposal should be acceptable from an acoustic perspective assuming the recommended mitigation measures are implemented.

References

Assessing Vibration a Technical Guideline, Department of Environment and Conservation, February 2006

Construction Noise Strategy, (Transport for NSW, 2012)

Code of practice for noise and vibration control on construction and open sites, BS 5228-1, British Standards, 2009

Environmental Criteria for Road Traffic Noise, Environmental Protection Authority, 1999

Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz), BS 6472 – 1992, British Standards, 1992

Guide to noise and vibration control on construction, demolition and maintenance sites, AS 2436 - 2010, Australian Standards, 2010

Industrial Noise Policy, Environmental Protection Authority, January 2000

Interim Construction Noise Guideline, Department of Environment and Climate Change, July 2009

ISO 9613-2, Acoustics – Attenuation of sound during propagation outdoors, International Organization for Standardization, 1996.

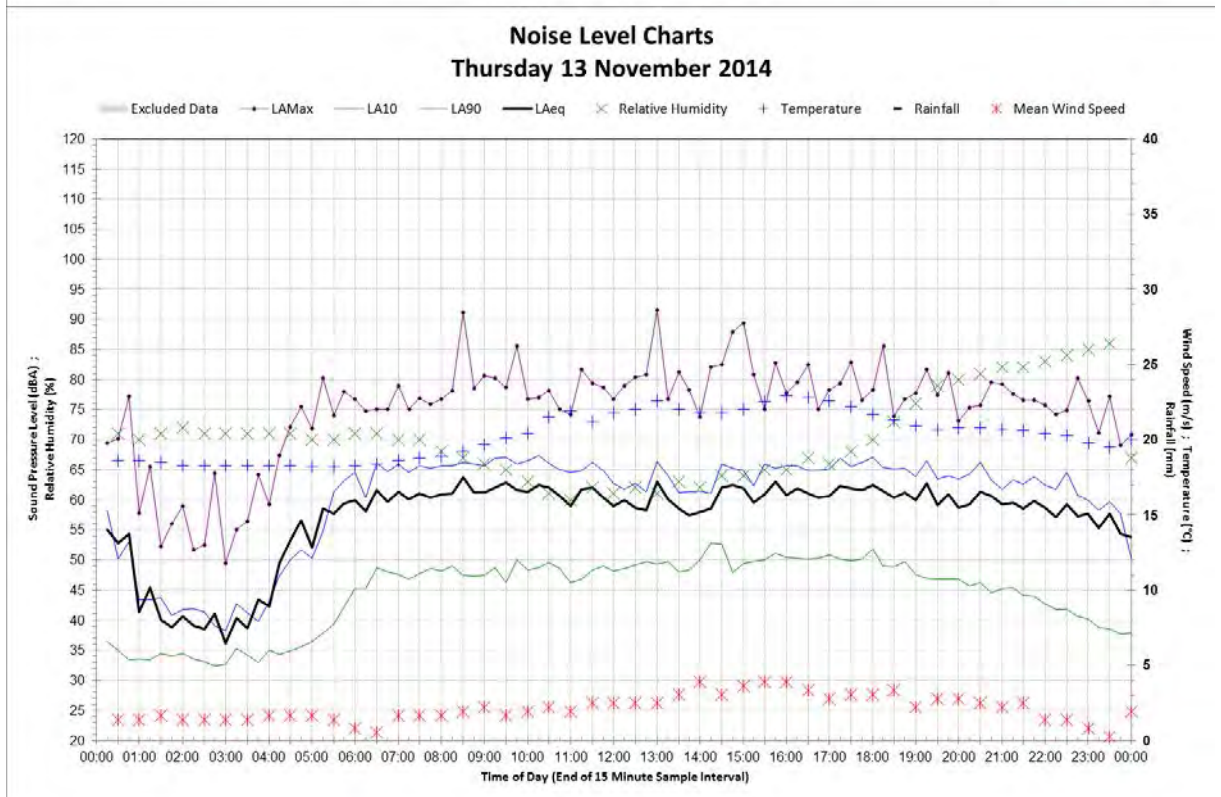
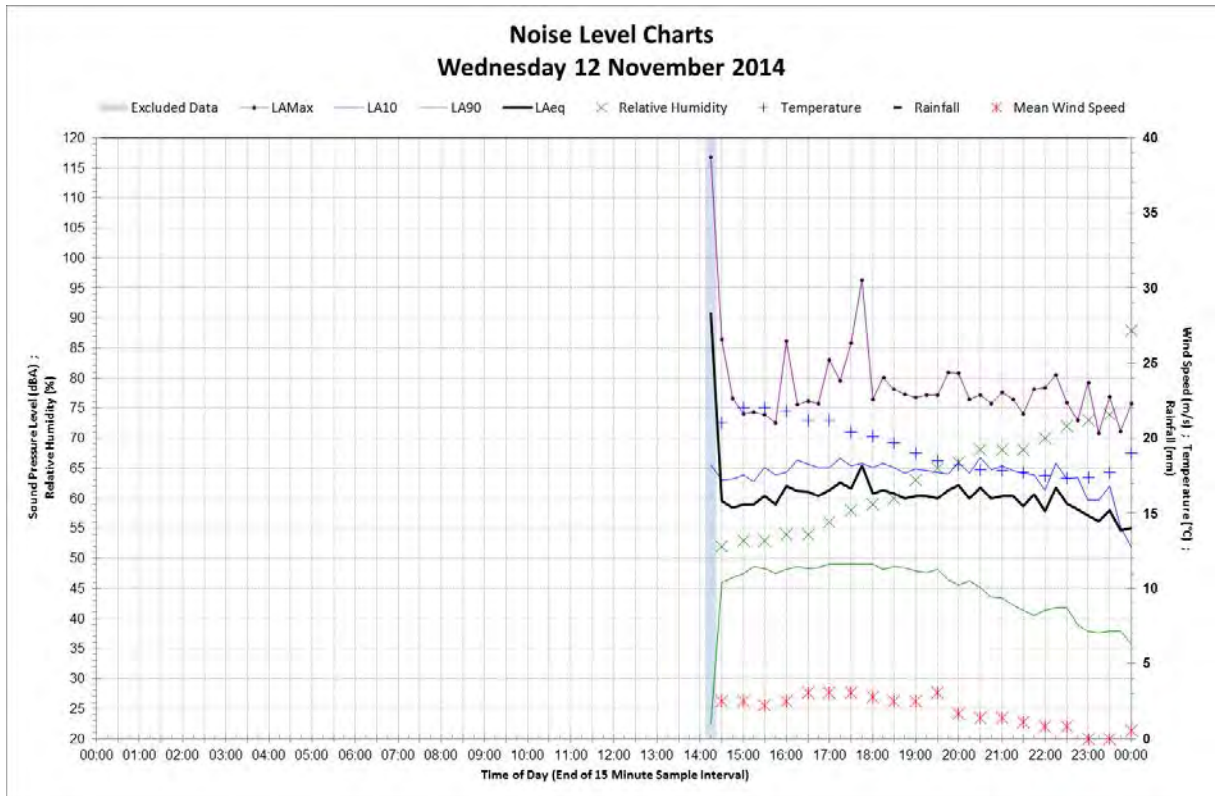
Road Noise Policy, Office of Environment and Heritage, March 2011

Structural Vibration Part 3: Effects of vibration on structures, DIN 4150-3 -1999, German Standards, 1999

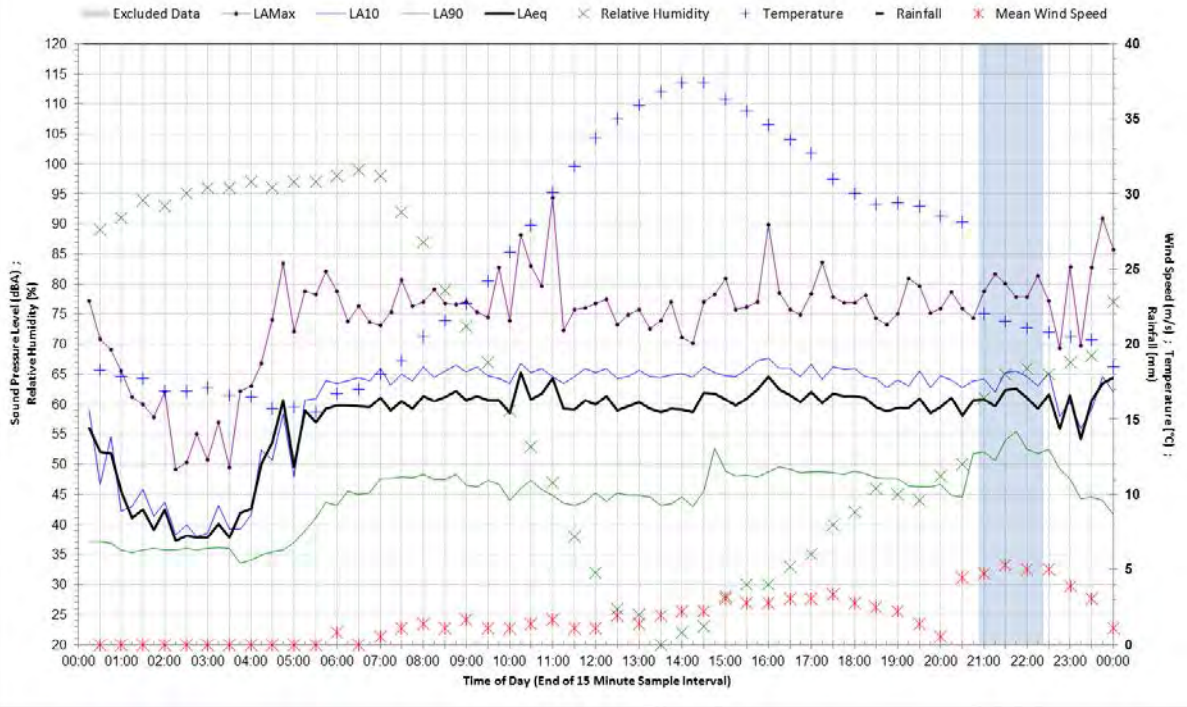
Sydney Trains Environmental Management System Guide Noise and Vibration from Rail Facilities (Sydney Trains, 2013)

Appendices

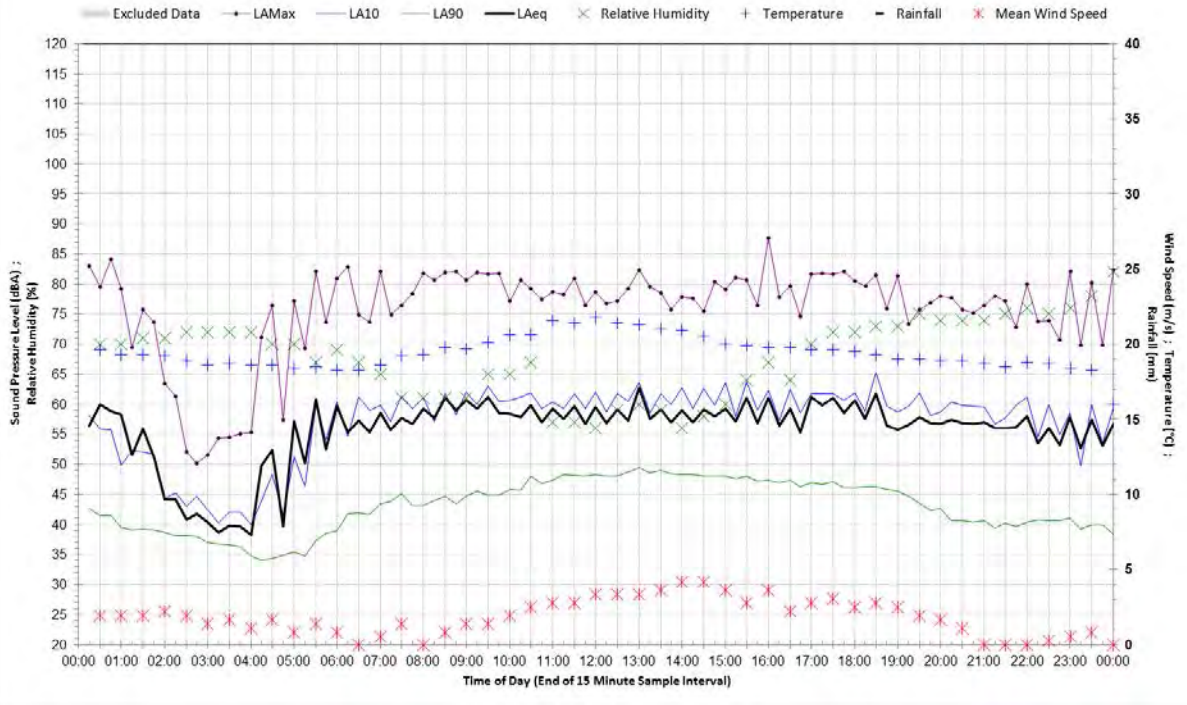
Appendix A - Noise monitoring charts



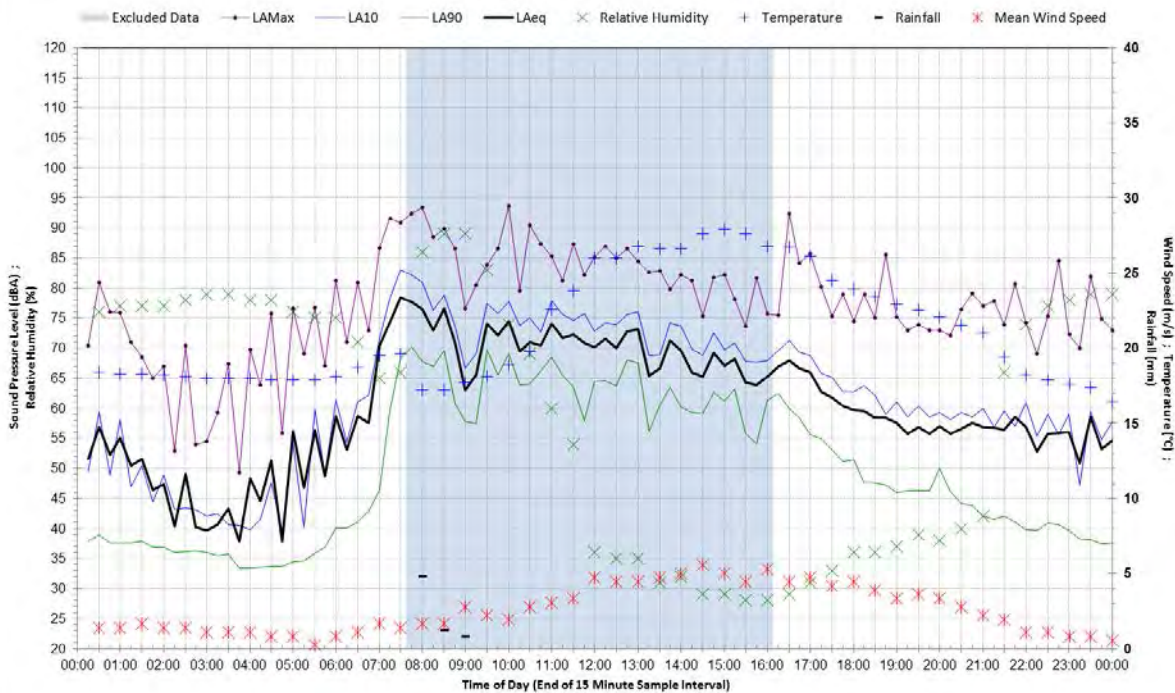
Noise Level Charts Friday 14 November 2014



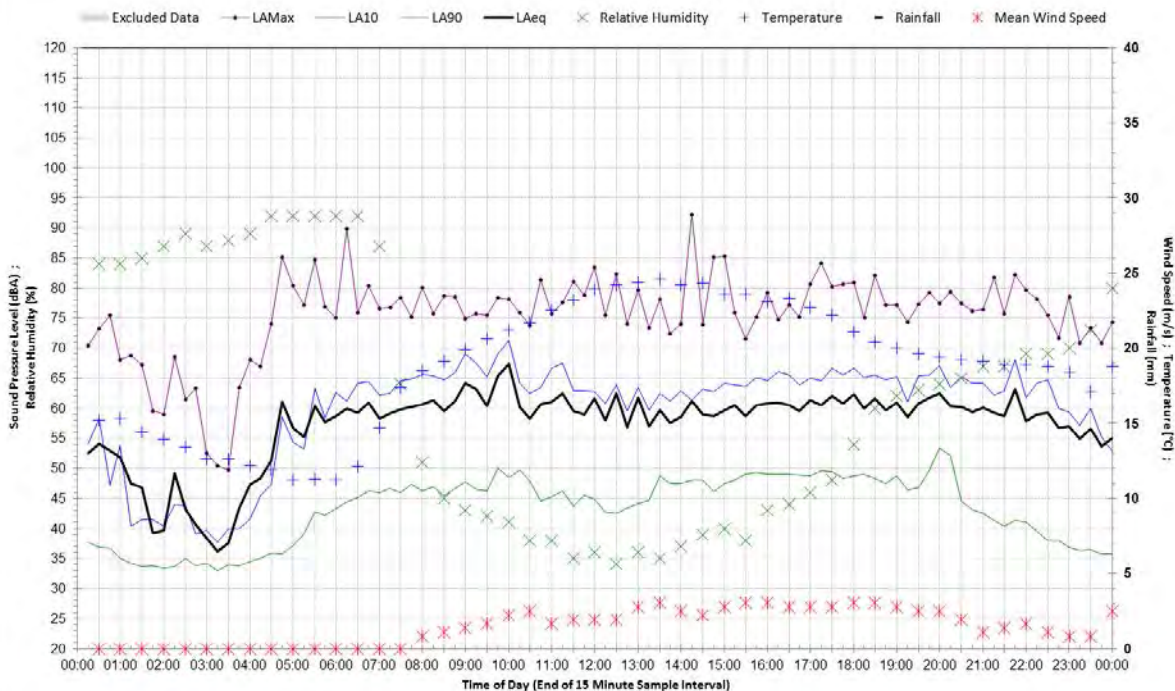
Noise Level Charts Saturday 15 November 2014



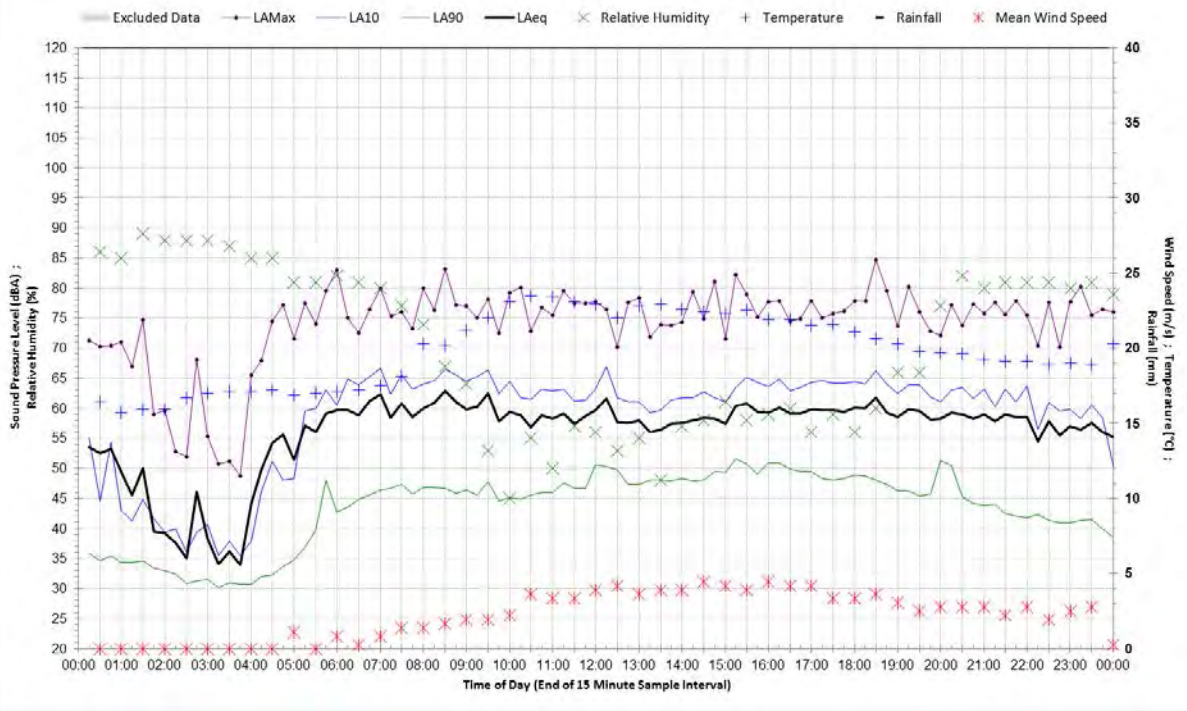
Noise Level Charts Sunday 16 November 2014



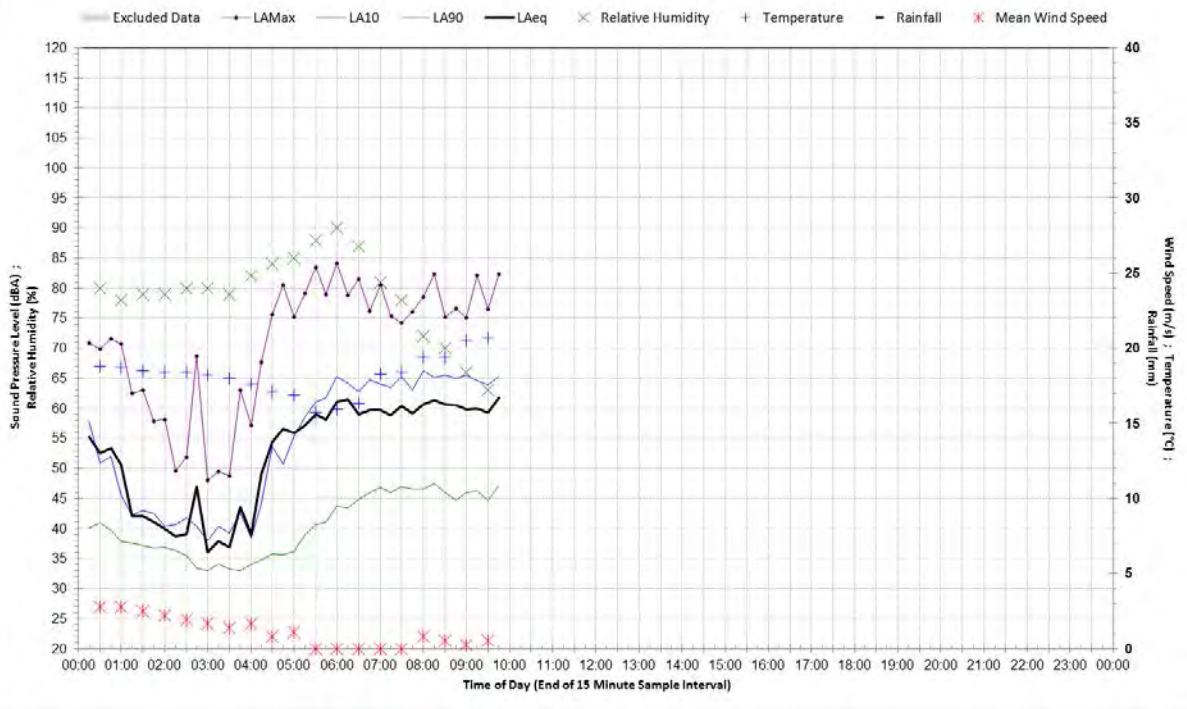
Noise Level Charts Monday 17 November 2014



Noise Level Charts Tuesday 18 November 2014



Noise Level Charts Wednesday 19 November 2014



Appendix B – Indicative construction activity summary

Scenario	Construction activity	Timing	Equipment
S1	<p>Establishment of site compound (erect fencing, tree protection zones, site offices, amenities and plant/material storage areas etc)</p> <p>Temporary booking office fitted with equipment and staff facilities</p> <p>Temporary station entrance and access path to maintain the existing level of service from Paisley Road to allow public access to the station and platforms</p>	<p>Standard hours</p> <p>Out of hours: Periods 1</p>	<p>Trucks, Generator with acoustic enclosure, Excavator (small), Hand tools (electric), Crane, Concrete pump and truck, Excavator (medium)</p>
S2	<p>Removal of vegetation on north and south sides to allow for temporary footbridge and new concourse and support structure</p>	<p>Standard hours</p>	<p>Mulcher, Chainsaw, Excavator (small), Truck, Hand tools (electric)</p>
S3	<p>Services relocation (including HV under grounding and crossing of Meta Street)</p>	<p>Standard hours</p>	<p>Excavator (medium), Truck, Hand tools (electric), Roller (small), Under bore drill rig</p>
S4	<p>OHW adjustment works, including new structures</p>	<p>Out of hours: Periods 2</p>	<p>Crane, Truck, Concrete pump and truck, Concrete vibrator, Scissor lift, Elevated working platform, Hand tools (electric)</p>
S5	<p>Temporary footbridge and stairs including foundations, steel supports, bridge installation, lighting, CCTV and Opal card readers</p>	<p>Out of hours: Periods 1 and 2</p>	<p>Crane x 2, Truck, Concrete pump and truck, Concrete vibrator, Scissor lift, Elevated working platform, Hand tools (electric), Manitou</p>
S6	<p>Demolition of existing structures including footbridge, concrete trestles and stairways</p>	<p>Standard hours</p> <p>Out of hours: Periods 1</p>	<p>Concrete saw, Generator with acoustic enclosure, Excavator with rock breaker, Jack hammer, Excavator with auger (small), Hand tools (electric), Excavator (small), Truck</p>

Scenario	Construction activity	Timing	Equipment
S7	<p>Construction of footings for bridge columns and lift shaft</p> <p>Construction of concourse spanning from Paisley Road to Hennessy Street</p> <p>Construction of retaining walls and stormwater drainage works</p> <p>Construction of bridge columns</p> <p>Construction of lifts (shaft and lift base)</p>	<p>Standard hours</p> <p>Out of hours: Periods 1 and 2</p>	<p>Piling rig (Bored) , Concrete pump and truck, Concrete vibrator, Generator with acoustic enclosure, Truck, Hand tools (electric), Crane, Excavator (small), Hand tools (pneumatic), Scissor lift, Elevated working platform, Concrete helicopter</p>
S8	<p>Installation of lifts (fitout)</p>	<p>Standard hours</p> <p>Out of hours: Periods 1 and 2</p>	<p>Generator, Truck , Hand tools (electric)</p> <p>Crane, Hand tools (pneumatic), Elevated working platform</p>
S9	<p>Lifting of bridge spans into position</p>	<p>Out of hours: Periods 1 and 2</p>	<p>Truck, Crane x 2, Hand tools (pneumatic), Hand tools (electric), Elevated working platform</p>
S10	<p>Construction of stairs, canopies, balustrades and anti-throw screens</p>	<p>Out of hours: Periods 1 and 2</p>	<p>Truck, Hand tools (electric), Generator with acoustic enclosure, Crane, Scissor lift, Hand tools (pneumatic), Piling rig (Bored) , Concrete pump and truck, Concrete vibrator, Elevated working platform</p>
S11	<p>Platform resurfacing and re levelling /regrading</p>	<p>Out of hours: Periods 1 and 2</p>	<p>Truck, Excavator (small), Concrete saw, Excavator (medium), Asphalt paver, Hand tools (electric), Generator, Dump truck, Wacker compactor , Roller (vibratory)</p>

Scenario	Construction activity	Timing	Equipment
S12	Construction of building for new staff operational area and amenities at concourse level.	Standard hours Out of hours: Periods 1 and 2	Crane, Concrete saw, Jack hammer, Excavator (medium), Hand tools (electric), Trucks, Elevated working platform, Scissor lift
S13	Installation of fixtures, lighting and CCTV cameras for affected areas	Standard hours Out of hours: Periods 1 and 2	Generator, Crane, Truck, Hand tools (electric), Hand tools (pneumatic), Elevated working platform, Scissor lift
S14	<p>Road works for accessible parking spaces with shared area to provide access and egress space, car park spaces, loading zone to accommodate existing capacity, kerb adjustments, accessible footpath, ramps, undercover bicycle racks and Landscaping</p> <p>Provision of new kiss and ride spaces in Paisley Road</p> <p>Reconfiguration to sections of Hennessy Street which are limited to the southern side of Hennessy Street between the back of kerb and RailCorp land and the Burwood/Ashfield Council boundary including accessible footpath, ramps, undercover bicycle racks and landscaping</p>	Standard hours	Truck, Excavator (medium), Excavator (small), Concrete pump and truck, Concrete vibrator, Concrete helicopter, Roller (vibratory), Hand tools (electric), Wacker compactor

Scenario	Construction activity	Timing	Equipment
S15	<p>Installation of new bicycle racks at both sides of the station.</p> <p>Installation of wayfinding signage</p> <p>Electrical and power supply upgrade works including installation of a new padmount substation to replace the existing (in the vicinity of the existing located adjacent to Paisley Road)</p> <p>Adjustment of all boundary fencing and pedestrian fencing</p> <p>Upgrading or new station services and systems</p> <p>Replanting/landscaping and fencing adjustments and bollards</p>	<p>Standard hours</p> <p>Out of hours: Periods 1 and 2</p>	<p>Truck, Drill (coring), Hand tools (electric), Wacker compactor , Excavator (small) x 2, Concrete pump and truck, Concrete vibrators , Concrete helicopter</p>

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