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Transport Access Program

Environmental Noise and Vibration Impact Assessment

Pendle Hill Station Easy Access Upgrade

Report Number 610.14617.00200-R1

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Transport for NSW

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Transport for New South Wales (TfNSW) to prepare a construction and operational noise and vibration assessment for the proposed Easy Access upgrade at Pendle Hill Station (Proposal Site).

The purpose of this Noise and Vibration Impact Assessment (NVIA) report is to provide input for the Review of Environmental Factors (REF) for the Proposal Site.

1.1 Relevant Guidelines

The noise and vibration guidelines for construction and operations are based on the publications managed by the NSW Environment Protection Authority (EPA). The EPA guidelines applicable to this assessment include:

- Operational Noise – *Industrial Noise Policy (INP)* (OEH 2010).
- Construction Noise – *Interim Construction Noise Guideline (ICNG)* (DECC 2009).
- Construction and Operational Vibration (human comfort) - *Assessing Vibration - a technical guideline* (DEC 2006).

The following additional guidelines and standards are also referenced in this study:

- Construction Noise and Vibration Mitigation - *Construction Noise Strategy (CNS) (TfNSW 2012)*
- Sleep Disturbance – *Application Notes to Industrial Noise Policy* (OEH 2010).
- Rail Infrastructure Noise Guidelines (RING) (EPA 2013)

1.2 Acoustic Terminology

Specific acoustic terminology is used within this assessment. An explanation of common acoustic terms is included as **Appendix A**.

1.3 Acronym List

The following acronyms are referred to in this report:

- ANL - Acceptable Noise Level
- BOM - Bureau of Meteorology
- DEC - Department of Environment and Conservation NSW
- DECC - Department of Environment Climate Change NSW
- EPA - Environment Protection Authority
- ICNG - Interim Construction Noise Guideline
- INP - Industrial Noise Policy
- NVIA - Noise and Vibration Impact Assessment
- OEH - Office of Environment and Heritage NSW
- OOHW - Out of Hours Work
- POEO - Protection of the Environment Operation
- PSNC - Project Specific Noise Criteria
- RBL - Rating Background Level
- REF - Review of Environment Factors
- rms - Root Mean Square
- RNP - Road Noise Policy NSW
- SLR - SLR Consulting Australia Pty Ltd
- TAP - Transport Access Program
- TfNSW - Transport for New South Wales
- TfNSW CHS - Transport for New South Wales Construction Noise Strategy
- VDV - Vibration Does Value

2 PROJECT DESCRIPTION

2.1 Background

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

The main project objectives of the Transport Access Program include:

- modern interchanges that support an integrated network and allow seamless transfers between all modes for all customers
- modern buildings and facilities for all modes that meet the needs of a growing population
- stations that are accessible to those with a disability, the ageing and parents with prams
- safety improvements including extra lighting, help points, fences and security measures for car parks and interchanges, including stations, bus stops and wharves
- signage improvements so customers can more easily use public transport and transfer between modes at interchanges
- other improvements and maintenance such as painting, new fencing and roof replacements.

2.2 Project Overview

The proposed Station Upgrade generally includes the following:

- Partial demolition and the removal of the exiting station footbridge, ramps and leaving the stairs and bridge between the two station platforms.
- services diversion and/or relocation to accommodate new infrastructure, including HV
- new station concourse and street level entrances
- four new lifts and stairs with canopies to the station concourse and platforms
- new station operational areas including booking office, ticketing facilities, amenities / accessible toilet, station management and staff facilities, communications equipment room, and electrical switch room
- upgraded seating areas on platforms with weather protection including canopies and wind barriers
- station power supply upgrade, adjustment to lighting, and augmentation of station communication systems associated with the new infrastructure
- minor refurbishments of station buildings
- modifications to passenger information systems and ticketing facilities
- station precinct upgrade and enhanced interchange provisions including: new pedestrian crossing and other access improvements such as footpath widening and kerb realignment, accessible parking, kiss & ride parking, bicycle parking facilities, and additional commuter parking spaces.

Figure 1 and **Figure 2** show the site locality and conceptual layout of the Project. It is relevant to note that the conceptual layout is a concept only and is subject to detailed design changes.

Figure 1 Site Locality

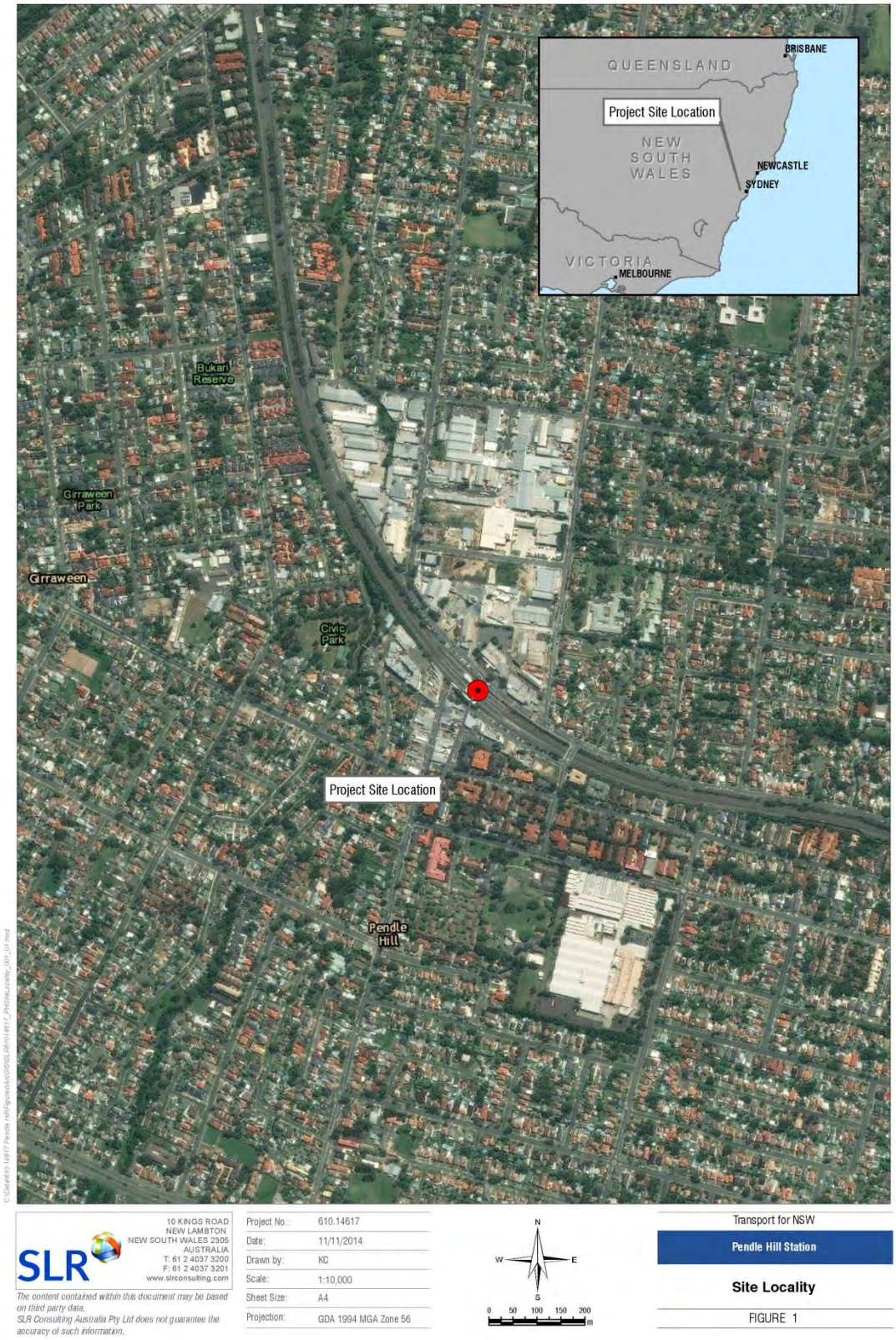

Figure 2 General Site Layout

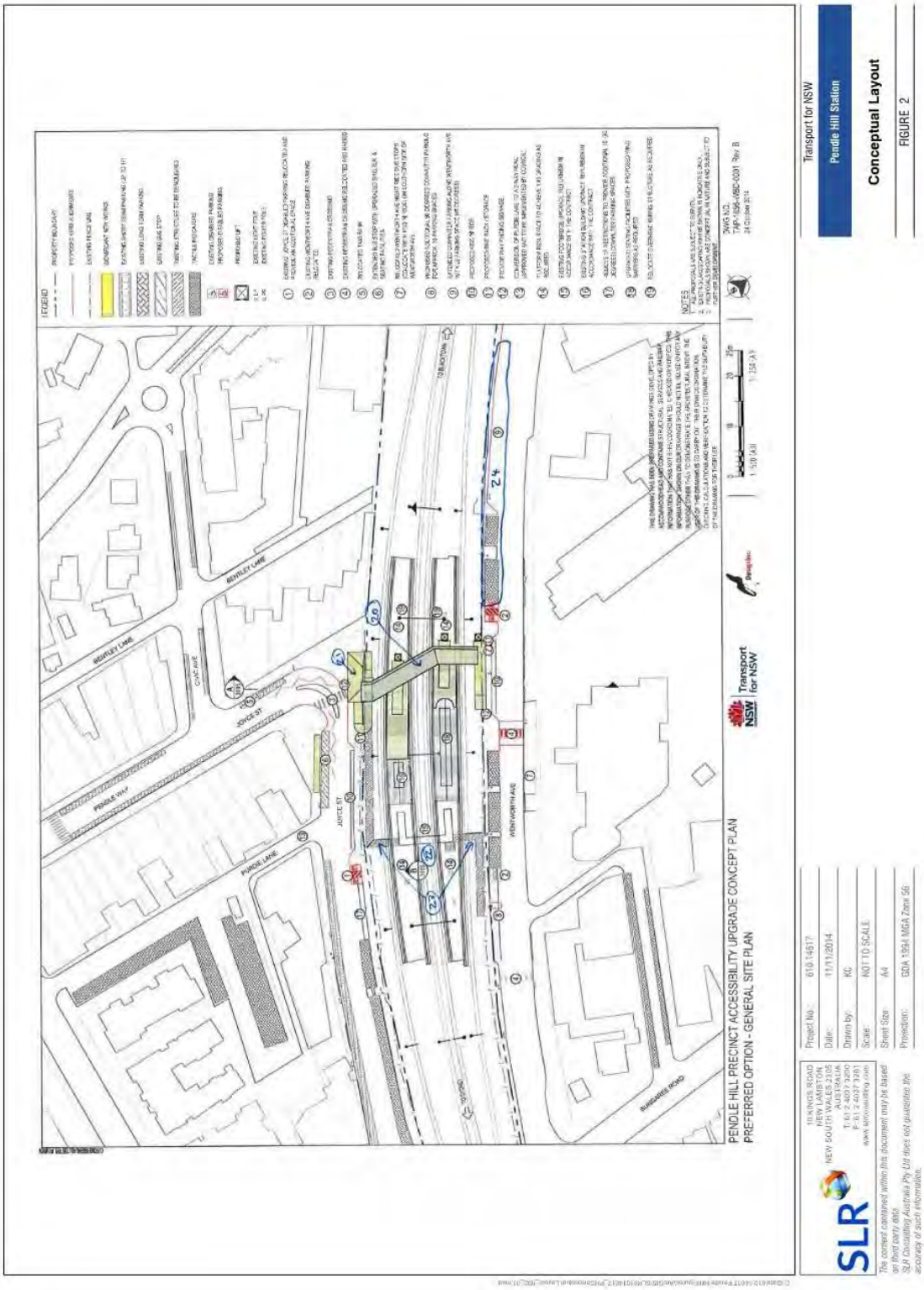

Image Source: GHD 2013

3 SENSITIVE RECEIVERS

Table 1 provides a summary of the representative noise sensitive receivers shown as Locations R1 to R6 in **Figure 3**.

Table 1 Representative Noise Sensitive Receivers

Receiver	Address	Brief Description
R1	2-12 Bentley Lane, Pendle Hill	Residential Apartments, three storey
R2	158 Bentley Lane, Pendle Hill	Commercial, two storey
R3	9 Joyce Street, Pendle Hill	Commercial, single storey
R4	115-117 Stapleton Street, Pendle Hill	Residential Apartments, three storey
R5	223 Wentworth Ave, Pendle Hill	Pendle Inn, two storey
R6	213 Wentworth Ave, Pendle Hill	Residential, single storey

Figure 3 Sensitive Receiver Locations

4 NOISE IMPACT ASSESSMENT PROCEDURES

4.1 General Objectives – NSW Industrial Noise Policy (INP)

Responsibility for the control of noise emission in NSW is vested in Local Government and the EPA. The INP was released in January 2000 and provides a framework and process for deriving noise criteria for consents and licences that will enable the relevant authority to regulate premises that are scheduled under the *Protection of the Environment Operations Act 1997 (POEO Act)*.

The specific policy objectives are:

- To establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses
- To use the criteria as the basis for deriving project specific noise criteria
- To promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects
- To outline a range of mitigation measures that could be used to minimise noise impacts
- To provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development
- To carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The policy sets two separate noise criteria to meet environmental noise objectives; one to account for intrusive noise and the other to protect the amenity of particular land uses.

Assessing Intrusiveness

For assessing intrusiveness, the background noise level must be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than five decibels above the measured background level (L_{A90}).

Assessing Amenity

The amenity assessment is based on noise criteria specific to land use and associated activities (**Table 2**). The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion (**Table 3**).

Table 2 Amenity Criteria Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq(Period)}$ Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface (for existing situations only)	Day	65	70
		Evening	55	60
		Night	50	55
School classrooms - internal	All	Noisiest 1 hour period when in use	35	40
Hospital wards - internal - external	All	Noisiest 1 hour period	35 50	40 55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (eg National Park)	All	When in use	50	55
Active recreation area (eg school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note: Monday - Saturday: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am. Sundays, Public Holidays: Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table 3 Modification to Acceptable Noise Level (ANL)* to Account for Existing Levels of Industrial Noise

Total Existing L_{Aeq} Noise Level from Industrial Noise Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone, dBA
≥ Acceptable noise level plus 2 dBA	If existing noise level is *likely to decrease* in future acceptable noise level minus 10 dBA If existing noise level is *unlikely to decrease* in future existing noise level minus 10 dBA
Acceptable noise level plus 1 dBA	Acceptable noise level minus 8 dBA
Acceptable noise level	Acceptable noise level minus 8 dBA
Acceptable noise level minus 1 dBA	Acceptable noise level minus 6 dBA
Acceptable noise level minus 2 dBA	Acceptable noise level minus 4 dBA
Acceptable noise level minus 3 dBA	Acceptable noise level minus 3 dBA
Acceptable noise level minus 4 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 5 dBA	Acceptable noise level minus 2 dBA
Acceptable noise level minus 6 dBA	Acceptable noise level minus 1 dBA
< Acceptable noise level minus 6 dBA	Acceptable noise level

* ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from **Table 2**

4.2 INP Noise Assessment Strategy

The INP Project Specific Noise Criteria (PSNC) are the more stringent of either the amenity or intrusive criteria. The INP states that these criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

In those cases where the INP PSNC are not achieved, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedances of the INP project specific noise criteria can be generally described as follows:

- Negligible noise level increase <1 dBA (Not noticeable by all people)
- Marginal noise level increase 1 dBA to 2 dBA (Not noticeable by most people)
- Moderate noise level increase 3 dBA to 5 dBA (Not noticeable by some people but may be noticeable by others)
- Appreciable noise level increase >5 dBA (Noticeable by most people)

4.3 Assessing Sleep Disturbance

The potential for sleep arousal has been assessed using the guidance provided in the INP Application Notes and the Road Noise Policy (RNP).

As per the INP Application Notes (last updated 12 July 2012), it is recognised that the current $L_{A1(1minute)}$ sleep disturbance criteria of 15 dBA above the prevailing $L_{A90(15minute)}$ level is not ideal. The assessment of potential sleep disturbance is complex and poorly understood and the EPA believes that there is insufficient information to determine a suitable alternative criteria.

The INP guideline suggests that the $L_{A1(1minute)}$ level of 15 dBA above the Rating Background Level (RBL) is a suitable screening criterion for sleep disturbance for the night-time period.

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

- maximum internal noise levels below 50 - 55 dBA are unlikely to awaken people from sleep
- one or two noise events per night, with maximum internal noise levels of 65 - 70 dBA, are not likely to affect health and wellbeing significantly.

It is generally accepted that internal noise levels in a dwelling, with the windows open, are 10 dBA lower than external noise levels. Based on a worst case minimum attenuation, with windows open, of 10 dBA, the first conclusion above suggests that short term external noises of 60 dBA to 65 dBA are unlikely to cause awakening reactions. The second conclusion suggests that one or two noise events per night with maximum external noise levels of 75 dBA to 80 dBA are not likely to affect health and wellbeing significantly.

4.4 Construction Noise

The Interim Construction Noise Guideline (ICNG) sets out noise management levels for residential and other noise-sensitive receivers and how they are to be applied. The policy suggests restriction to the hours of construction that apply to activities that generate noise at residences above the 'highly affected' noise management level. A summary of the noise management levels is contained in **Table 4** and **Table 5**.

Table 4 Construction Noise Management at Residential Receivers

Time of day	Management level LAeq(15minute)	How to apply
Recommended standard hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work Sundays or public holidays	Noise Affected RBL** + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	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: 1. 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 2. 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 dBA above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 of the ICNG.

*Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise-affected residence.
**RBL: Rating Background Level, as defined in the NSW Industrial Noise Policy (EPA, 2000).

Table 5 Noise at sensitive land uses (other than residences)

Land use	Management level, LAeq(15minute) (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterized by sporting activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterized by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

Other Sensitive Land Uses

The ICNG's quantitative assessment method includes guidance on how to establish noise management levels for residential receivers and appropriate management levels for some 'other sensitive land uses' such as educational institutions, hospitals etc. however, a suitable management level is not specified for all classifications of sensitive land use. Where other sensitive land uses are identified within a construction noise catchment, the following guidance is given:

The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors may assist in determining relevant noise levels (Standards Australia 2000).

Commercial Receivers

The ICNG explains that due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories:

- Industrial premises: external $L_{Aeq(15minute)}$ 75 dBA
- Offices, retail outlets: external $L_{Aeq(15minute)}$ 70 dBA

The external noise levels should be assessed at the most-affected occupied point of the premises.

4.5 Assessing Vibration

4.5.1 Human Response

The EPA released *Assessing Vibration: a technical guideline* (the Guideline) in February 2006. The Guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. The Guideline is based on British Standard BS 6472-1998 *Evaluation of human exposure to vibration in buildings (1-80Hz)* which is similar to Australian Standard AS-2670.2-1990 but includes additional guidelines in relation to intermittent vibration. The criteria presented in the Guideline are non-mandatory. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, the operator would need to negotiate directly with the affected community.

Section 2.4 of the Guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted root mean square (rms) acceleration over the frequency range 1 Hz to 80 H. To calculate VDV the following formula is used:

$$VDV = \left[\int_0^T a^4(t)dt \right]^{0.25}$$

where VDV is the vibration dose value in $m/s^{1.75}$, *a(t)* is the frequency-weighted acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable VDV are reproduced here in **Table 6**.

Table 6 Acceptable Vibration Dose Values for Intermittent Vibration

Location	Daytime		Night-time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residences	0.20 $m/s^{1.75}$	0.40 $m/s^{1.75}$	0.13 $m/s^{1.75}$	0.26 $m/s^{1.75}$

Note: Daytime is 7.00 am to 10.00 pm and night-time is 10:00pm to 7:00am

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

4.5.2 Human Perception

The human perception intermittent vibration dose levels at residences for the project are provided in **Table 7** from the *British Standard BS 6472:2008*.

Table 7 Human Perception Values for Intermittent Vibration

Vibration dose values ($m/s^{1.75}$) above which various degrees of adverse comment may be expected in residential buildings			
Place	**Low probability of adverse comment**	**Adverse comment possible**	**Adverse comment probable**
Residential building 16 hours day*	0.2 to 0.4[1]	0.4 to 0.8	0.8 to 1.6[2]
Residential building 8 hours night	0.13[1]	0.26	0.51[2]

Note: *Daytime is 7:00 am to 11:00 pm and Night-time 11:00pm to 7:00am

1. Below these ranges adverse comment is not expected.
2. Above these ranges adverse comment is very likely.

4.5.3 Building Response

British Standard 7385: Part 2-1993 "*Evaluation and measurement for vibration in buildings Part 2*" provides criteria against which the likelihood of building damage from ground vibration can be assessed.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extractions or construction excavation), demolition, piling, ground treatments (compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The standard states that the guide values relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%. Since the nearest buildings could potentially experience resonance effects, a conservative level of continuous "minimal risk of cosmetic damage" criterion has been adopted here and is shown in **Table 8**.

Table 8 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

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	25 mm/s at 4 Hz and above	
Unreinforced or light framed structures - Residential or light commercial type buildings	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above

Note: Values referred to are at the base of the building being considered.

Furthermore, **Table 9** outlines the adopted structural damage vibration limits for residential dwellings from the German Standard *DIN 4150: Part 3-1999* for the proposed development.

Table 9 Adopted Long-term Structural Vibration Velocity Limits on Structures

Line	Type of Structure	Guideline values for velocity, v_i, in mm/s, of vibration in horizontal plane of highest floor, at all frequencies
1	Building used for commercial purposes, industrial buildings, and buildings of similar design	10
2	Dwellings and buildings of similar design and/or occupancy	5
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are great intrinsic value (e.g. listed buildings under preservation order)	2.5

5 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

5.1 General Methodology

An ambient noise survey was conducted to characterise and quantify the existing acoustical environment in the area surrounding the Project Site. Noise monitoring was undertaken at two (2) locations M1 and M2 considered representative of the nearest potentially-affected noise-sensitive receivers to the Project Site. The noise monitoring locations are shown in **Figure 4**.

The ambient noise monitoring consisted of continuous, unattended noise logging and operator attended noise surveys. The operator attended noise surveys help to define noise sources and the character of noise in the area and are, therefore, used to qualify unattended noise logging results.

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of AS IEC 61672 2004 "*Electroacoustics - Sound Level Meters*" (parts 1 and 2) and carries current NATA or manufacturer calibration certificates. Instrument calibration was checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

Figure 4 Noise Monitoring Locations

5.2 Operator-Attended Noise Monitoring

Operator-attended noise measurements were conducted during the day time periods at the unattended noise monitoring locations (Location M1 and M2). The purpose of these surveys was twofold; to qualify the unattended noise logging results and to determine the contribution of existing industrial noise sources (including those from the Project Site) to the total ambient noise environment.

Operator-attended noise measurements were conducted during the day time on Monday 3 November 2014 using a B&K 2260 integrating sound level meter (S/N 2414605). Each operator-attended noise survey was 15 minutes duration.

The results of the operator-attended noise measurements are given in **Table 10**. Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds, and any other industrial operations.

The tables provide the following information:

- Monitoring location.
- Date & start time.
- Wind velocity (m/s) and Temperature (ºC) at the measurement location.
- Typical maximum (L_{Amax}) and contributed noise levels.

Table 10 Operator-Attended Noise Survey Results

Date/Start Time Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission and Typical Maximum Levels LAmax – dBA
	LAmax	LA1	LA10	LA90	LAeq	
Location M1 (10 Billabong Street, Pendle Hill) Day 03/11/2014 2:21 pm W = 0.5m/s N Temp = 24°C	73	67	61	43	57	Road traffic (Billabong Street) 65 to 73 dBA Road traffic (Civic Ave.) 45 to 50 dBA Road traffic (Gilba Road) 45 to 50 dBA Birds 42 to 45 dBA
Location M2 (169 Bungaree Road, Pendle Hill) Day 03/11/2014 2:46 pm W = 0.5 m/s N Temp = 23°C	81	73	64	49	91	Road traffic 50 to 72 dBA Pedestrians walking past 60 to 81 Nearby industrial spraying 49 to 55

Results of operator-attended noise surveys indicate that natural noise sources, local and distant road traffic are the main contributors to the ambient noise environment during all monitoring periods at logger locations M1 and M2.

5.3 Unattended Continuous Noise Monitoring

Background noise levels were monitored by SLR with the objective being to measure $L_{A90(period)}$ and $L_{Aeq(15minute)}$ noise levels at the nearest potentially affected residential locations during the day, evening and night-time periods to enable the determination of the intrusiveness and amenity criteria for the project.

Background noise levels were monitored from Friday 24 October 2014 to Monday 3 November 2014 inclusive at locations M1 and M2. Details of the monitoring location are provided in **Table 11** and **Figure 4**.

Table 11 Ambient Noise Monitoring Locations

Logger Type/ Serial No.	Location	Location (m, UTM)		Elevation (m, AHD)
		Easting	Northing	
ARL EL316 16-004-034	Logger Location M1	310629.00	6257923.00	43
ARL EL316 16-306-041	Logger Location M2	311009.00	6258020.00	56

The noise logger was programmed to record statistical noise level indices continuously in 15 minute intervals, including L_{Amax}, L_{A1}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}. Precautions were taken to minimise influences from extraneous noise sources and reflections from adjacent buildings.

Weather data for the survey period was obtained from the Bureau of Meteorology (BOM) weather station located at Sydney Olympic Park (approximately 10 km east-south-east of the Project Site). Noise data corresponding to periods of rainfall and/or wind speeds in excess of 5 m/s (approximately 9 knots) were discarded in accordance with INP data exclusion methodology. A summary of the results of the background survey is given in **Table 12**. Results are displayed graphically in **Appendix B**.

Table 12 Summary of Existing Ambient Noise Levels

Location	Period[1]	Measurement Parameter			
		LA1	LA10	LA90 (RBL)	LAeq
Logger Location M1	Daytime	65 dBA	57 dBA	40 dBA	55 dBA
	Evening	62 dBA	52 dBA	39 dBA	53 dBA
	Night-time	54 dBA	42 dBA	35 dBA	51 dBA
Logger Location M2	Daytime	69 dBA	62 dBA	46 dBA	59 dBA
	Evening	65 dBA	59 dBA	40 dBA	56 dBA
	Night-time	62 dBA	50 dBA	37 dBA	52 dBA

Note 1: INP Governing Periods - Day: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays & Public Holidays, Evening: 6:00 pm to 10:00 pm, Night: 10:00 pm to 7:00 am Monday to Saturday, 10:00 pm to 8:00 am Sundays & Public Holidays.

The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level

L_{Aeq} - The equivalent continuous noise level is defined as the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

The results of continuous unattended noise monitoring at these locations show levels typical of a suburban noise environment with low evening and night-time noise levels dominated by the natural environment with some infrequent human activity. Daytime noise levels are likely to be dominated by road traffic on adjacent roads and nearby industrial/commercial activities.

6 PROJECT SPECIFIC NOISE CRITERIA

6.1 Operational Noise Design Criteria

Potential sources of operational noise from the proposed redevelopment include the new lift, lighting and electrical equipment including security cameras. Given that these sources produce negligible noise emissions and operational activities at the Station are not proposed to change as part of the redevelopment, operational noise emission from these source are not considered further in this assessment. It is relevant to note that mechanical plant for the lift would be identified during detailed design and selected in order to achieve the acceptable noise levels identified in the INP

6.2 Construction Noise Management Levels

The adopted project specific noise criteria (PSNC) for construction activities are background (refer to **Table 12**) plus 10 dBA (L_{A90} + 10 dBA) for standard hours, background (refer to **Table 12**) plus 5 dBA (L_{A90} + 5 dBA) for out of hours works and background (refer to **Table 12**) plus 15 dBA (L_{A90} + 15 dBA) for sleep disturbance. **Table 13** and **Table 14** present the noise management levels for construction activities at the Project Site.

The resulting construction PSNC for the assessment receiver locations R1 to R4 (see **Figure 3**) are based on L_{A90} and L_{Aeq} noise levels measured at Logger Location M1 (see **Figure 4**).

The resulting construction PSNC for the assessment receiver locations R5 and R6 (see **Figure 3**) are based on L_{A90} and L_{Aeq} noise levels measured at Logger Location M2 (see **Figure 4**).

Table 13 Construction Noise Management Levels – Standard Construction Hours

Residential Location	Period	Noise Management Level (LAeq,15minute) (dBA)	
		Noise Affected	**Highly Noise Affected**
R1	Recommended Standard Hours	50 dBA	75 dBA
R2		70 dBA External noise level	
R3		70 dBA External noise level	
R4		50 dBA	75 dBA
R5		60 dBA external noise level and 50 dBA Internal noise level [1]	
R6		56 dBA	75 dBA

Note: Recommended standard hours for construction are between the hours of 7.00 am and 6.00 pm Monday to Friday and Saturday 8am to 1pm. No work Sundays or public holidays.

1. Design noise levels specified in AS 2107 for Bars and Lounges.

Where internal PSNC are presented, the corresponding external noise level (which the assessments are based upon) has been determined on the conservative assumption that a 10 dB noise reduction from outside to inside is applicable for an openable window. Where mechanical ventilation is installed in a building and windows are able to be kept closed, a greater noise reduction would be expected from outside to inside and hence the predicted impacts would be considered conservative.

Table 14 Construction Noise Goals – Out of Hours Works

Assessment Location	Period	Noise Goal (LAeq,15minute) (dBA)	Sleep Disturbance Noise Goal (LA1,1minute) (dBA)
R1	Day	45 dBA	N/A
	Evening	44 dBA	N/A
	Night	39 dBA	50 dBA
R2	Day	N/A	N/A
	Evening	N/A	N/A
	Night	N/A	N/A
R3	Day	N/A	N/A
	Evening	N/A	N/A
	Night	N/A	N/A
R4	Day	45 dBA	N/A
	Evening	44 dBA	N/A
	Night	39 dBA	50 dBA
R5	Day	60 dBA	N/A
	Evening	60 dBA	N/A
	Night	45 dBA	52
R6	Day	51 dBA	N/A
	Evening	45 dBA	N/A
	Night	42 dBA	52 dBA

Note: Out of hours work (OOHW) period 1 – Monday to Friday (6pm – 10pm), Saturday (7am-8am & 1pm-10pm) and Sunday/public holidays (8am-6pm).
Out of hours work (OOHW) period 2 – Monday to Friday (10pm – 7am), Saturday (10pm-8am) and Sunday/public holidays (6pm-7am).

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6.3 Operational and Construction Vibration Goals

Table 6 and **Table 9** provide the relevant project specific operational vibration goals that are applicable for the Project

7 CONSTRUCTION NOISE ASSESSMENT

7.1 Construction Works

In order to assess the potential noise and vibration impacts during construction, a number of scenarios comprising typical plant and equipment have been developed. These are summarised in **Table 15** and the locality of the work areas are shown in **Figure 5**.

In order to minimise the potential noise and vibration impacts upon nearby sensitive receivers, the majority of the construction works are proposed to be undertaken during standard daytime periods (7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturdays) with no work on Sundays or Public Holidays. Some out of hours works (OOHWs) may be required for Scenario areas 15, 16, 18, 19, 23, 24, 28, 29 and 31.

It is relevant to note that the construction scenarios have been developed based on information in the concept design (refer to **Figure 2**) for the purposes of this assessment, and that a detailed construction methodology would be developed by the construction contractor.

Figure 5 Proposal Site Construction Areas

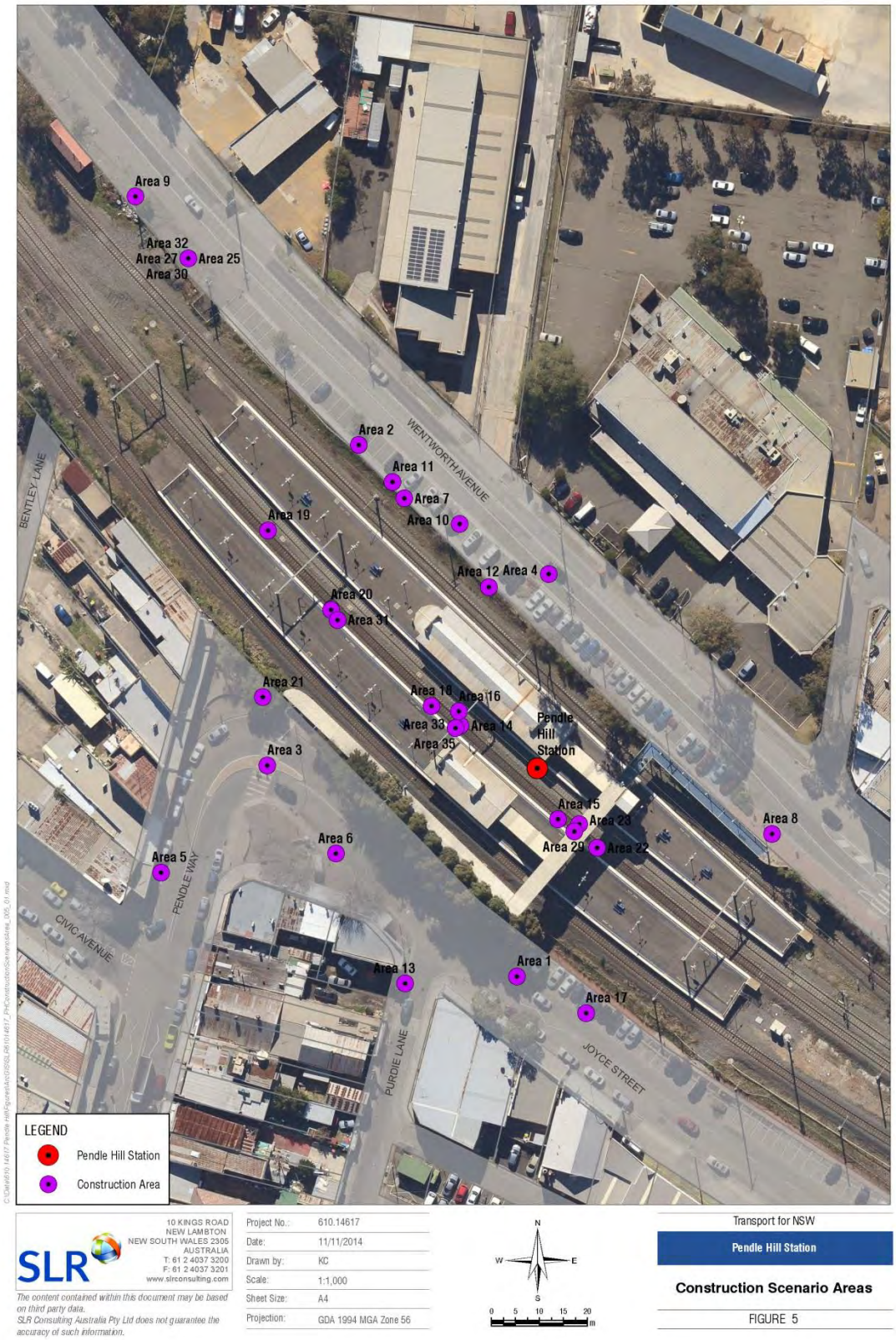


Table 15 Proposal Site Construction Scenarios

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
1	Existing Joyce St accessible parking relocated and provide an additional space	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
2	Existing Wentworth Avenue accessible parking relocated	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
4	Existing pedestrian crossing relocated and raised	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
5	Relocated taxi rank	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
6	Extended bus stop with upgrade shelter and seating facilities	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
7	Relocated Wentworth Avenue night ride and bus stop (co-locate with kiss 'n' ride) on southern side of Wentworth Avenue	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
8	Proposed additional 90 degree commuter parking for approx. 10 parking spaces	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
9	Extended commuter parking along Wentworth Avenue with 28 parking spaces (45 degrees)	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
10	Proposed kiss 'n' ride	All Plant	Line Marking Plant	1	98	118
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	
			Jackhammer*	1	108[3]	
			Vibratory Roller (~10 - 12 tonne)*	1	109	
			Truck (25t)	1	98	
			Concrete Truck / Agitator	1	106	
			Paving Machine	1	104	
			Excavator (Breaker - Small)*	1	117[4]	
11	Proposed bike / storage	All Plant	Hammer Drill*	1	108[5]	109
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Hand Tools	1	94	
12	Provide way finding signage	All Plant	Hand Tools	1	94	94

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
14	Platform resurface to achieve 1:40 grading as required	All Plant	Excavator (15 tonne)	4	96	115
			Asphalt Milling Machine*	1	111	
			Truck (25t)	1	98	
			Bobcat	2	104	
			Hi-Rail Truck	4	102	
			Roller (non-vibratory)*	1	100	
			Mobile Crane (300 tonne)	1	104	
15	Existing footbridge upgrade/refurbish in accordance with the contract	All Plant	Excavator (Breaker - Small)*	1	117[4]	117
			Truck (25t)	1	98	
			Piling Rig (Bored)*	1	108[4]	
			Mobile Crane (300 tonne)	1	104	
			Hi-Rail Truck	1	102	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	4	97	
			Jackhammer*	1	108[3]	
16	Existing station building upgrade/refurbish in accordance with the contract. For Stores - make good floor, walls and ceiling, removed joinery & fit out. For Toilets - make good floor, walls and ceiling, repair joinery and fit new seating as required. Generally - adjust doors, thresholds and adjacent ground level refurbish	All Plant	Hand Tools	1	94	110
			Hammer Drill*	1	108[5]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Jackhammer*	1	108[3]	
			Grinder 5"*	1	98[4]	
17	Remove 1p restriction to provide additional 10 (90 degree) commuter parking spaces	All Plant	Line Marking Plant	1	98	112
			Bobcat	1	104	
			Impact Wrench (pneumatic)	1	99	
			Grinder 5"*	1	98[4]	
			Concrete Saw*	1	115[3]	
			Hand Tools	1	94	

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
			Jackhammer*	1	108[3]	
18	Upgrade seating facilities with proposed wind barriers as required	All Plant	Hand Tools	1	94	108
			Hammer Drill*	1	108[5]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Grinder 5"*	1	98[4]	
19	Relocate overhead wiring structure as required	All Plant	Elevated Working Platform	1	97	113
			Truck (25t)	1	98	
			Mobile Crane (25 tonne)	1	99	
			Hand Tools	1	94	
			Excavator (20 tonne)	1	99	
			Concrete Vibrator	1	102	
			Concrete Truck / Agitator	1	106	
			Concrete Saw*	1	115[3]	
23	Construction of a new suspended concourse, station operations area and footbridge including enclosed accessible walkways connecting lifts on either side of the station	All Plant	Excavator (Breaker - Small)*	1	117[4]	117
			Truck (25t)	1	98	
			Piling Rig (Bored)*	1	108[4]	
			Mobile Crane (100 tonne)	1	101	
			Hi-Rail Truck	1	102	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	1	97	
			Jackhammer*	1	108[3]	
24	Provision of new canopies to the concourse, footbridge, stairs, lifts and platforms. New canopies are to marry into the existing platform canopy structures to be maintained on platform 1/2 and 3/4.	All Plant	Excavator (Breaker - Small)*	1	117[4]	117
			Truck (25t)	1	98	
			Piling Rig (Bored)*	1	108[4]	
			Mobile Crane (100 tonne)	1	101	
			Hi-Rail Truck	1	102	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	1	97	
			Jackhammer*	1	108[3]	
25	Provision of a dedicated electrical/switch room below the new Station Operation Area accessible from the Joyce Street entry.	All Plant	Excavator (Breaker - Small)*	1	117[4]	117
			Truck (25t)	1	98	
			Piling Rig (Bored)*	1	108[4]	
			Mobile Crane (100 tonne)	1	101	
			Hi-Rail Truck	1	102	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	1	97	
			Jackhammer*	1	108[3]	
26	Provision of a dedicated Communications Equipment Rom (CER) and Station Operation Area (SOA) accessible from Joyce Street including the relocation and/or upgrading of communication equipment as required. The new CER is required to house the communication racks and equipment required for (but not limited to) CCTV, PA, SPI Ticketing and station LAN services.	All Plant	Excavator (Breaker - Small)*	1	117[4]	117
			Truck (25t)	1	98	
			Piling Rig (Bored)*	1	108[4]	
			Mobile Crane (100 tonne)	1	101	
			Hi-Rail Truck	1	102	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	1	97	
			Jackhammer*	1	108[3]	
27	A new Station Operations Area (SOA) at concourse level to include (as a minimum) a booking office, count	All Plant	Excavator (Breaker - Small)*	1	117[4]	117
			Truck (25t)	1	98	
			Piling Rig (Bored)*	1	108[4]	
			Mobile Crane (100 tonne)	1	101	

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
	room, station manager area, staff meal room, staff locker room, staff toilet, and a minimum of one (1) family accessible toilet.		Hi-Rail Truck	1	102	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	1	97	
			Jackhammer*	1	108[3]	
28	modifications and adjustments to the existing 1500V overhead wire (OHW) and overhead wire structures (OHWS) as may be required to accommodate the installation of new structures and the partial demolition of the existing footbridge	All Plant	Elevated Working Platform	1	97	113
			Truck (25t)	1	98	
			Mobile Crane (25 tonne)	1	99	
			Hand Tools	1	94	
			Excavator (20 tonne)	1	99	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Concrete Saw*	1	115[3]	
29	Demolition and removal of the existing footbridge, ramps, canopies, retail kiosk, footings and associated structures except the middle portion of footbridge and its supports spanning between platforms 1/2 and 3/4 as identified in the Works Brief Drawings	All Plant	Excavator (Breaker - Small)*	1	117[4]	116
			Truck (25t)	1	98	
			Mobile Crane (300 tonne)	1	104	
			Jackhammer*	1	108[3]	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Elevated Working Platform	1	97	
			Bobcat	1	104	
			Hand Tools	1	94	
31	Train impact protection to new structures adjacent to the tracks as required and dependent on the Contractor's design.	All Plant	Excavator (7.5 tonne)	1	92	112
			Mobile Crane (25 tonne)	1	99	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Grinder 5"*	1	98[4]	
			Generator	1	101	
33	All temporary works.	All Plant	Hand Tools	1	94	104
			Generator	1	101	

Area	Scenario	Works Ref	Equipment (realistic worst-case)	No of items in one 15 min period	Maximum LAeq Sound Power Level (dBA)	
					Individual Item	Activity
			Mobile Crane (25 tonne)	1	99	
			Excavator (7.5 tonne)	1	92	
34	Construction Compound	All Plant	Excavator (20 tonne)	1	99	116
			Smooth Drum Roller*	1	109	
			Bobcat	1	104	
			Line Marking Plant	1	98	
			Mobile Crane (25 tonne)	1	99	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Welding Equipment	1	97	
			Grinder 5"*	1	98[4]	
			Impact Wrench (pneumatic)	1	99	
			Generator	1	101	
			Concrete Saw*	1	115[3]	
			Truck (25t)	1	98	
35	Potential Undergrounding of overhead electrical wires (to both sides of rail corridor)	All Plant	Excavator (20 tonne)	1	99	116
			Smooth Drum Roller*	1	109	
			Bobcat	1	104	
			Mobile Crane (25 tonne)	1	99	
			Concrete Pump	1	106	
			Concrete Truck / Agitator	1	106	
			Concrete Vibrator	1	102	
			Hammer Drill*	1	108[5]	
			Generator	1	101	
			Concrete Saw*	1	115[3]	
			Truck (25t)	1	98	

Note 1: * denotes "annoying" item of equipment, as defined in the ICNG, and as such includes a +5 dBA penalty to predictions.
Note 2: LAeq sound power levels are based on LAmax noise levels published in TfNSW *Construction Noise Strategy* and the SLR Consulting noise database compiled from on-site measurements and observations.
Note 3: Overall SWL assumes a maximum 5 minutes on-time in any 15-minute period.
Note 4: Overall SWL assumes a maximum 7.5 minutes on-time in any 15-minute period.
Note 5: Overall SWL assumes a maximum 10 minutes on-time in any 15-minute period.

The ICNG lists a number of construction activities which have been proven to be "annoying" and which require to have a 5 dB penalty applied to them. Annoying characteristics may include tones, impulses, low frequency noise and intermittent noise. The ICNG identifies the following proposed activities as being particularly annoying and as such, a 5 dB correction has been incorporated into the noise modelling process for them:

- Jackhammer
- Rock breaking/cutting

- Rolling/compacting
- Grinding
- Piling

7.2 Construction Noise Modelling

In order to quantify the noise emissions from the proposed construction works, spreadsheet noise calculations have been undertaken to predict the $L_{Aeq(15minute)}$ noise levels at the nearest sensitive receivers. The calculations include the source noise levels of the anticipated equipment, the location of the nearest sensitive receivers, the number of plant items likely to be operating at any given time and the distance between the equipment and the receivers.

This source data has been verified through SLR Consulting's experience of noise from construction sites.

In practice, noise levels will depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. Noise levels will vary due to the movement of plant and equipment about the worksites and the concurrent operation of plant. In some cases, reductions in noise levels will occur when plant are located in cuttings or behind embankments, buildings or other items of equipment.

The predictions in **Table 16** are representative of the worst-case scenario with all equipment listed in **Table 15** operating simultaneously. Furthermore, noise contours for each scenario are provided in **Appendix C**.

Table 16 Construction Noise Predictions – Standard Construction Hours

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)			
			Worst-case Predicted	RBL	Daytime PSNC	Exceedance
1	Existing Joyce St accessible parking relocated and provide an additional space	R1	67	40	50	17
		R2	70	n/a	70	-
		R3	82	n/a	70	12
		R4	72	40	50	22
		R5	69	n/a	60	9
		R6	66	46	56	10
2	Existing Wentworth Avenue accessible parking relocated	R1	72	40	50	22
		R2	76	n/a	70	6
		R3	69	n/a	70	-
		R4	64	40	50	14
		R5	75	n/a	60	15
		R6	63	46	56	7
4	Existing pedestrian crossing relocated and raised	R1	69	40	50	19
		R2	73	n/a	70	3
		R3	71	n/a	70	1
		R4	66	40	50	16
		R5	82	n/a	60	22
		R6	65	46	56	9
5	Relocated taxi rank	R1	73	40	50	23

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)			
			Worst-case Predicted	RBL	Daytime PSNC	Exceedance
		R2	76	n/a	70	6
		R3	76	n/a	70	6
		R4	69	40	50	19
		R5	68	n/a	60	8
		R6	63	46	56	7
6	Extended bus stop with upgrade shelter and seating facilities	R1	71	40	50	21
		R2	75	n/a	70	5
		R3	82	n/a	70	12
		R4	70	40	50	20
		R5	70	n/a	60	10
		R6	64	46	56	8
7	Relocated Wentworth Avenue night ride and bus stop (co-locate with kiss 'n' ride) on southern side of Wentworht Avenue	R1	72	40	50	22
		R2	76	n/a	70	6
		R3	70	n/a	70	-
		R4	65	40	50	15
		R5	77	n/a	60	17
		R6	63	46	56	7
8	Proposed additional 90 degree commuter parking for approx. 10 parking spaces	R1	66	40	50	16
		R2	68	n/a	70	-
		R3	72	n/a	70	2
		R4	68	40	50	18
		R5	72	n/a	60	12
		R6	68	46	56	12
9	Extended commuter parking along Wentworth Avenue with 28 parking spaces (45 degrees)	R1	71	40	50	21
		R2	70	n/a	70	-
		R3	65	n/a	70	-
		R4	62	40	50	12
		R5	68	n/a	60	8
		R6	60	46	56	4
10	Proposed kiss 'n' ride	R1	71	40	50	21
		R2	75	n/a	70	5
		R3	71	n/a	70	-
		R4	65	40	50	15
		R5	79	n/a	60	19
		R6	64	46	56	8
11	Proposed bike / storage	R1	63	40	50	13
		R2	67	n/a	70	-
		R3	61	n/a	70	-
		R4	56	40	50	6
		R5	67	n/a	60	7

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)			
			Worst-case Predicted	RBL	Daytime PSNC	Exceedance
		R6	54	46	56	-
12	Provide way finding signage	R1	47	40	50	-
		R2	51	n/a	70	-
		R3	48	n/a	70	-
		R4	42	40	50	-
		R5	55	n/a	60	-
		R6	41	46	56	-
14	Platform resurface to achieve 1:40 grading as required	R1	67	40	50	17
		R2	72	n/a	70	2
		R3	73	n/a	70	3
		R4	65	40	50	15
		R5	71	n/a	60	11
		R6	62	46	56	6
15	Existing footbridge upgrade/refurbish in accordance with the contract	R1	68	40	50	18
		R2	72	n/a	70	2
		R3	77	n/a	70	7
		R4	69	40	50	19
		R5	73	n/a	60	13
		R6	66	46	56	10
16	Existing station building upgrade/refurbish in accordance with the contract. For Stores - make good floor, walls and ceiling, removed joinery & fit out. For Toilets - make good floor, walls and ceiling, repair joinery and fit new seating as required. Generally - adjust doors, thresholds and adjacent ground level refurbish	R1	62	40	50	12
		R2	67	n/a	70	-
		R3	67	n/a	70	-
		R4	59	40	50	9
		R5	67	n/a	60	7
		R6	57	46	56	-
17	Remove 1p restriction to provide additional 10 (90 degree) commuter parking spaces	R1	61	40	50	11
		R2	64	n/a	70	-
		R3	73	n/a	70	3
		R4	67	40	50	17
		R5	64	n/a	60	4
		R6	62	46	56	6
18	Upgrade seating facilities with proposed wind barriers as required	R1	61	40	50	11
		R2	67	n/a	70	-
		R3	66	n/a	70	-
		R4	58	40	50	8
		R5	65	n/a	60	5
		R6	55	46	56	-
19	Relocate overhead wiring structure as required	R1	70	40	50	20
		R2	77	n/a	70	7

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)			
			Worst-case Predicted	RBL	Daytime PSNC	Exceedance
		R3	66	n/a	70	-
		R4	60	40	50	10
		R5	68	n/a	60	8
		R6	58	46	56	2
23	Construction of a new suspended concourse, station operations area and footbridge including enclosed accessible walkways connecting lifts on either side of the station	R1	67	40	50	17
		R2	71	n/a	70	-
		R3	76	n/a	70	6
		R4	68	40	50	18
		R5	72	n/a	60	12
		R6	66	46	56	10
24	Provision of new canopies to the concourse, footbridge, stairs, lifts and platforms. New canopies are to marry into the existing platform canopy structures to be maintained on platform 1/2 and 3/4.	R1	71	40	50	21
		R2	71	n/a	70	1
		R3	66	n/a	70	-
		R4	62	40	50	12
		R5	69	n/a	60	9
		R6	60	46	56	4
25	Provision of a dedicated electrical/switch room below the new Station Operation Area accessible from the Joyce Street entry.	R1	71	40	50	21
		R2	71	n/a	70	1
		R3	66	n/a	70	-
		R4	62	40	50	12
		R5	69	n/a	60	9
		R6	60	46	56	4
26	Provision of a dedicated Communications Equipment Rom (CER) and Station Operation Area (SOA) accessible from Joyce Street including the relocation and/or upgrading of communication equipment as required. The new CER is required to house the communication racks and equipment required for (but not limited to) CCTV, PA, SPI Ticketing and station LAN services.	R1	71	40	50	21
		R2	71	n/a	70	1
		R3	66	n/a	70	-
		R4	62	40	50	12
		R5	69	n/a	60	9
		R6	60	46	56	4
27	A new Station Operations Area (SOA) at concourse level to include (as a minimum) a booking office, count room, station manager area, staff meal room, staff locker room, staff toilet, and a minimum of one (1) family accessible toilet.	R1	71	40	50	21
		R2	71	n/a	70	1
		R3	66	n/a	70	-
		R4	62	40	50	12
		R5	69	n/a	60	9
		R6	60	46	56	4
28	Modifications and adjustments to the existing 1500V overhead wire (OHW) and overhead wire structures (OHWS) as may be	R1	63	40	50	13
		R2	67	n/a	70	-
		R3	73	n/a	70	3

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)			
			Worst-case Predicted	RBL	Daytime PSNC	Exceedance
	required to accommodate the installation of new structures and the partial demolition of the existing footbridge	R4	64	40	50	14
		R5	68	n/a	60	8
		R6	61	46	56	5
29	Demolition and removal of the existing footbridge, ramps, canopies, retail kiosk, footings and associated structures except the middle portion of footbridge and its supports spanning between platforms 1/2 and 3/4 as identified in the Works Brief Drawings	R1	66	40	50	16
		R2	69	n/a	70	-
		R3	75	n/a	70	5
		R4	67	40	50	17
		R5	71	n/a	60	11
		R6	64	46	56	8
31	Train impact protection to new structures adjacent to the tracks as required and dependent on the Contractor's design.	R1	68	40	50	18
		R2	76	n/a	70	6
		R3	67	n/a	70	-
		R4	61	40	50	11
		R5	68	n/a	60	8
		R6	58	46	56	2
33	All temporary works.	R1	56	40	50	6
		R2	62	n/a	70	-
		R3	62	n/a	70	-
		R4	54	40	50	4
		R5	60	n/a	60	-
		R6	51	46	56	-
34	Construction Compound	R1	69	40	50	19
		R2	74	n/a	70	4
		R3	75	n/a	70	5
		R4	66	40	50	16
		R5	73	n/a	60	13
		R6	63	46	56	7
35	Potential Undergrounding of overhead electrical wires (to both sides of rail corridor)	R1	68	40	50	18
		R2	74	n/a	70	4
		R3	74	n/a	70	4
		R4	66	40	50	16
		R5	72	n/a	60	12
		R6	63	46	56	7

Note: Recommended standard hours for construction are between the hours of 7.00 am and 6.00 pm Monday to Friday and Saturday 8am to 1pm. No work Sundays or public holidays.

Note: Bold indicates highly noise affected as per the ICNG.

7.3 Discussion of Construction Noise Levels during Standard Construction Hours

A worst-case exceedance of the daytime (standard construction hours) $L_{Aeq(15minute)}$ noise goal of up to 23 dB is predicted at the most affected sensitive receiver location R1 (Bentley Lane, Pendle Hill) during Scenario *Area 5 Relocated taxi rank*. This level of exceedance is common for these types of construction activities. It is noted that these works are restricted to the daytime periods only.

For most scenarios, the predicted construction noise levels exceed the applicable noise management levels. However, in all cases, the predicted levels are below the "highly noise affected" level of 75 dBA.

The exceedances are a function of the nature of the proposed construction activities and the proximity of the nearest sensitive receivers (refer to **Figure 3**) and are not necessarily the result of construction activities that are uncharacteristically noisy in their own right. The fact that exceedances have been identified does not indicate that the proposed activities cannot be undertaken, but that care needs to be taken during the detailed planning stage to identify feasible and reasonable mitigation and management measures that can be implemented to minimise the potential impacts. Proposed noise mitigation and management recommendations have been provided in **Section 9** of this report.

As per the requirements of the ICNG, predictions are based on a "worst case" assessment and in most cases, the measured levels during construction are likely to be lower than predicted in this assessment. The modelling assumes that all equipment is operating at the same time which is rarely the case in practice.

7.4 Out-of-Hours Works

We understand that construction work scenarios 14, 15, 16, 18, 19, 23, 24, 28, 29 and 31 may require works to be undertaken outside of standard construction hours. The predictions for these scenarios are detailed in **Table 17**.

A worst-case exceedance of the day, evening and night-time OOH $L_{Aeq(15minute)}$ noise goal of up to 26 dB, 27 dB and 31 dB respectively, is predicted at the most affected sensitive receiver locations.

The sleep disturbance screening criterion is also predicted to be exceeded by up to 29 dB for the proposed works.

For most scenarios, the predicted OOHW construction noise levels exceed the applicable noise management levels.

The exceedances are a function of the nature of the proposed construction activities and the proximity of the nearest sensitive receivers and are not necessarily the result of construction activities that are uncharacteristically noisy in their own right. The fact that exceedances have been identified does not indicate that the proposed activities cannot be undertaken, but that care needs to be taken during the detailed planning stage to identify feasible and reasonable mitigation and management measures that can be implemented to minimise the potential impacts. Proposed noise mitigation and management recommendations have been provided in **Section 9** of this report

As per the requirements of the ICNG, predictions are based on a "worst case" assessment and in most cases, the measured levels during construction are likely to be lower than predicted in this assessment. The modelling assumes that all equipment is operating at the same time which is rarely the case in practice.

It is relevant to note that the OOHW activities identified are such because they need to be undertaken during rail possessions for rail operation and safety reasons. The OOHW works would therefore occur for a relative short period of time in the context of the whole program. Furthermore, OOHW may be required for other works/times but all OOHW applications would need to be approved by TfNSW first and be accompanied with community notification.

Table 17 Out-of-Hours Construction Noise Predictions

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)												Noise Level – LA1(60second) (dBA)		
			Worst-case Predicted	RBL			PSNL				Exceedance				Worst-case Predicted	Sleep Disturbance.	Exceedance
				Day	Eve	Night	Day	DayOOH	Eve	Night	Day	DayOOH	Eve	Night		(RBL+15 dBA)	
14	Platform resurface to achieve 1:40 grading as required	R1	67	40	39	35	50	45	44	40	17	22	23	27	75	50	25
		R2	72	n/a	n/a	n/a	70	70	n/a	n/a	2	2	n/a	n/a	80	n/a	n/a
		R3	73	n/a	n/a	n/a	70	70	n/a	n/a	3	3	n/a	n/a	81	n/a	n/a
		R4	65	40	39	35	50	45	44	40	15	20	21	25	73	50	23
		R5	71	n/a	n/a	n/a	60	60	60	45	11	11	11	26	79	n/a	n/a
		R6	62	46	40	37	56	51	45	42	6	11	17	20	70	52	18
15	Existing footbridge upgrade/refurbish in accordance with the contract.	R1	68	40	39	35	50	45	44	40	18	23	24	28	76	50	26
		R2	72	n/a	n/a	n/a	70	70	n/a	n/a	2	2	n/a	n/a	80	n/a	n/a
		R3	77	n/a	n/a	n/a	70	70	n/a	n/a	7	7	n/a	n/a	85	n/a	n/a
		R4	69	40	39	35	50	45	44	40	19	24	25	29	77	50	27
		R5	73	n/a	n/a	n/a	60	60	60	45	13	13	13	28	81	n/a	n/a
		R6	66	46	40	37	56	51	45	42	10	15	21	24	74	52	22
16	Existing station building upgrade/refurbish in accordance with the contract. For Stores - make good floor, walls and ceiling, removed joinery & fit out. For Toilets - make good floor, walls and ceiling, repair joinery and fit new seating as required. Generally - adjust doors, thresholds and adjacent ground level refurbish	R1	62	40	39	35	50	45	44	40	12	17	18	22	70	50	20
		R2	67	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	75	n/a	n/a
		R3	67	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	75	n/a	n/a
		R4	59	40	39	35	50	45	44	40	9	14	15	19	67	50	17
		R5	67	n/a	n/a	n/a	60	60	60	45	7	7	7	22	75	n/a	n/a
		R6	57	46	40	37	56	51	45	42	-	6	12	15	65	52	13
18	Upgrade seating facilities	R1	61	40	39	35	50	45	44	40	11	16	17	21	69	50	19

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)												Noise Level – LA1(60second) (dBA)		
			Worst-case Predicted	RBL			PSNL				Exceedance				Worst-case Predicted	Sleep Disturbance.	Exceedance
				Day	Eve	Night	Day	DayOOH	Eve	Night	Day	DayOOH	Eve	Night		(RBL+15 dBA)	
	with proposed wind barriers as required	R2	67	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	75	n/a	n/a
		R3	66	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	74	n/a	n/a
		R4	58	40	39	35	50	45	44	40	8	13	14	18	66	50	16
		R5	65	n/a	n/a	n/a	60	60	60	45	5	5	5	20	73	n/a	n/a
		R6	55	46	40	37	56	51	45	42	-	4	10	13	63	52	11
19	Relocate overhead wiring structure as required	R1	70	40	39	35	50	45	44	40	20	25	26	30	78	50	28
		R2	77	n/a	n/a	n/a	70	70	n/a	n/a	7	7	n/a	n/a	85	n/a	n/a
		R3	66	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	74	n/a	n/a
		R4	60	40	39	35	50	45	44	40	10	15	16	20	68	50	18
		R5	68	n/a	n/a	n/a	60	60	60	45	8	8	8	23	76	n/a	n/a
		R6	58	46	40	37	56	51	45	42	2	7	13	16	66	52	14
23	Construction of a new suspended concourse, station operations area and footbridge including enclosed accessible walkways connecting lifts on either side of the station	R1	67	40	39	35	50	45	44	40	17	22	23	27	75	50	25
		R2	71	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	79	n/a	n/a
		R3	76	n/a	n/a	n/a	70	70	n/a	n/a	6	6	n/a	n/a	84	n/a	n/a
		R4	68	40	39	35	50	45	44	40	18	23	24	28	76	50	26
		R5	72	n/a	n/a	n/a	60	60	60	45	12	12	12	27	80	n/a	n/a
		R6	66	46	40	37	56	51	45	42	10	15	21	24	74	52	22
24	Provision of new canopies to the concourse, footbridge, stairs, lifts and platforms. New canopies are to marry into the existing platform canopy structures to be maintained on platform 1/2 and 3/4.	R1	71	40	39	35	50	45	44	40	21	26	27	31	79	50	29
		R2	71	n/a	n/a	n/a	70	70	n/a	n/a	1	1	n/a	n/a	79	n/a	n/a
		R3	66	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	74	n/a	n/a
		R4	62	40	39	35	50	45	44	40	12	17	18	22	70	50	20
		R5	69	n/a	n/a	n/a	60	60	60	45	9	9	9	24	77	n/a	n/a
		R6	60	46	40	37	56	51	45	42	4	9	15	18	68	52	16

Area	Scenario	Receiver	Noise Level – LAeq(15minute) (dBA)												Noise Level – LA1(60second) (dBA)		
			Worst-case Predicted	RBL			PSNL				Exceedance				Worst-case Predicted	Sleep Disturbance.	Exceedance
				Day	Eve	Night	Day	DayOOH	Eve	Night	Day	DayOOH	Eve	Night		(RBL+15 dBA)	
28	Modifications and adjustments to the existing 1500V overhead wire (OHW) and overhead wire structures (OHWS) as may be required to accommodate the installation of new structures and the partial demolition of the existing footbridge	R1	63	40	39	35	50	45	44	40	13	18	19	23	71	50	21
		R2	67	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	75	n/a	n/a
		R3	73	n/a	n/a	n/a	70	70	n/a	n/a	3	3	n/a	n/a	81	n/a	n/a
		R4	64	40	39	35	50	45	44	40	14	19	20	24	72	50	22
		R5	68	n/a	n/a	n/a	60	60	60	45	8	8	8	23	76	n/a	n/a
		R6	61	46	40	37	56	51	45	42	5	10	16	19	69	52	17
29	Demolition and removal of the existing footbridge, ramps, canopies, retail kiosk, footings and associated structures except the middle portion of footbridge and its supports spanning between platforms 1/2 and 3/4 as identified in the Works Brief Drawings	R1	66	40	39	35	50	45	44	40	16	21	22	26	74	50	24
		R2	69	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	77	n/a	n/a
		R3	75	n/a	n/a	n/a	70	70	n/a	n/a	5	5	n/a	n/a	83	n/a	n/a
		R4	67	40	39	35	50	45	44	40	17	22	23	27	75	50	25
		R5	71	n/a	n/a	n/a	60	60	60	45	11	11	11	26	79	n/a	n/a
		R6	64	46	40	37	56	51	45	42	8	13	19	22	72	52	20
31	Train impact protection to new structures adjacent to the tracks as required and dependent on the Contractor's design.	R1	68	40	39	35	50	45	44	40	18	23	24	28	76	50	26
		R2	76	n/a	n/a	n/a	70	70	n/a	n/a	6	6	n/a	n/a	84	n/a	n/a
		R3	67	n/a	n/a	n/a	70	70	n/a	n/a	-	-	n/a	n/a	75	n/a	n/a
		R4	61	40	39	35	50	45	44	40	11	16	17	21	69	50	19
		R5	68	n/a	n/a	n/a	60	60	60	45	8	8	8	23	76	n/a	n/a
		R6	58	46	40	37	56	51	45	42	2	7	13	16	66	52	14

Note: Out of hours work (OOHW) period 1 – Monday to Friday (6pm – 10pm), Saturday (7am-8am & 1pm-10pm) and Sunday/public holidays (8am-6pm).
Out of hours work (OOHW) period 2 – Monday to Friday (10pm – 7am), Saturday (10pm-8am) and Sunday/public holidays (6pm-7am).

8 VIBRATION ASSESSMENT

8.1 Operational Vibration

The operation activities at the Station are not proposed to change as part of the proposed redevelopment. As a result, existing vibration levels generated by the site are unlikely to change. On this basis, a detailed assessment of operational vibration has not been undertaken as part of this assessment.

8.2 Construction Vibration

8.2.1 Vibration Intensive Equipment

The proposed construction activities either contain plant items that are not significantly vibration intensive or the separation distance from the nearest receivers is sufficient to mitigate the potential impacts.

8.2.2 Safe Working Distances

As a guide, safe working distances for typical items of vibration intensive plant are listed in **Table 18**. The safe working distances are quoted for both "cosmetic" damage (refer British Standard BS 7385) and human comfort (refer British Standard BS 6472). The safe working distances must be complied with at all times, unless otherwise approved by the relevant authority.

Table 18 Recommended Safe Working Distances for Vibration Intensive Plant

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

Note: More stringent conditions may apply to heritage or other sensitive structures.

The safe working distances presented in **Table 18** are indicative only and will vary depending on the particular item of plant and local geotechnical conditions. They apply to typical buildings under typical geotechnical conditions.

Cosmetic Damage Assessment

The separation distance(s) between the proposed works and the nearest receivers will typically be sufficient to ensure that the nearby buildings are unlikely to fall below the safe working distances with regard to *'Cosmetic Damage*' for most of the proposed construction equipment.

Attended vibration monitoring or vibration trials will be undertaken when the proposed works are below the safe working distances to ensure that levels remain below the criterion. If there is a risk that buildings may be impacted by the proposed works building condition surveys will be undertaken both before and after the works at all potentially affected properties to identify existing damage and any project related damage.

Human Comfort Vibration Assessment

In relation to human comfort (response), the safe working distances in **Table 18** relate to continuous vibration and apply to **residential** receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in BS 6472-1.

Construction vibration levels at the nearest residential receivers are unlikely to be perceptible during the works. The separation distance from the nearest residential receivers is sufficient to mitigate the potential impacts, and as such have not been considered further in this assessment.

No exceedances of the human comfort vibration levels are therefore anticipated for these works.

8.2.3 Heritage Buildings

Pendle Hill Station has been identified as a heritage building. At this stage in the proposal, the construction vibration assessment of these heritage buildings is considered in the same manner as other buildings along the proposal area in close vicinity to the works (i.e. judicious selection of plant and equipment would be necessary for vibration intensive activities) due to the potential for significant levels of vibration from construction works.

It is recommended that during the later stages of the design process, building surveys of sensitive structures within this property are carried out in order to assess the potential for increased susceptibility to building damage from vibration. Should these buildings be considered more susceptible to vibration, reduced vibration criteria levels may be applicable and subsequently adopted during the selection process for suitable equipment to be used in the vicinity of these buildings.

9 NOISE MITIGATION AND MANAGEMENT RECOMMENDATIONS

9.1 Construction Noise Mitigation

The expected noise impacts are likely to be concerning for surrounding residents and particular effort should be directed towards the implementation of all reasonable and feasible noise mitigation and management strategies.

9.1.1 Noise Management

In order to minimise the potential noise and vibration impacts upon nearby sensitive receivers, most construction works are proposed to be undertaken during the EPA's standard daytime construction periods (7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturdays).

9.1.2 Noise Mitigation

Examples of mitigation measures which may be considered appropriate for these works are:

- Where practicable, install localised acoustic hoarding around significantly noise generating items of plant. This is expected to provide between 5 dB and 10 dB of additional noise attenuation, if adequately constructed to ensure that the line-of-sight between all receivers and the construction equipment is broken. This option is considered reasonable for noise intensive stationary items of plant and those operating within a relatively confined area.
- Scheduling for the higher Noise Management Level exceedance activities/locations to be undertaken predominantly during less noise-sensitive time periods, where possible. The adjacent residents should be consulted to assist in identifying less noise sensitive time periods.
- Briefing of the work team in order to create awareness of the locality of sensitive receivers and the importance of minimising noise emissions.
- Ensuring spoil is placed and not dropped into awaiting trucks.
- Use of less noise-intensive equipment, where reasonable and feasible.

9.1.3 Additional Mitigation Measures - Construction Noise Strategy

The TfNSW *Construction Noise Strategy (Transport Projects)* (CNS) provides practical guidance on how to minimise, to the fullest extent practicable, the impacts on the community from noise and vibration generated during the construction of transportation projects (and related infrastructure) through the application of all feasible and reasonable mitigation measures.

The strategy includes a standard suite of noise and vibration management measures that are to be applied on all projects, together with additional mitigation measures which are applicable when construction noise or vibration is predicted to exceed the project's construction noise and vibration objectives.

The standard suite of mitigation measures includes management measures such as community consultation, site inductions (with guidance on how to minimise noise and vibration) and the preparation of site specific Construction Noise and Vibration Management Plans. The strategy also includes several recommendations for reducing the source noise levels of construction equipment via good planning and equipment selection.

In many instances, impacts from construction noise are unavoidable and it is not feasible to achieve the construction noise objectives. Therefore the TfNSW CNS includes a list of additional noise mitigation measures which aim to minimise the potential noise impacts. These include measures ranging from letter box drops and phone calls to offers of alternative accommodation (should noise intensive night-time works be required). A summary of the additional noise mitigation measures matrix is provided in **Table 19**.

Table 19 Additional Mitigation Measures Matrix - Airborne Construction Noise (from TfNSW Construction Noise Strategy)

Time Period		Mitigation Measure			
		$L_{Aeq(15minute)}$ Noise Level above Background (RBL) Qualitative Assessment of Noise Levels[1]			
		0 to 10 dBA Noticeable	10 to 20 dBA Clearly Audible	20 to 30 dBA Moderately Intrusive	>30 dBA Highly Intrusive
Standard	Mon-Fri (7am - 6pm)	-	-	LB, M	LB, M
	Sat (8am - 1pm)				
	Sun/Pub Hol (Nil)				
OOHW Period 1	Mon-Fri (6pm - 10pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN
	Sat (7am - 8am) & (1pm - 10pm)				
	Sun/Pub Hol. (8am - 6pm)				
OOHW Period 2	Mon-Fri (10pm - 7am)	LB	M, LB	M, IB, LB, PC, SN	AA, M, IB, LB, PC, SN
	Sat (10pm - 8am)				
	Sun/Pub Hol. (6pm - 7am)				

Notes:

1. The following abbreviations are used: Alternative accommodation (AA), Monitoring (M), Individual briefings (IB), Letter box drops (LB), Project specific respite offer (RO), Phone calls (PC), Specific notifications (SN).
2. For some types of construction activities (refer Appendix B of the TCA Construction Noise Strategy), a qualitative assessment of the potential noise impacts can be undertaken in lieu of detailed noise modelling. For these activities, noise mitigation measures should be evaluated on the basis of the noise levels being noticeable, clearly audible, moderately intrusive or highly intrusive. The qualitative assessment should consider the type of equipment being used, the character of the noise emissions, time of day, the location of the nearest receivers and the noise sensitivity of the nearest receivers. Where a qualitative assessment is being undertaken, this will need to be approved by the Environmental Management Representative.

9.1.4 Noise Mitigation Requirements

An assessment of the additional noise mitigation measures which are required to be applied at residential receivers affected by the proposed construction works during standard construction hours and OOHW is summarised in **Table 20** and **Table 21** respectively.

Table 20 Additional Mitigation Measures for the Works – Standard Construction Hours

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
1	Existing Joyce St accessible parking relocated and provide an additional space	R1	Standard	Daytime	27	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	32	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	20	-
2	Existing Wentworth Avenue accessible parking relocated	R1	Standard	Daytime	32	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	24	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	17	-
4	Existing pedestrian crossing relocated and raised	R1	Standard	Daytime	29	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	26	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	19	-
5	Relocated taxi rank	R1	Standard	Daytime	33	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	29	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	17	-
6	Extended bus stop with upgrade shelter and seating facilities	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	30	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	18	-
7	Relocated Wentworth Avenue night ride and bus stop (co-locate with kiss 'n' ride) on southern side of Wentworth Avenue	R1	Standard	Daytime	32	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
		R4	Standard	Daytime	25	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	17	-
8	Proposed additional 90 degree commuter parking for approx. 10 parking spaces	R1	Standard	Daytime	26	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	28	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	22	LB, M
9	Extended commuter parking along Wentworth Avenue with 28 parking spaces (45 degrees)	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	22	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	14	-
10	Proposed kiss 'n' ride	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	25	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	18	-
11	Proposed bike / storage	R1	Standard	Daytime	23	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	16	-
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	8	-
12	Provide way finding signage	R1	Standard	Daytime	7	-
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	2	-
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	-5	n/a
14	Platform resurface to achieve 1:40 grading as required	R1	Standard	Daytime	27	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	25	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	16	-

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
15	Existing footbridge upgrade/refurbish in accordance with the contract	R1	Standard	Daytime	28	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	29	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	20	-
16	Existing station building upgrade/refurbish in accordance with the contract. For Stores - make good floor, walls and ceiling, removed joinery & fit out. For Toilets - make good floor, walls and ceiling, repair joinery and fit new seating as required. Generally - adjust doors, thresholds and adjacent ground level refurbish	R1	Standard	Daytime	22	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	19	-
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	11	-
17	Remove 1p restriction to provide additional 10 (90 degree) commuter parking spaces	R1	Standard	Daytime	21	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	27	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	16	-
18	Upgrade seating facilities with proposed wind barriers as required	R1	Standard	Daytime	21	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	18	-
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	9	-
19	Relocate overhead wiring structure as required	R1	Standard	Daytime	30	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	20	-
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	12	-
23	Construction of a new suspended concourse, station operations area and footbridge including enclosed accessible walkways connecting lifts on either side of the station	R1	Standard	Daytime	27	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	28	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	20	-
24	Provision of new canopies to the concourse, footbridge, stairs, lifts and platforms. New canopies are to marry into the existing platform canopy	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
	structures to be maintained on platform 1/2 and 3/4.	R4	Standard	Daytime	22	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	14	-
25	Provision of a dedicated electrical/switch room below the new Station Operation Area accessible from the Joyce Street entry.	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	22	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	14	-
26	Provision of a dedicated Communications Equipment Rom (CER) and Station Operation Area (SOA) accessible from Joyce Street including the relocation and/or upgrading of communication equipment as required. The new CER is required to house the communication racks and equipment required for (but not limited to) CCTV, PA, SPI Ticketing and station LAN services.	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	22	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	14	-
27	A new Station Operations Area (SOA) at concourse level to include (as a minimum) a booking office, count room, station manager area, staff meal room, staff locker room, staff toilet, and a minimum of one (1) family accessible toilet.	R1	Standard	Daytime	31	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	22	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	14	-
28	Modifications and adjustments to the existing 1500V overhead wire (OHW) and overhead wire structures (OHWS) as may be required to accommodate the installation of new structures and the partial demolition of the existing footbridge	R1	Standard	Daytime	23	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	24	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	15	-
29	Demolition and removal of the existing footbridge, ramps, canopies, retail kiosk, footings and associated structures except the middle portion of footbridge and its supports spanning between platforms 1/2 and 3/4 as identified in the Works Brief Drawings	R1	Standard	Daytime	26	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	27	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	18	-
31	Train impact protection to new structures adjacent to the tracks as required and dependent on the Contractor's design.	R1	Standard	Daytime	28	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	21	LB, M
		R5	Standard	Daytime	n/a	n/a

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
		R6	Standard	Daytime	12	-
33	All temporary works.	R1	Standard	Daytime	16	-
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	14	-
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	5	-
34	Construction Compound	R1	Standard	Daytime	29	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	26	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	17	-
35	Potential Undergrounding of overhead electrical wires (to both sides of rail corridor)	R1	Standard	Daytime	28	LB, M
		R2	Standard	Daytime	n/a	n/a
		R3	Standard	Daytime	n/a	n/a
		R4	Standard	Daytime	26	LB, M
		R5	Standard	Daytime	n/a	n/a
		R6	Standard	Daytime	17	-

Note: Recommended standard hours for construction are between the hours of 7.00 am and 6.00 pm Monday to Friday and Saturday 8am to 1pm. No work Sundays or public holidays.

Table 21 Additional Mitigation Measures for the Works – OOHW Construction

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
14	Platform resurface to achieve 1:40 grading as required	R1	OOHW Period 1	Evening	28	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	26	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	22	M, LB
15	Existing footbridge upgrade/refurbish in accordance with the contract	R1	OOHW Period 1	Evening	29	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	30	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	26	M, LB
16	Existing station building upgrade/refurbish in accordance with the contract. For Stores - make good floor, walls and ceiling, removed joinery & fit out. For Toilets - make good floor, walls and ceiling, repair joinery and fit new seating as required. Generally - adjust doors, thresholds and adjacent ground level refurbish	R1	OOHW Period 1	Evening	23	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	20	LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	17	LB
18	Upgrade seating facilities with proposed wind barriers as required	R1	OOHW Period 1	Evening	22	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	19	LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	15	LB
19	Relocate overhead wiring structure as required	R1	OOHW Period 1	Evening	31	M, IB, LB, RO, PC, SN
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	21	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	18	LB
23	Construction of a new suspended concourse, station operations area and footbridge including enclosed accessible walkways connecting lifts on either side of the station	R1	OOHW Period 1	Evening	28	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	29	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
		R6	OOHW Period 1	Evening	26	M, LB
24	Provision of new canopies to the concourse, footbridge, stairs, lifts and platforms. New canopies are to marry into the existing platform canopy structures to be maintained on platform 1/2 and 3/4.	R1	OOHW Period 1	Evening	32	M, IB, LB, RO, PC, SN
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	23	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	20	LB
28	Modifications and adjustments to the existing 1500V overhead wire (OHW) and overhead wire structures (OHWS) as may be required to accommodate the installation of new structures and the partial demolition of the existing footbridge	R1	OOHW Period 1	Evening	24	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	25	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	21	M, LB
29	Demolition and removal of the existing footbridge, ramps, canopies, retail kiosk, footings and associated structures except the middle portion of footbridge and its supports spanning between platforms 1/2 and 3/4 as identified in the Works Brief Drawings	R1	OOHW Period 1	Evening	27	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	28	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	24	M, LB
31	Train impact protection to new structures adjacent to the tracks as required and dependent on the Contractor's design.	R1	OOHW Period 1	Evening	29	M, LB
		R2	OOHW Period 1	Evening	n/a	n/a
		R3	OOHW Period 1	Evening	n/a	n/a
		R4	OOHW Period 1	Evening	22	M, LB
		R5	OOHW Period 1	Evening	n/a	n/a
		R6	OOHW Period 1	Evening	18	LB
14	Platform resurface to achieve 1:40 grading as required	R1	OOHW Period 2	Night-time	32	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	30	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	25	M, IB, LB, PC, SN
15	Existing footbridge upgrade/refurbish in accordance with the contract	R1	OOHW Period 2	Night-time	33	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	34	AA, M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
		R6	OOHW Period 2	Night-time	29	M, IB, LB, PC, SN
16	Existing station building upgrade/refurbish in accordance with the contract. For Stores - make good floor, walls and ceiling, removed joinery & fit out. For Toilets - make good floor, walls and ceiling, repair joinery and fit new seating as required. Generally - adjust doors, thresholds and adjacent ground level refurbish	R1	OOHW Period 2	Night-time	27	M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	24	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	20	M, LB
18	Upgrade seating facilities with proposed wind barriers as required	R1	OOHW Period 2	Night-time	26	M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	23	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	18	M, LB
19	Relocate overhead wiring structure as required	R1	OOHW Period 2	Night-time	35	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	25	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	21	M, IB, LB, PC, SN
23	Construction of a new suspended concourse, station operations area and footbridge including enclosed accessible walkways connecting lifts on either side of the station	R1	OOHW Period 2	Night-time	32	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	33	AA, M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	29	M, IB, LB, PC, SN
24	Provision of new canopies to the concourse, footbridge, stairs, lifts and platforms. New canopies are to marry into the existing platform canopy structures to be maintained on platform 1/2 and 3/4.	R1	OOHW Period 2	Night-time	36	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	27	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	23	M, IB, LB, PC, SN
28	Modifications and adjustments to the existing 1500V overhead wire (OHW) and overhead wire structures (OHWS) as may be required to accommodate the	R1	OOHW Period 2	Night-time	28	M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	29	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a

Area	Scenario	Receiver	Worst-Case Scheduled Construction Period	INP Defined Period	LAeq Exceedance of RBL (dBA)	TfNSW CNS Mitigation Measures
	installation of new structures and the partial demolition of the existing footbridge	R6	OOHW Period 2	Night-time	24	M, IB, LB, PC, SN
29	Demolition and removal of the existing footbridge, ramps, canopies, retail kiosk, footings and associated structures except the middle portion of footbridge and its supports spanning between platforms 1/2 and 3/4 as identified in the Works Brief Drawings	R1	OOHW Period 2	Night-time	31	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	32	AA, M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	27	M, IB, LB, PC, SN
31	Train impact protection to new structures adjacent to the tracks as required and dependent on the Contractor's design.	R1	OOHW Period 2	Night-time	33	AA, M, IB, LB, PC, SN
		R2	OOHW Period 2	Night-time	n/a	n/a
		R3	OOHW Period 2	Night-time	n/a	n/a
		R4	OOHW Period 2	Night-time	26	M, IB, LB, PC, SN
		R5	OOHW Period 2	Night-time	n/a	n/a
		R6	OOHW Period 2	Night-time	21	M, IB, LB, PC, SN

Note: Out of hours work (OOHW) period 1 – Monday to Friday (6pm – 10pm), Saturday (7am-8am & 1pm-10pm) and Sunday/public holidays (8am-6pm).
Out of hours work (OOHW) period 2 – Monday to Friday (10pm – 7am), Saturday (10pm-8am) and Sunday/public holidays (6pm-7am).

Standard Construction Hours

From the information contained in **Table 20**, the predicted construction noise level exceedances are considered moderately intrusive in accordance with the *Construction Noise Strategy* and would require letter-box drops and noise monitoring for the majority of the proposed works.

The purpose of letter box drops is to provide residents with specific notification of the duration and timing of the construction activities so that residents are informed about the proposed works ahead of time.

The purpose of the monitoring is to validate the construction noise predictions and confirm that the noise levels from individual equipment are not excessive.

Out of Hours Construction

OOHW Period 1

From the information contained in **Table 21**, the predicted construction noise level exceedances are considered moderately intrusive in accordance with the *Construction Noise Strategy* and would require letter-box drops and noise monitoring for the majority of the proposed works. However, predicted construction noise level exceedances for scenario 19 and scenario 24 are considered highly intrusive and would require noise monitoring, individual briefings, letter-box drops, project specific respite offer, phone call and specific notification for the proposed works.

It is relevant to note that no more than two (2) consecutive nights of high noise generating work will be undertaken over any seven day period during construction.

OOHW Period 2

From the information contained in **Table 21**, the predicted construction noise level exceedances are considered highly intrusive for the majority of the proposed works and would require alternative accommodation, noise monitoring, individual briefings, letter-box drops, phone call and specific notification for the proposed works.

Furthermore, to minimise the potential noise impacts, it is recommended that during OOHW Period 1 and Period 2, the use of high noise generating items of plant in potentially sensitive locations be restricted as far as is practicable and wherever possible operate only during standard construction hours. If high noise generating activities such as jack and rock hammering, rock breaking, piling, vibratory rolling and concrete saw are scheduled during OOHW, the works may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block.

Additionally, as per the guidance provided in the ICNG, highly noise generating work at night-time should be limited wherever possible. In order to minimise the potential impacts of high noise generating works at during night-time periods, OOHW will be scheduled so that no more than two (2) consecutive nights of high noise generating work will be undertaken over any seven day period during construction.

10 CONCLUSION

SLR has undertaken a construction and operational noise and vibration assessment for the proposed Easy Access upgrade at Pendle Hill Station.

Noise and vibration predictions, where appropriate, have been undertaken for construction works and operations associated with the Proposal Site.

10.1 Operational Noise and Vibration Assessment

The operational activities associated with the Station are not proposed to change significantly as part of the proposed upgrade. As a result, existing operational noise and vibration levels emissions from the site are unlikely to change.

10.2 Construction Noise and Vibration Assessment

The construction noise predictions during standard construction hours indicate that the majority of the proposed construction activities are moderately intrusive and likely to exceed ‘noise affected’ project specific noise criteria. In all cases, the predicted levels are below the “highly noise affected” level of 75 dBA.

The construction noise predictions during OOHW indicate that the majority of the proposed construction activities are highly intrusive at some locations.

The exceedances are a function of the nature of the proposed construction activities and the proximity of the nearest sensitive receivers. They are not specifically the result of construction activities that are uncharacteristically noisy in their own right. The fact that exceedances have been identified does not indicate that the proposed activities cannot be undertaken, but that care needs to be taken during the detailed planning stage to identify feasible and reasonable mitigation and management measures that can be implemented to minimise the potential impacts. Proposed noise mitigation and management recommendations have been provided in **Section 9**.

As per the requirements of the ICNG, predictions are based on a “worst case” assessment and in most cases, the measured levels during construction are likely to be lower than predicted in this assessment. The modelling assumes that all equipment is operating at the same time which is rarely the case in practice.

The proposed construction activities either contain plant items that are not significantly vibration intensive or the separation distance from the nearest receivers is sufficient to mitigate the potential impacts. Therefore, the impacts are predicted to meet the recommended project specific vibration goals. Nevertheless, safe working distances for typical items of vibration intensive plant are listed in **Table 18.** Furthermore, building condition surveys and attended monitoring will be undertaken if there is a risk of potential impacts.

During the detailed design stage, when more specific information is available in relation to the proposed construction methodology, we recommend that a site specific Construction Noise and Vibration Management Plan be prepared, consistent with the requirements of the ICNG and the TfNSW CHS.

11 REFERENCES

- Rail Infrastructure Noise Guideline, NSW EPA, 2013.
- Industrial Noise Policy, NSW EPA, 2000.
- Interim Construction Noise Guideline, DECC, 2009.
- Road Noise Policy, NSW EPA, 2011.
- Assessing Vibration: a technical guideline, DEC, 2006.
- AS IEC 61672.1—2004 & Electroacoustics—Sound level meters, Part 1: Specifications, Standards Australia, 2004.
- Construction Noise Strategy, TfNSW, 2012.
- Environmental Noise Management Manual, RTA, 2001.
- BS 7385 Part 2&1993 Evaluation and measurement for vibration in buildings Part 2, BSI, 1993.
- British Standard BS 6472:2008 Guideline to evaluation of human exposure to vibration in buildings, 2008.
- German Standard DIN 4150: Part 3-1999 Structural vibration – effects of vibration on structures, 1999.
- Pendle Hill Station Precinct Accessibility Upgrade – Concept Plan Project, GHD, 2013.

Acoustic Terminology

1 Sound Level or Noise Level

The terms "sound" and "noise" are almost interchangeable, except that in common usage "noise" is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2E-5 Pa.

2 "A" Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an "A-weighting" filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as "linear", and the units are expressed as dB(lin) or dB.

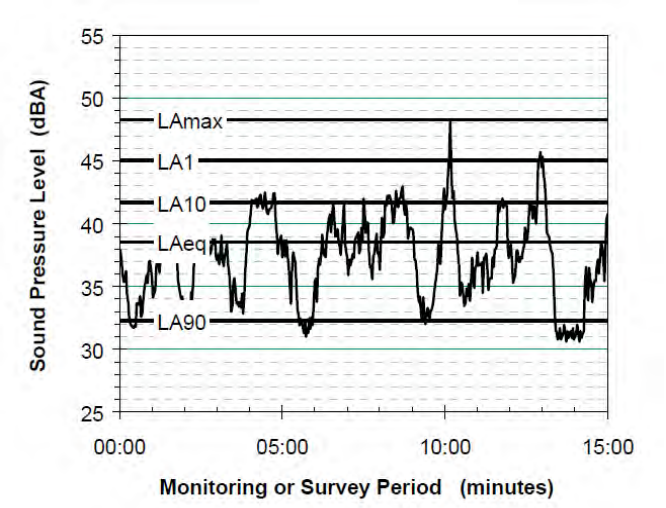
3 Sound Power Level

The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 1E-12 W.
The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of th source under consideration), or simply the background le el.

L_{Aeq} The A-weighted equivalent noise level (bas cally the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the "repeatable minimum" L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or "average" levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than "broad band" noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

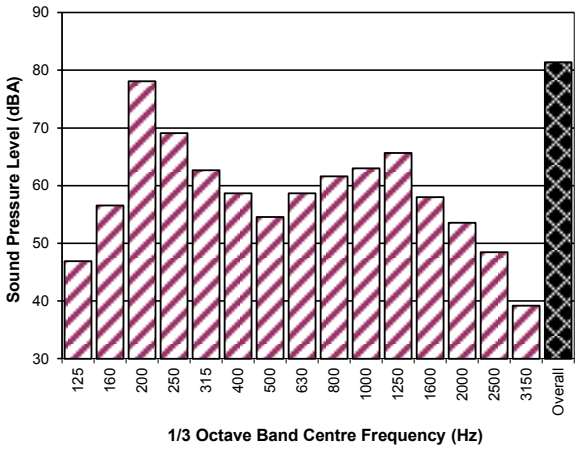
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of "peak" velocity or "rms" velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as "peak particle velocity", or PPV. The latter incorporates "root mean squared" averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (1E-6 mm/s). Care is required in this regard, as other reference levels are used by some organizations.

9 Human Perception of Vibration

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

10 Over-Pressure

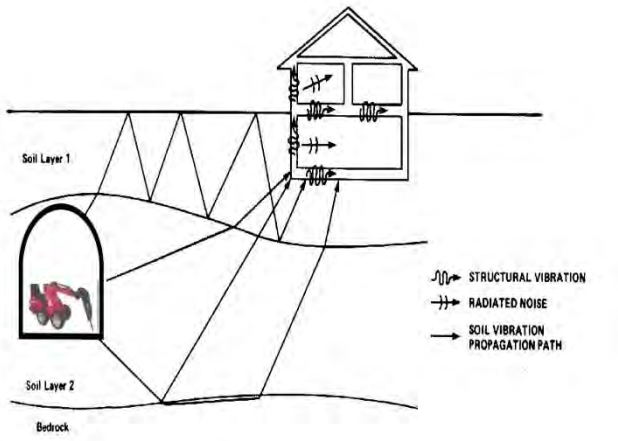
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

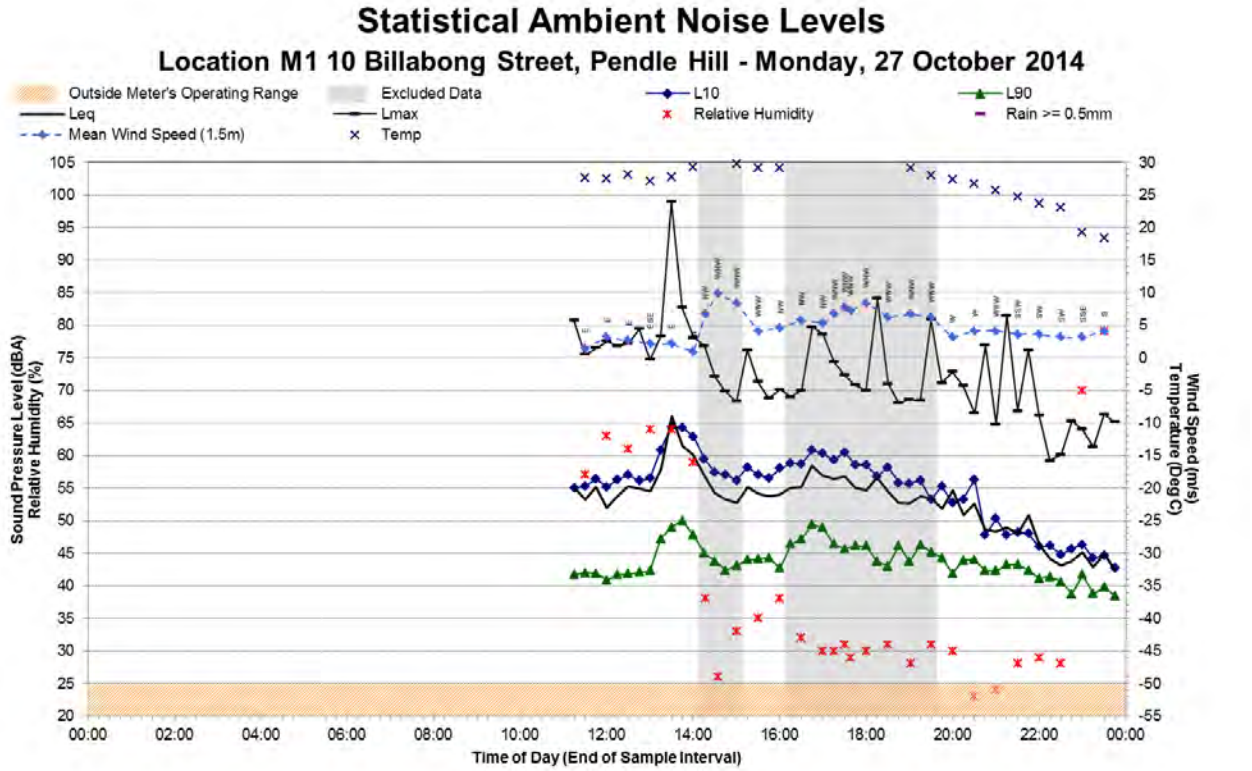
Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "regenerated noise", "structure-borne noise", or sometimes "ground-borne noise". Regenerated noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

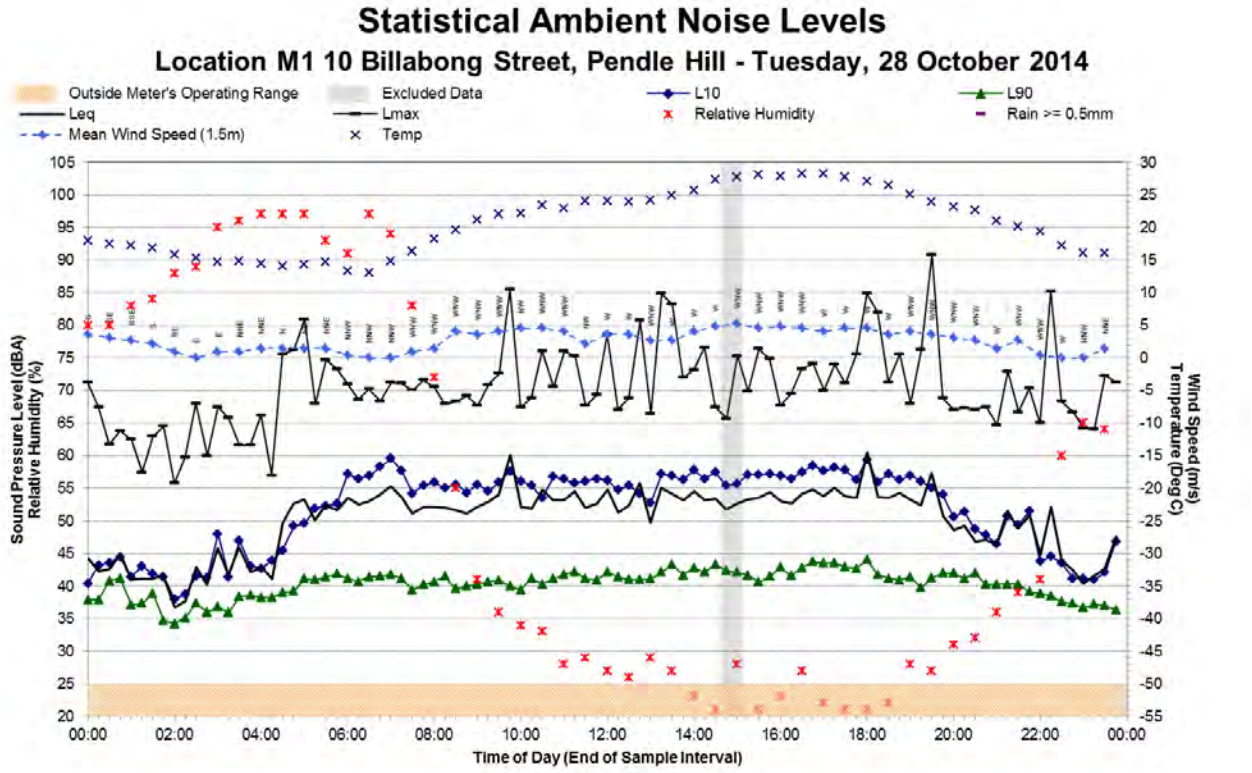
Typical sources of regenerated noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

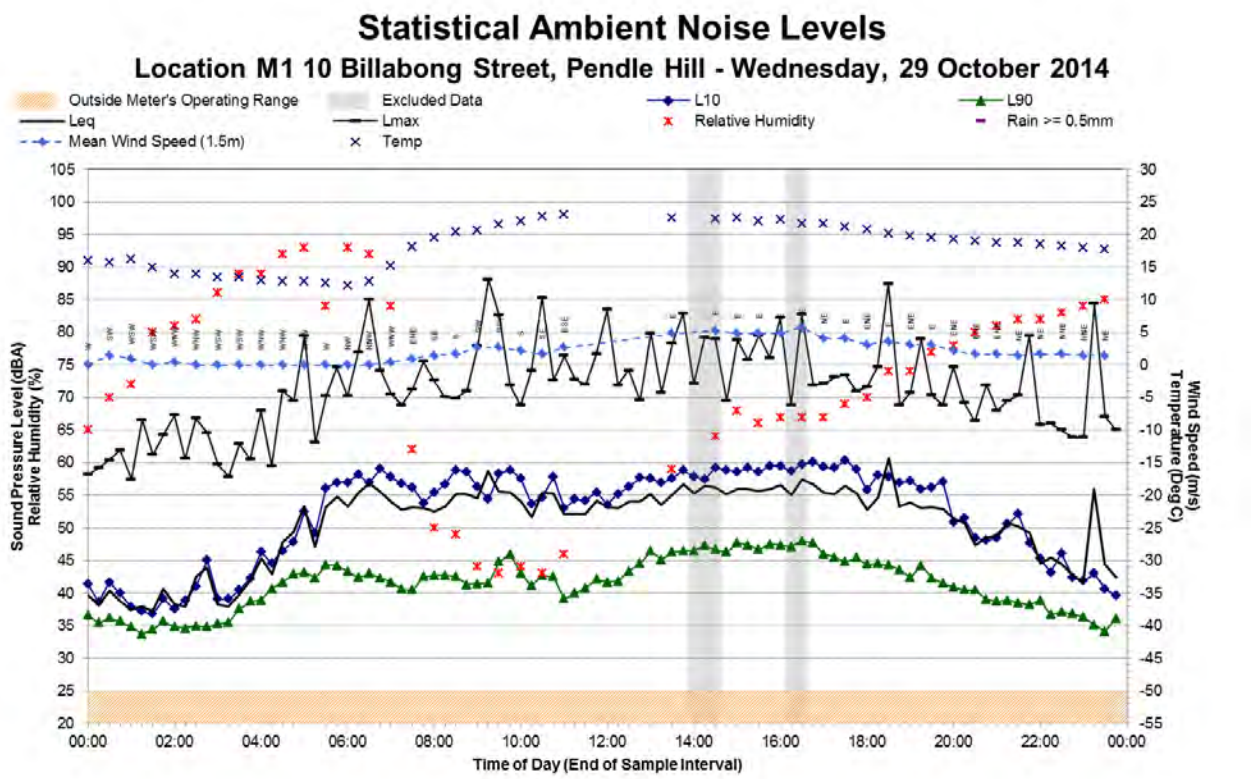
The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.

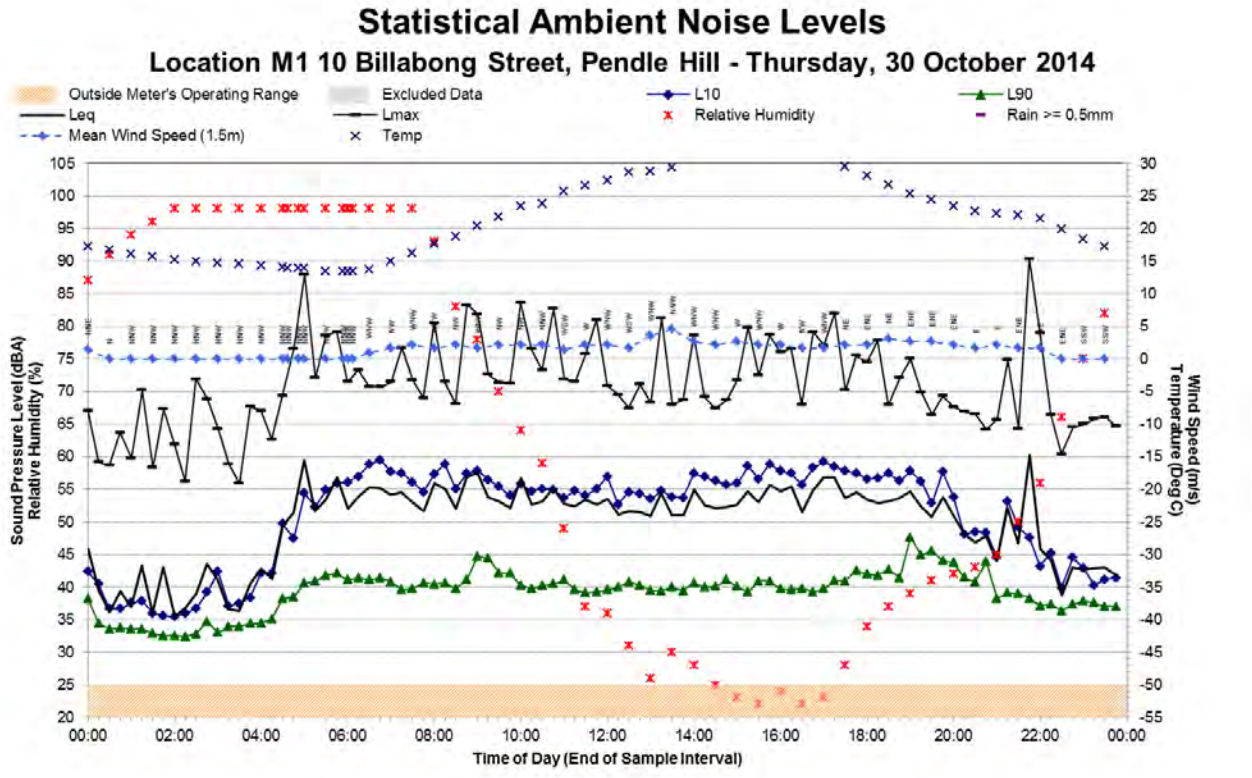


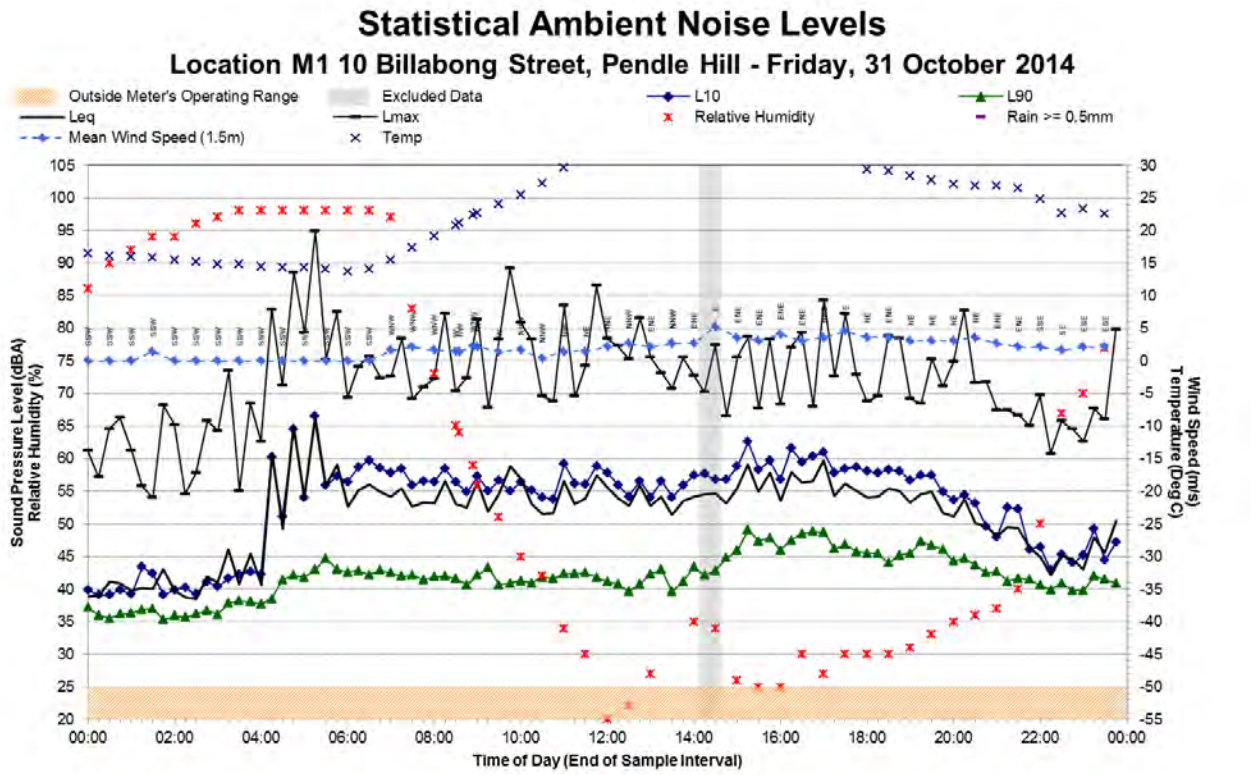
The term "regenerated noise" is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This "secondary" noise may be referred to as regenerated noise.


Statistical Ambient Noise Levels
Location M1 10 Billabong Street, Pendle Hill - Monday, 27 October 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M1 10 Billabong Street, Pendle Hill - Tuesday, 28 October 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M1 10 Billabong Street, Pendle Hill - Wednesday, 29 October 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M1 10 Billabong Street, Pendle Hill - Thursday, 30 October 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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Location M1 10 Billabong Street, Pendle Hill - Friday, 31 October 2014
Outside Meter's Operating Range
Excluded Data
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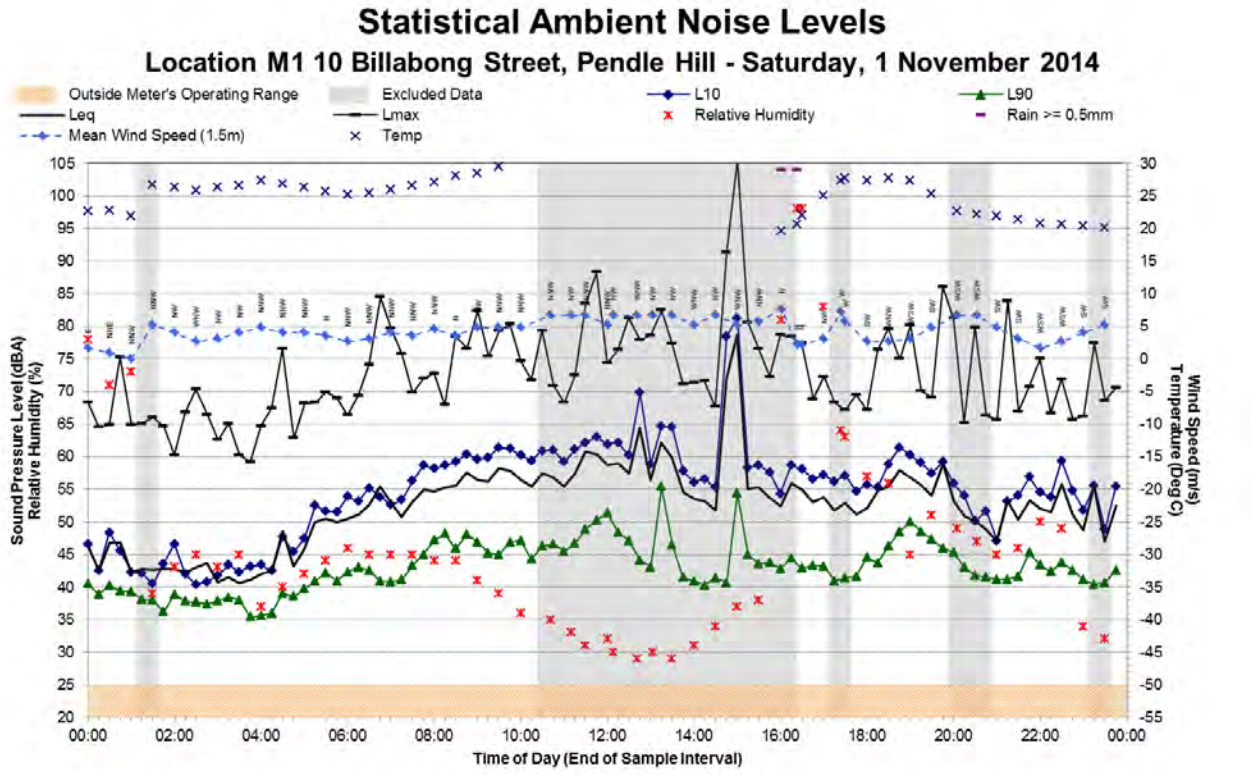
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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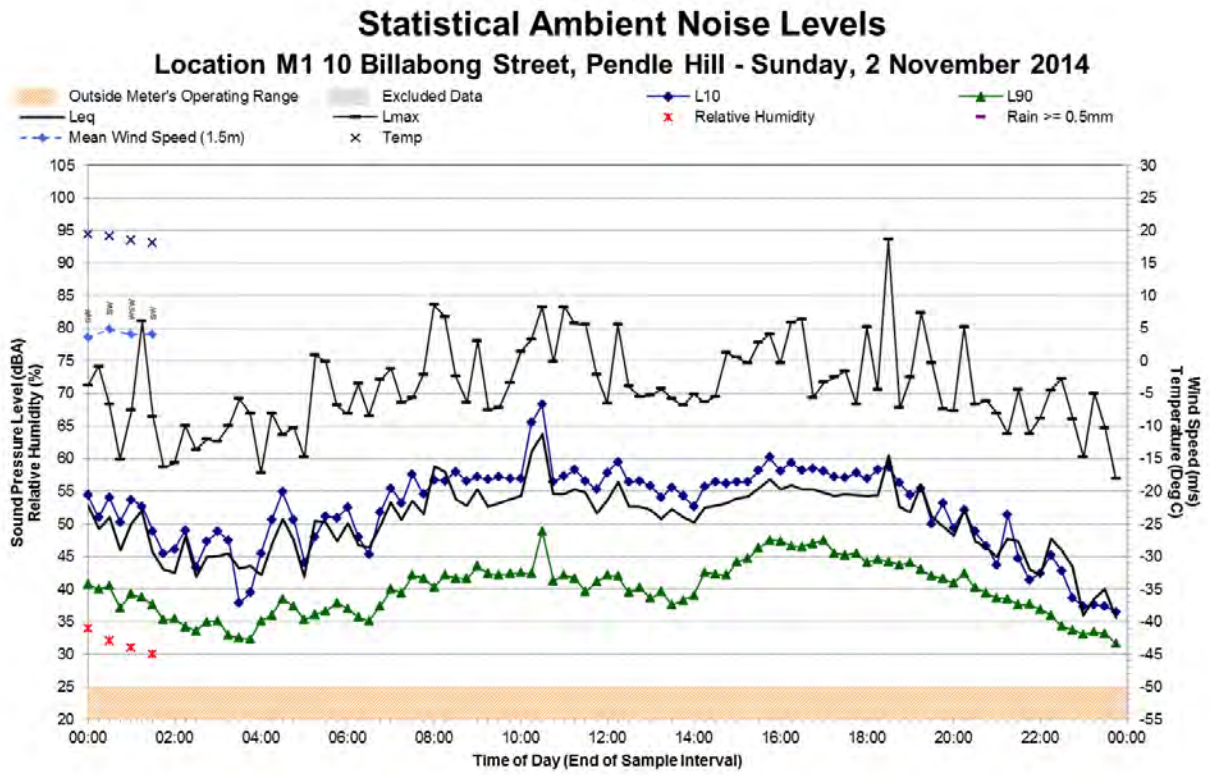
Location M1 10 Billabong Street, Pendle Hill - Saturday, 1 November 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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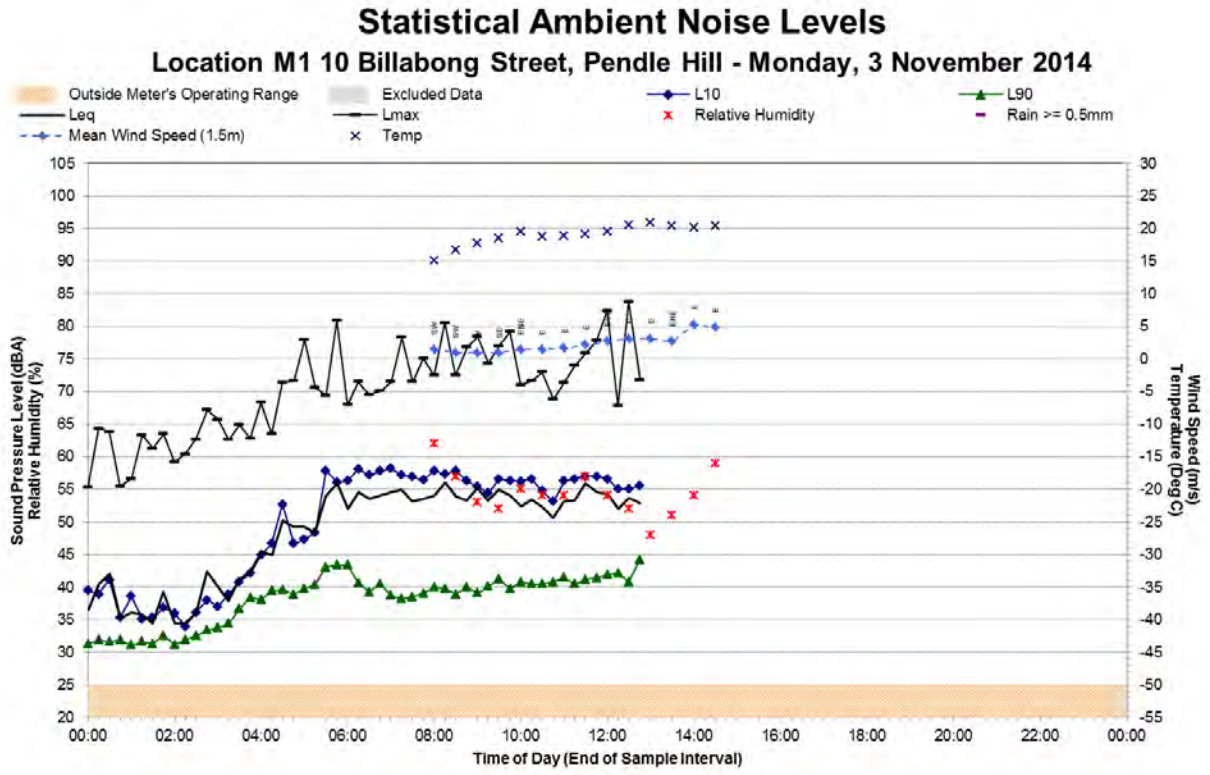
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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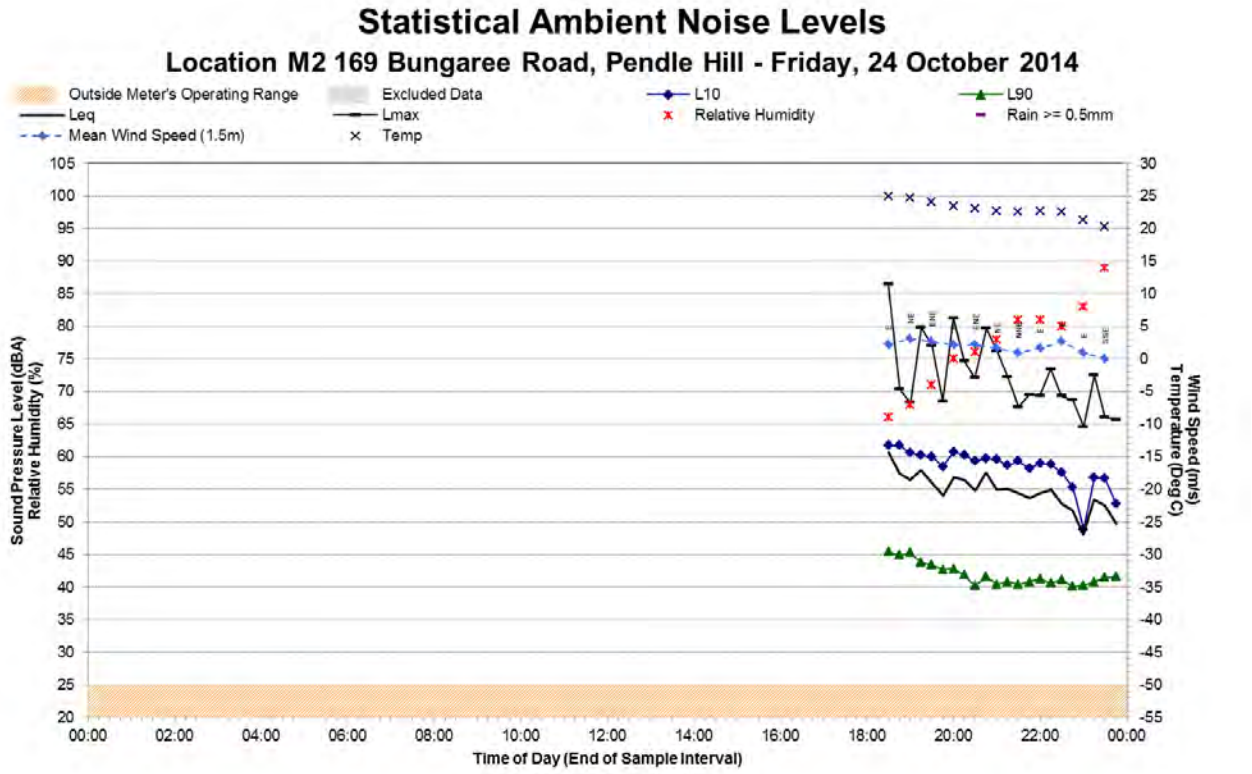
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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Outside Meter's Operating Range
Excluded Data
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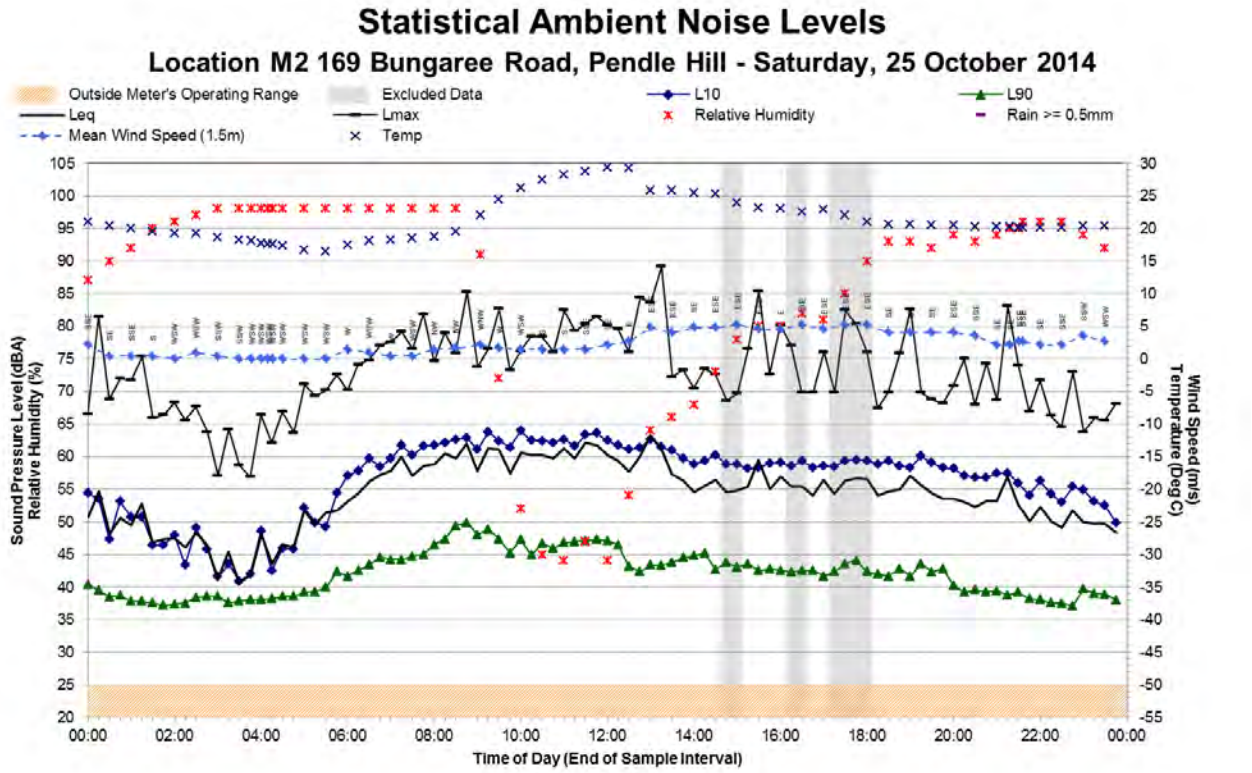
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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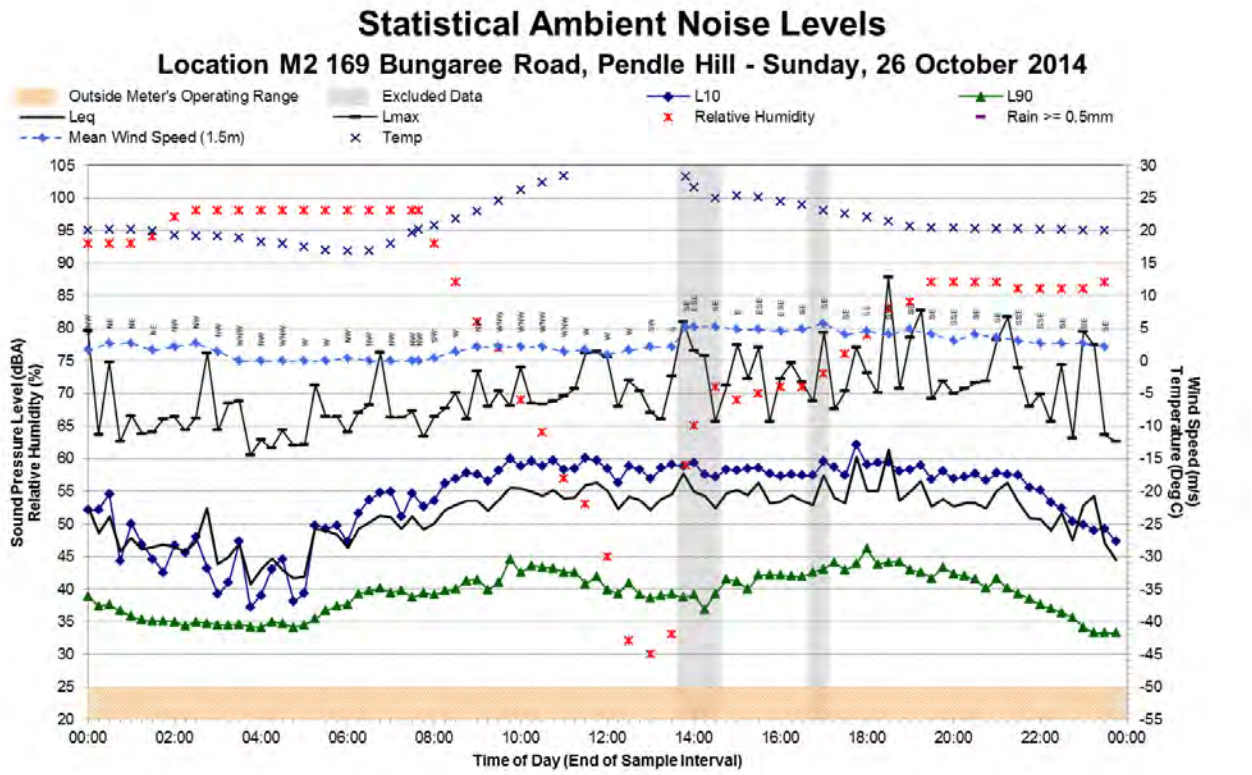
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)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Outside Meter's Operating Range
Excluded Data
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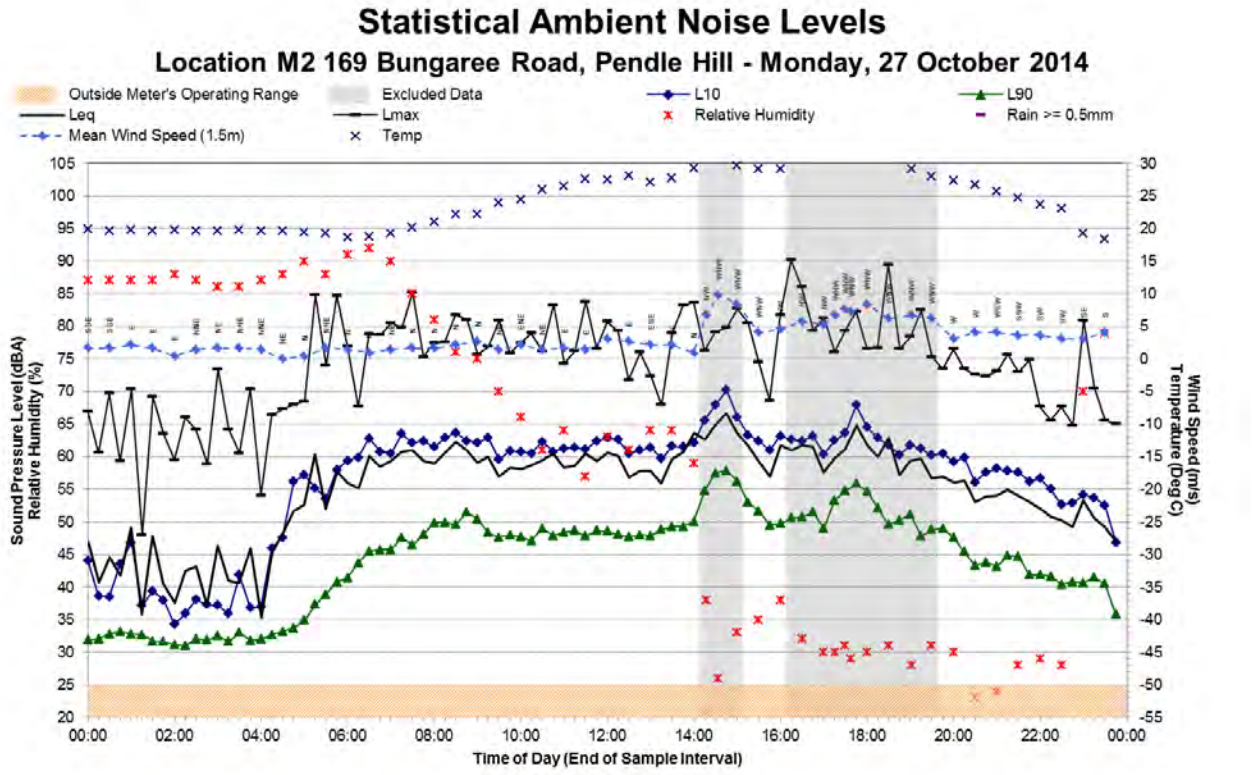
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
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Outside Meter's Operating Range
Excluded Data
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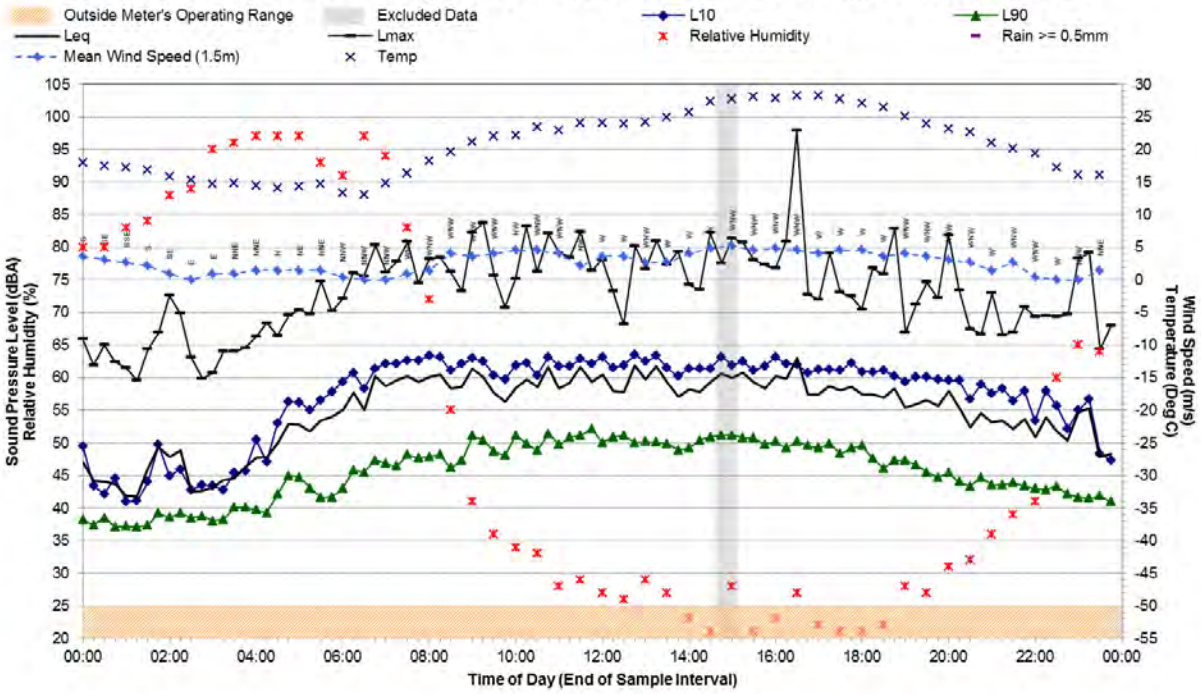
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)

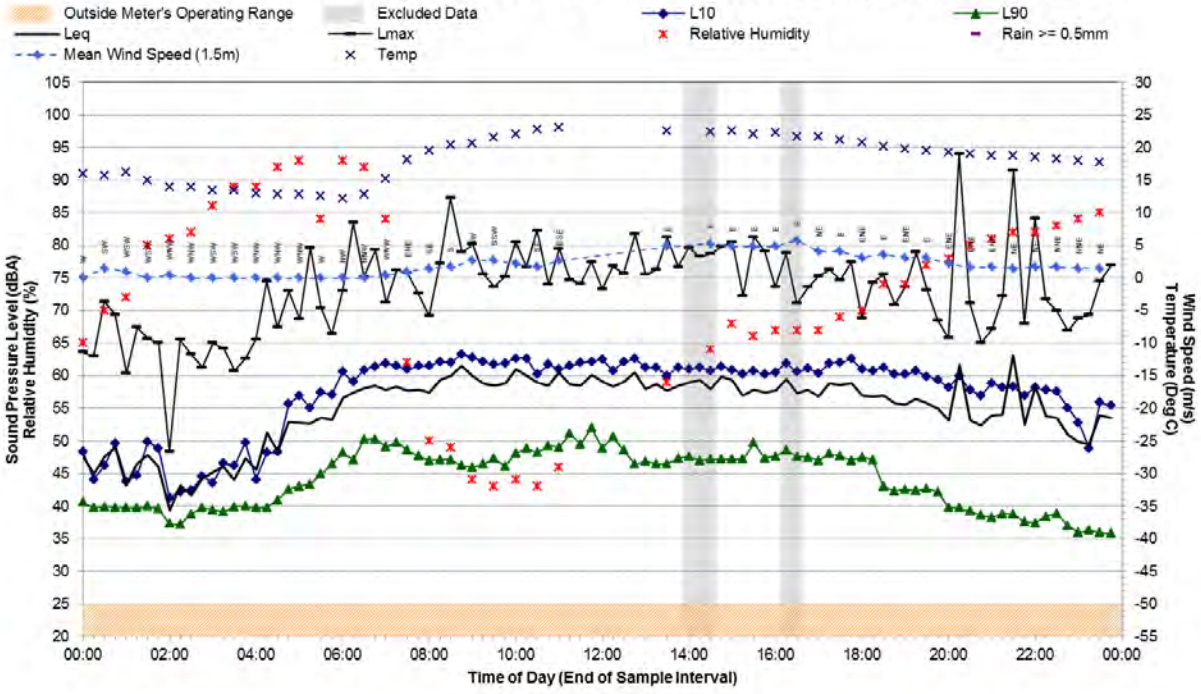
Statistical Ambient Noise Levels

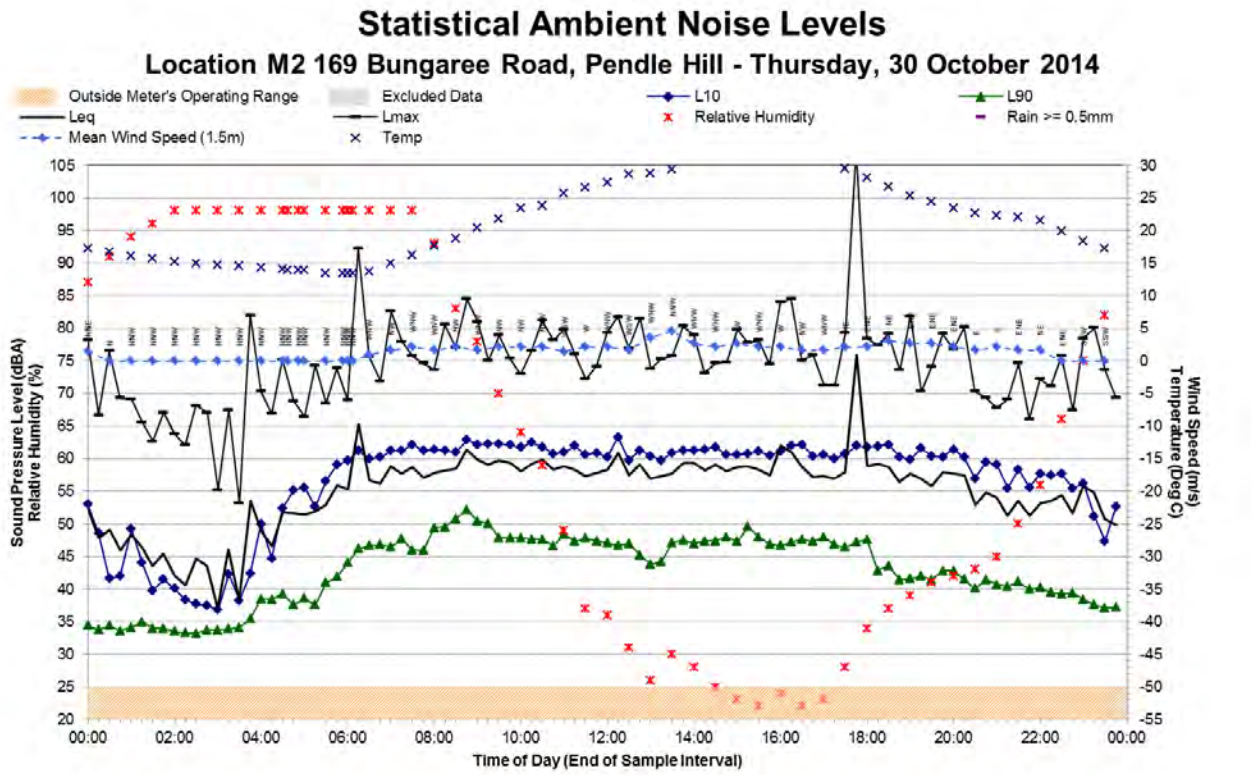
Location M2 169 Bungaree Road, Pendle Hill - Tuesday, 28 October 2014

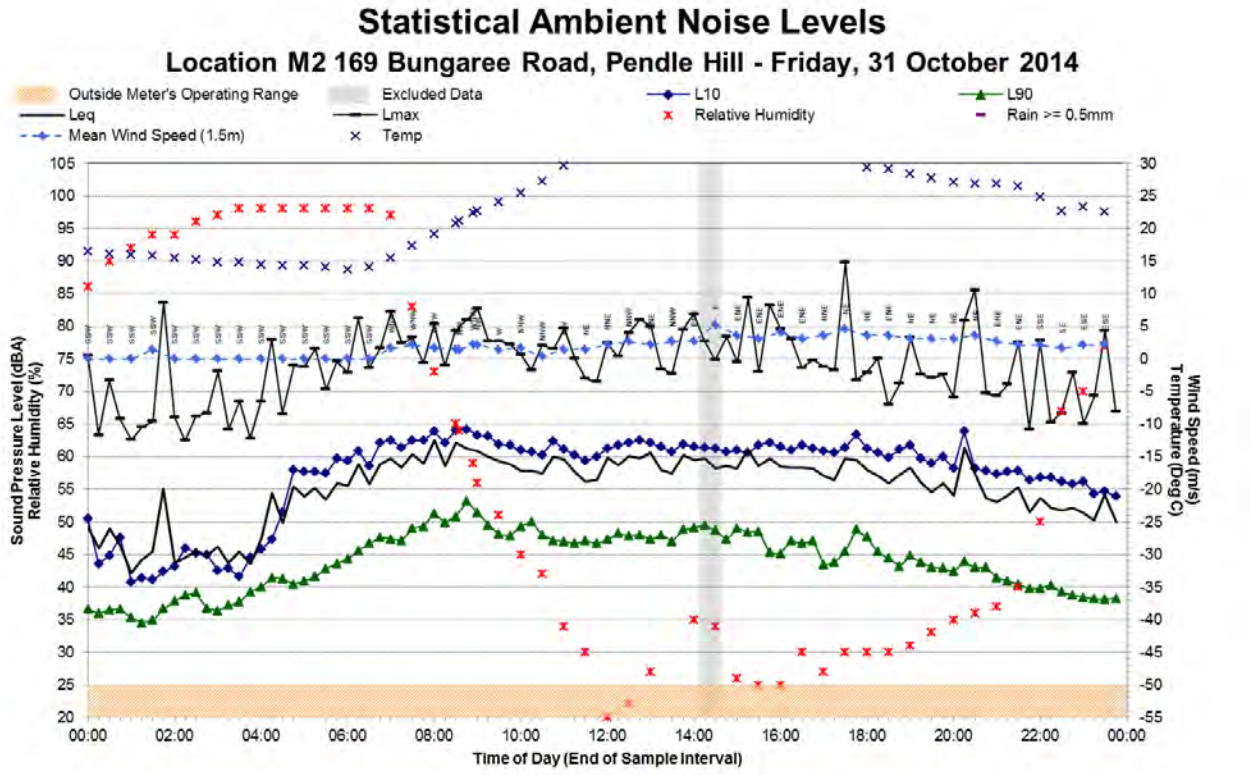


Statistical Ambient Noise Levels

Location M2 169 Bungaree Road, Pendle Hill - Wednesday, 29 October 2014




Statistical Ambient Noise Levels
Location M2 169 Bungaree Road, Pendle Hill - Thursday, 30 October 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M2 169 Bungaree Road, Pendle Hill - Friday, 31 October 2014
Outside Meter's Operating Range
Excluded Data
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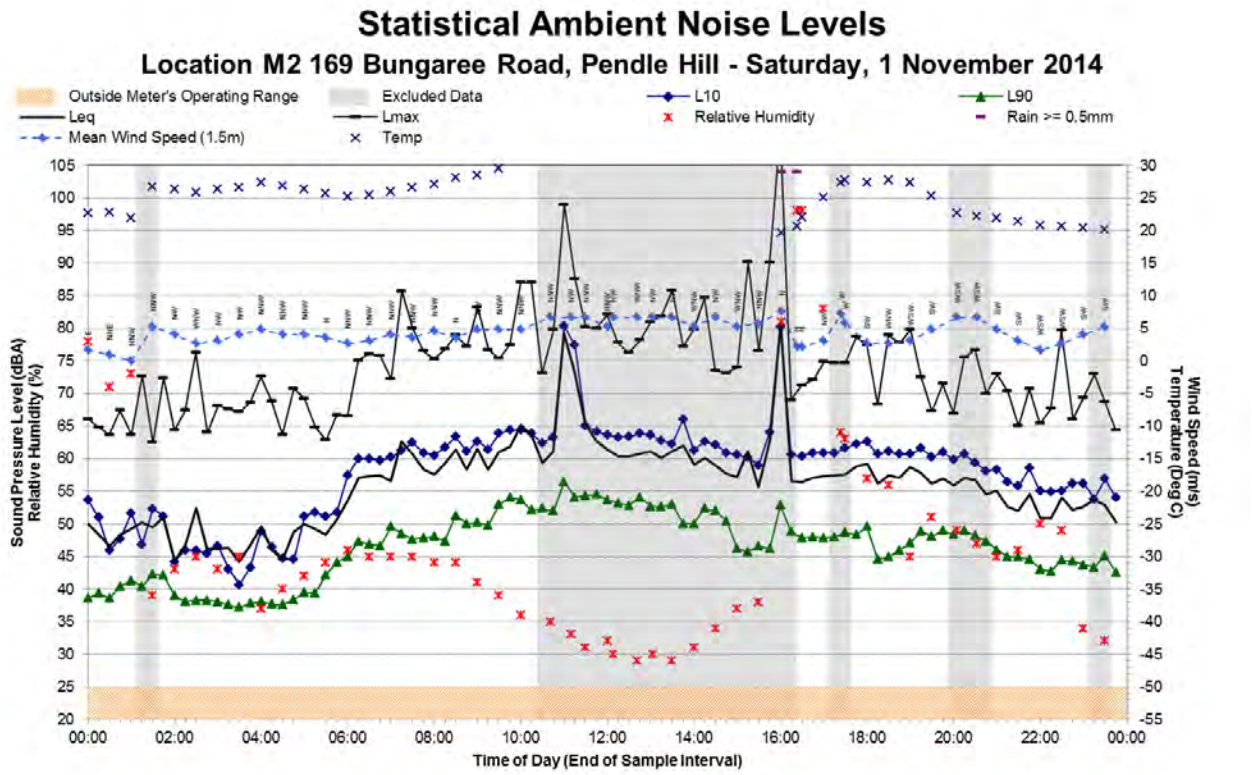
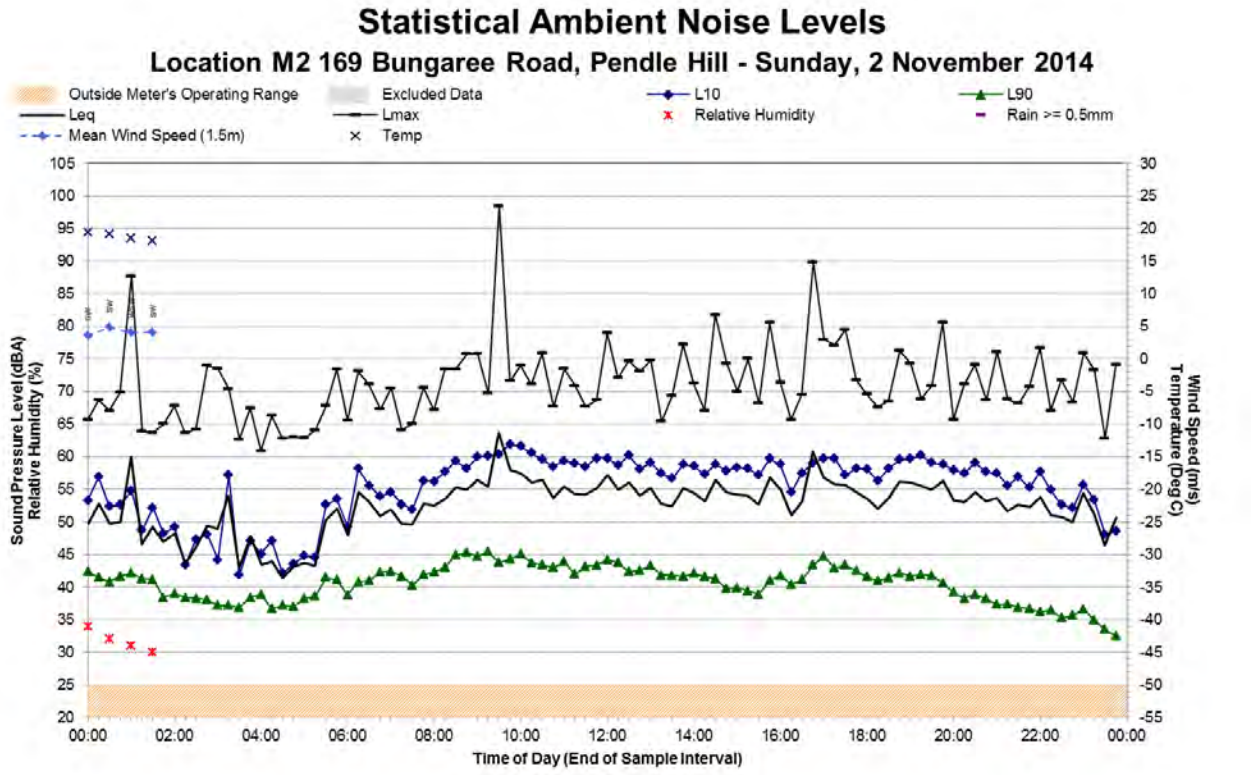
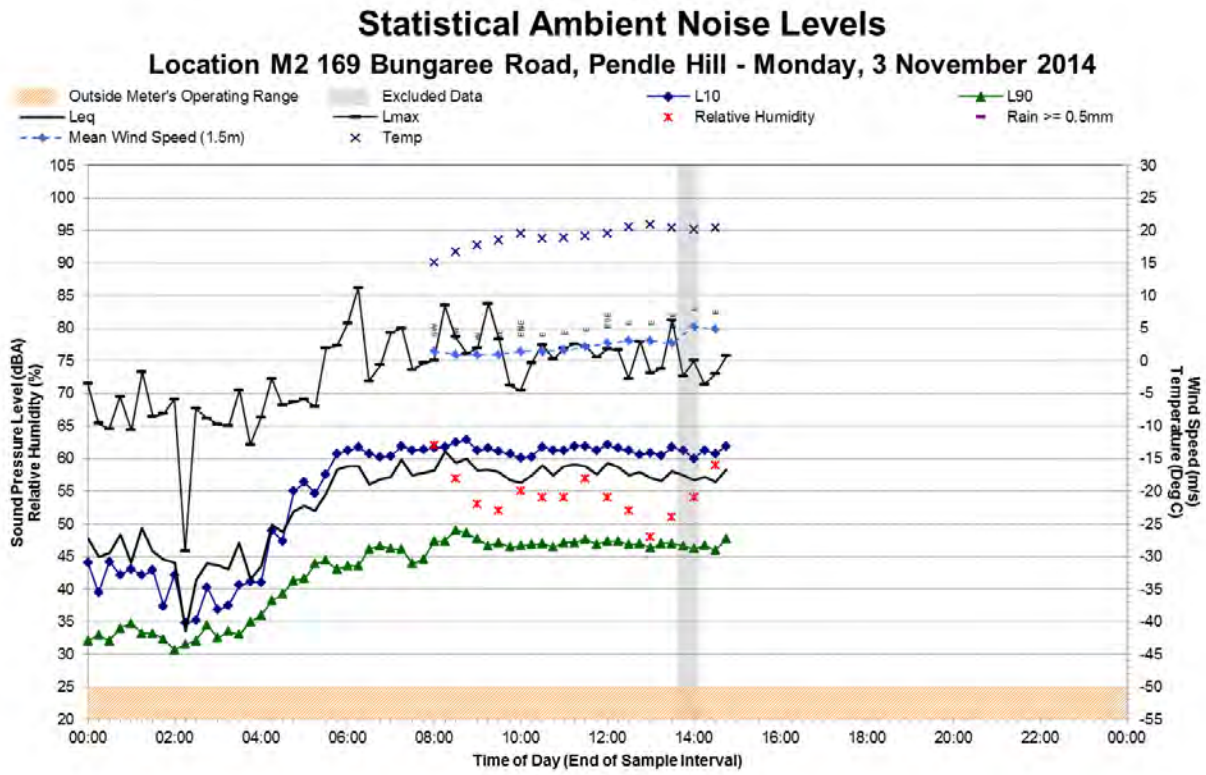
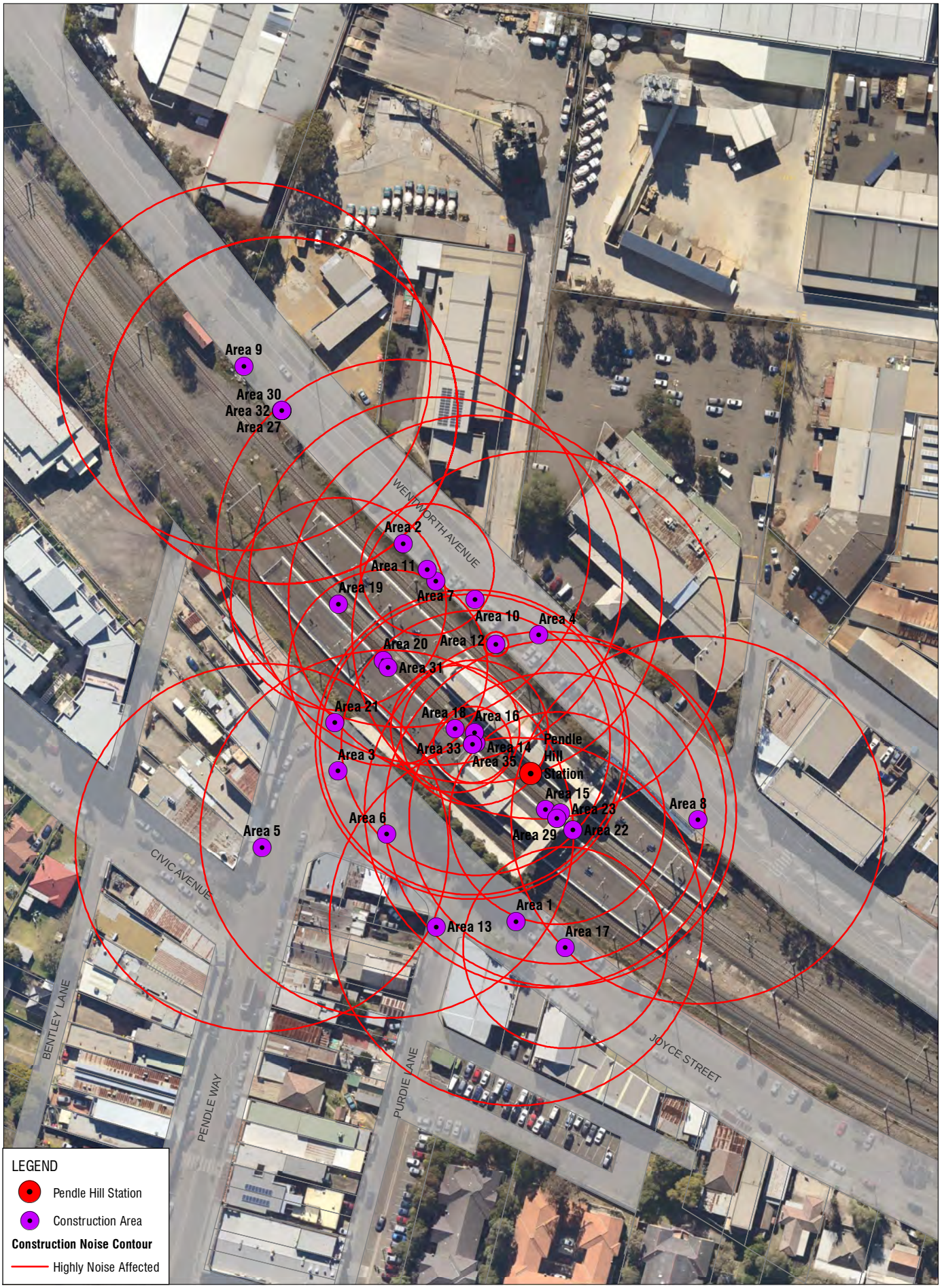
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M2 169 Bungaree Road, Pendle Hill - Saturday, 1 November 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (DegC)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M2 169 Bungaree Road, Pendle Hill - Sunday, 2 November 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (DegC)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
Location M2 169 Bungaree Road, Pendle Hill - Monday, 3 November 2014
Outside Meter's Operating Range
Excluded Data
L10
L90
Leq
Lmax
Relative Humidity
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Temp
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (m/s)
Temperature (Deg C)
Time of Day (End of Sample Interval)



C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_HighlyNoiseAffected.mxd

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Date:	11/11/2014
Drawn by:	KC
Scale:	1:1,500
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

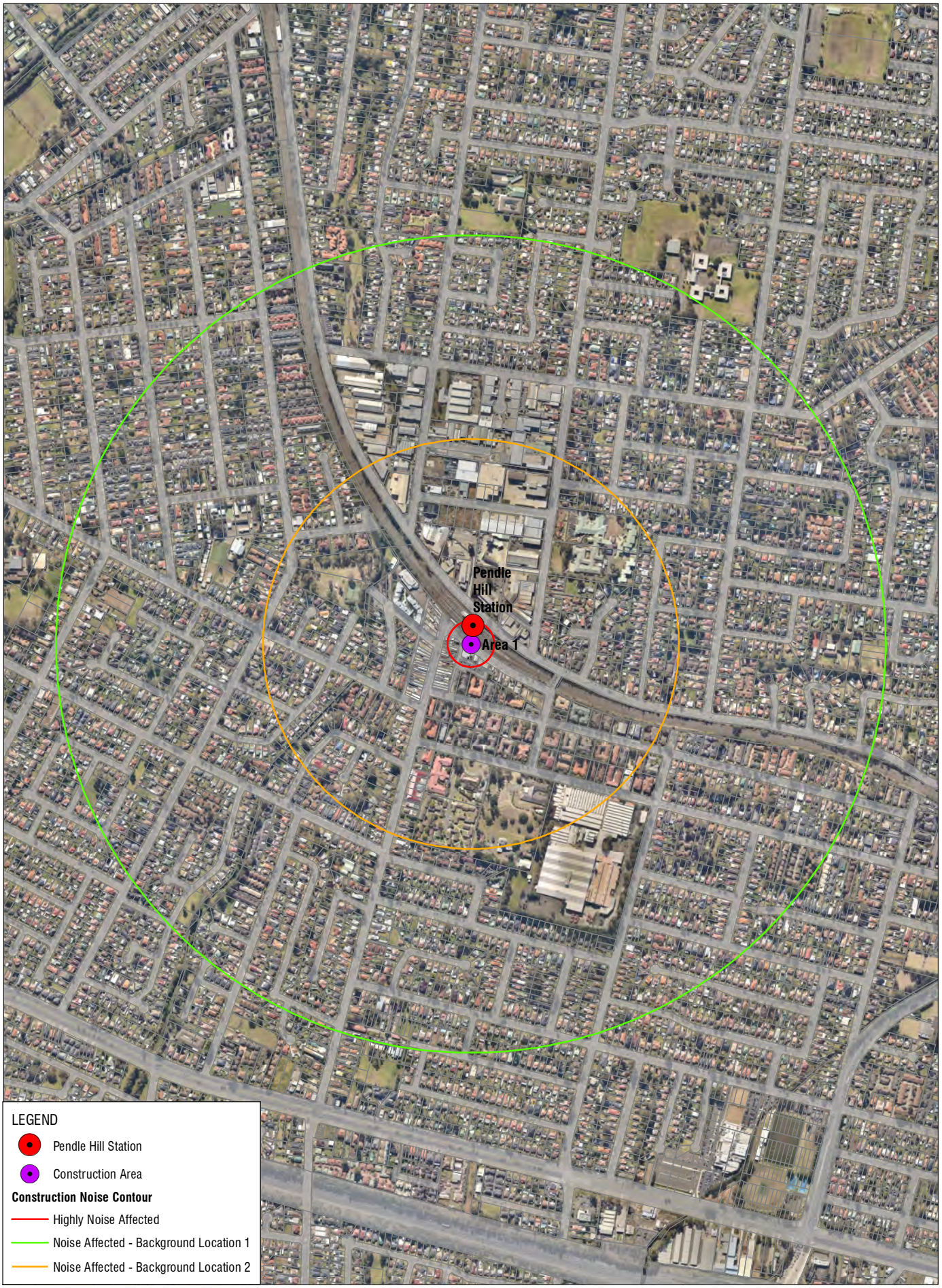
N
W E
S
0 10 20 30 40 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Highly Noise Affected

APPENDIX C



LEGEND

- Pendle Hill Station
- Construction Area

Construction Noise Contour

- Highly Noise Affected
- Noise Affected - Background Location 1
- Noise Affected - Background Location 2

C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area1.mxd

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Date:	11/11/2014
Drawn by:	KC
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Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N
W E
S

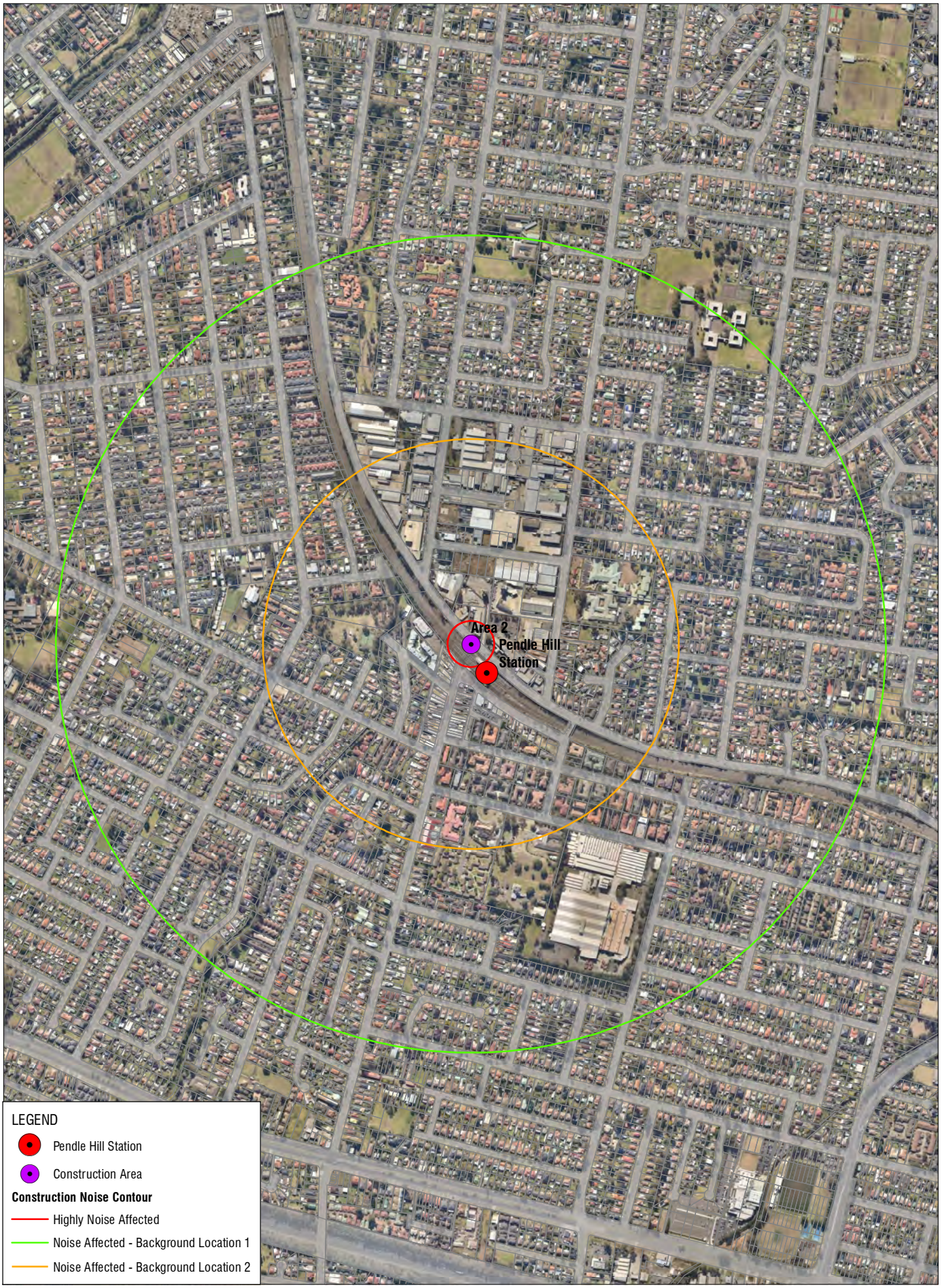
0 50 100 150 200 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 1

APPENDIX C



LEGEND

- Pendle Hill Station
- Construction Area

Construction Noise Contour

- Highly Noise Affected
- Noise Affected - Background Location 1
- Noise Affected - Background Location 2

C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area2.mxd

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Date:	11/11/2014
Drawn by:	KC
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N
W E
S

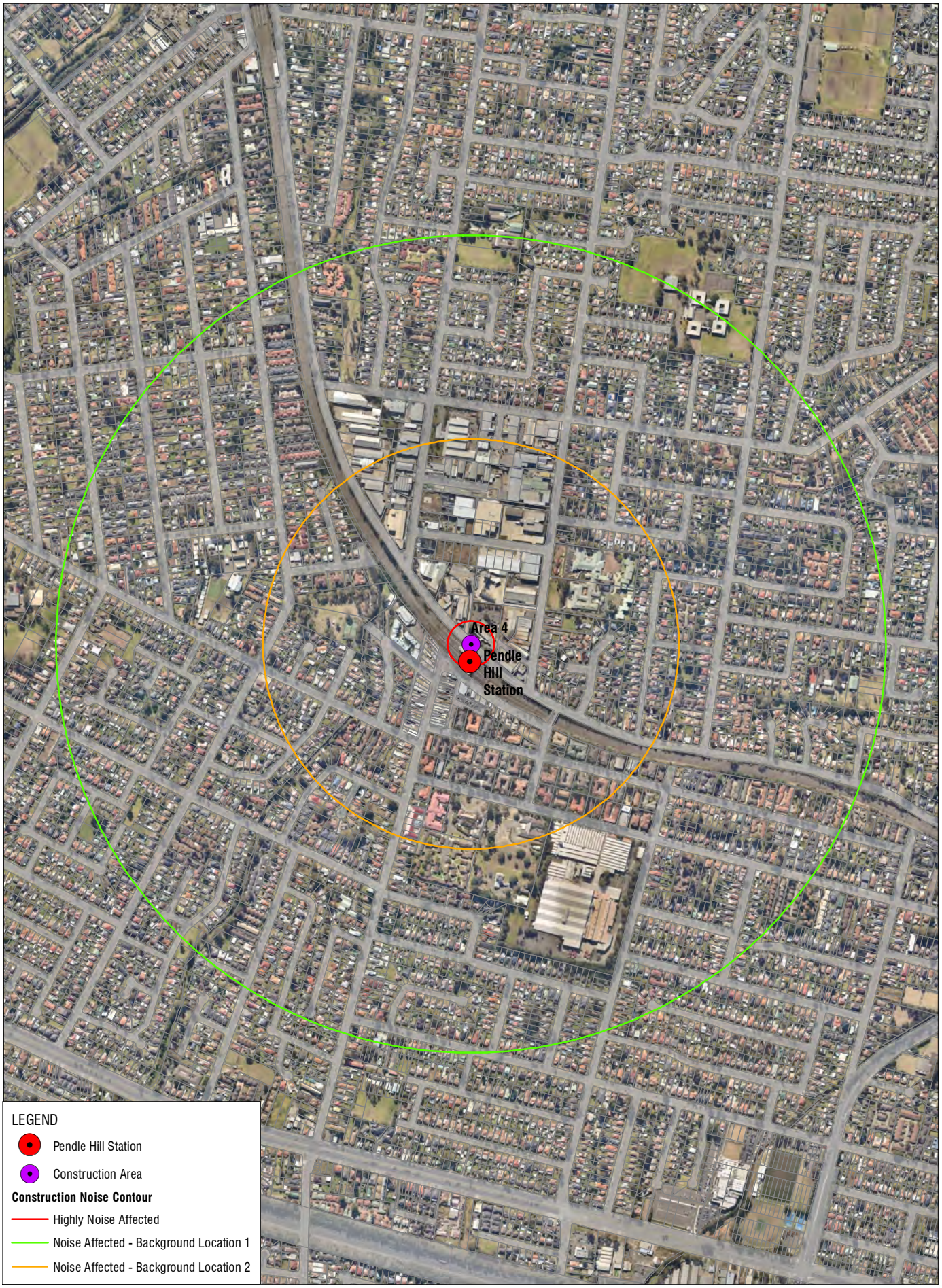
0 50 100 150 200 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 2

APPENDIX C



LEGEND

- Pendle Hill Station
- Construction Area

Construction Noise Contour

- Highly Noise Affected
- Noise Affected - Background Location 1
- Noise Affected - Background Location 2

C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area4.mxd

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Date:	11/11/2014
Drawn by:	KC
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N
W E
S

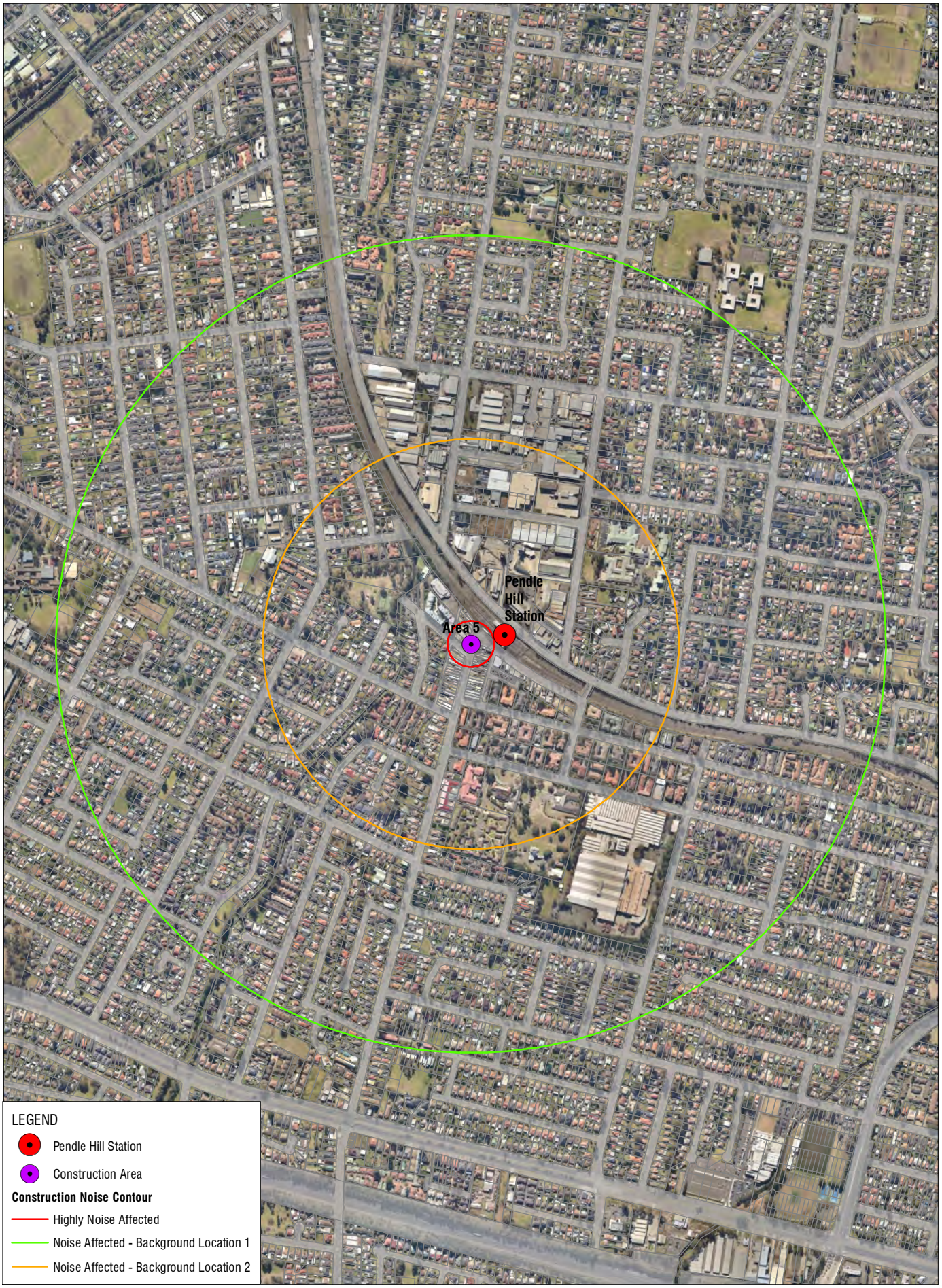
0 50 100 150 200 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 4

APPENDIX C



LEGEND

- Pendle Hill Station
- Construction Area

Construction Noise Contour

- Highly Noise Affected
- Noise Affected - Background Location 1
- Noise Affected - Background Location 2

C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area5.mxd

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Date:	11/11/2014
Drawn by:	KC
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N
W E
S

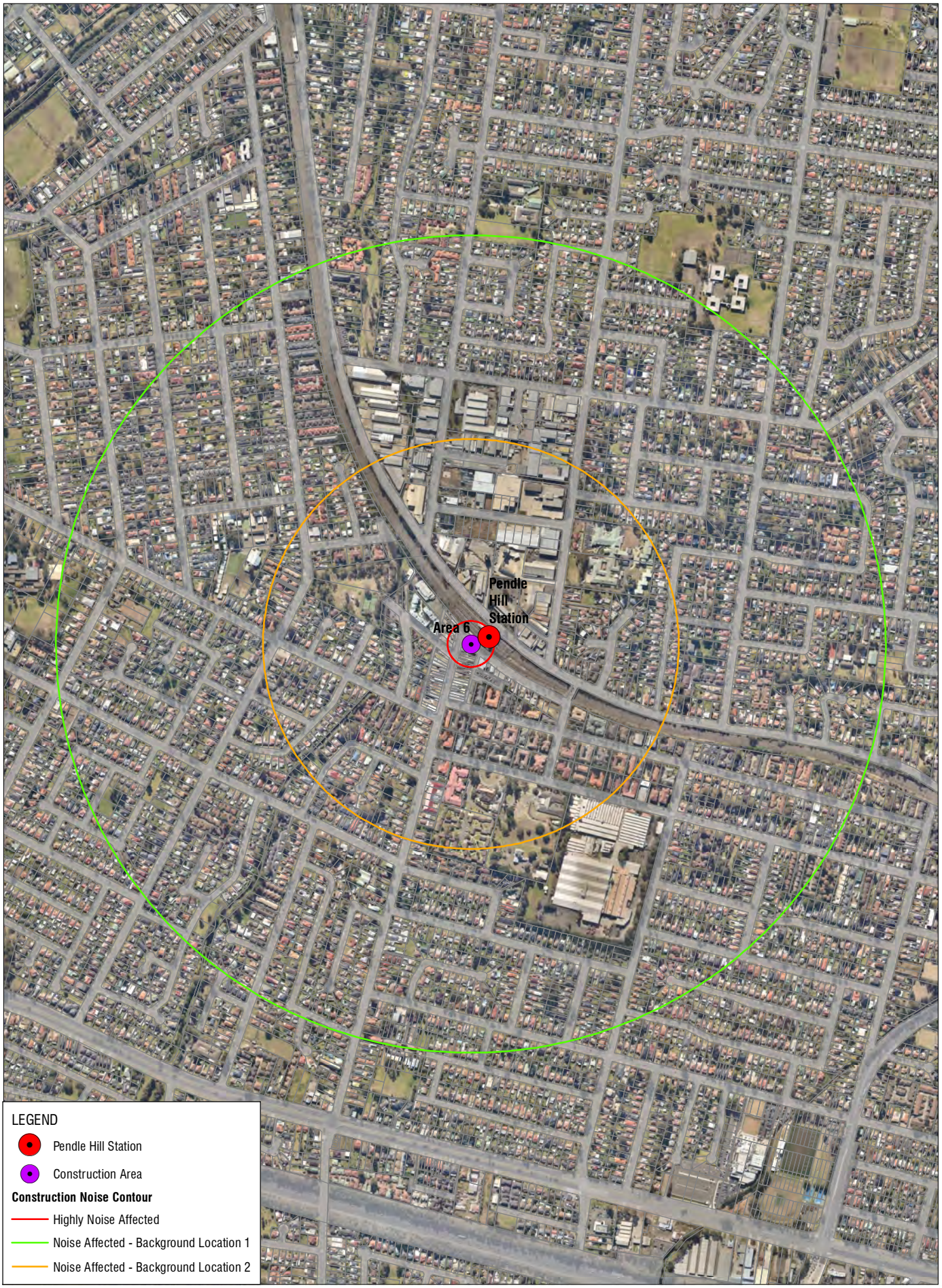
0 50 100 150 200 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 5

APPENDIX C



C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area6.mxd

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Date:	11/11/2014
Drawn by:	KC
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

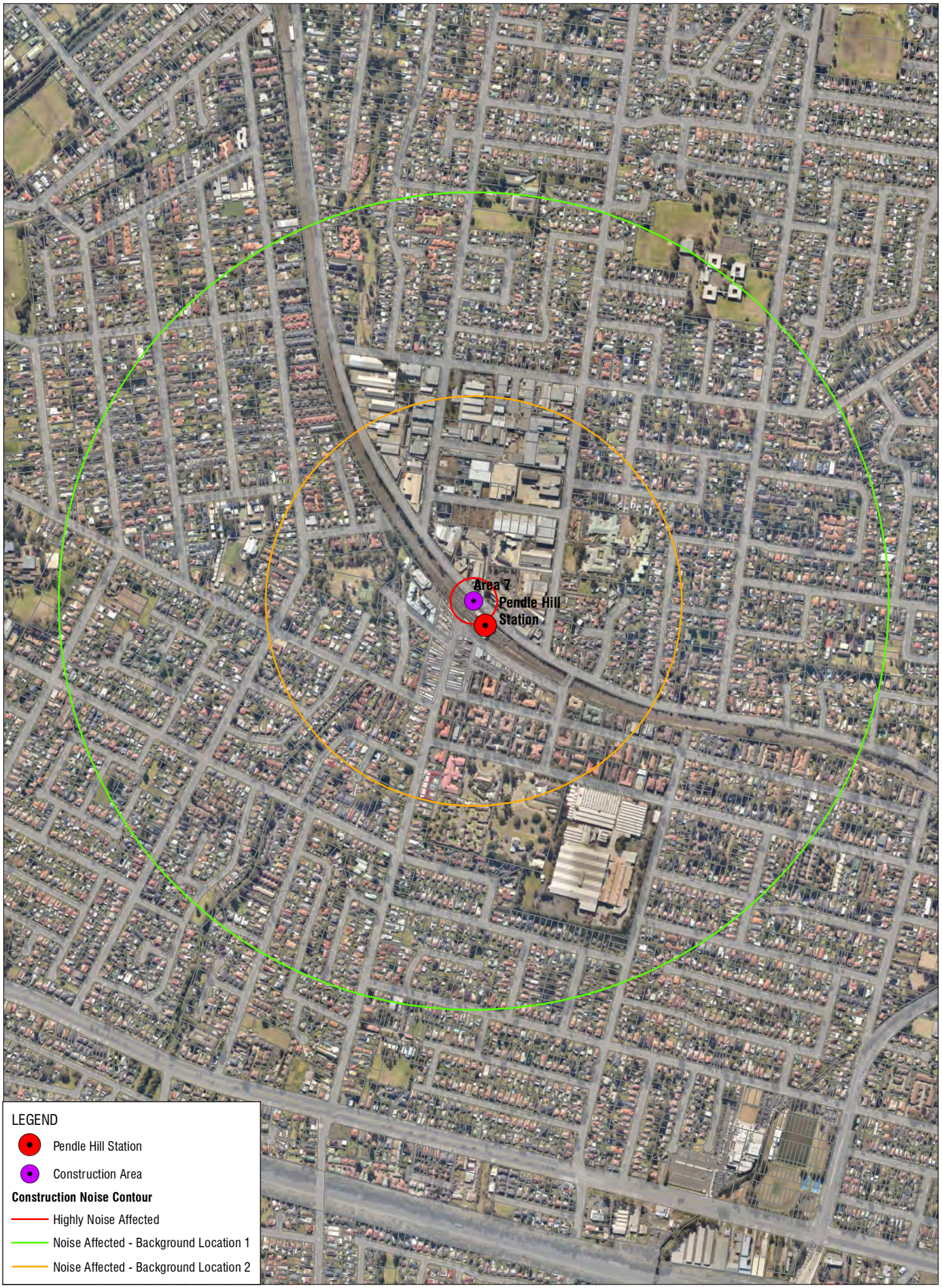
N
W E
S
0 50 100 150 200
m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 6

APPENDIX C



LEGEND

- Pendle Hill Station
- Construction Area

Construction Noise Contour

- Highly Noise Affected
- Noise Affected - Background Location 1
- Noise Affected - Background Location 2

C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area7.mxd

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Date:	11/11/2014
Drawn by:	KC
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N
W E
S

0 50 100 150 200 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 7

APPENDIX C

LEGEND

- Pendle Hill Station
- Construction Area

Construction Noise Contour

- Highly Noise Affected
- Noise Affected - Background Location 1
- Noise Affected - Background Location 2

C:\Data\610.14617 Pendle Hill\Figures\ArcGIS\SLR610.14617_PHConstructionNoiseContours_APPC_01_Area8.mxd

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Project No.:	610.14617
Date:	11/11/2014
Drawn by:	KC
Scale:	1:12,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N
W E
S
0 50 100 150 200 m

Transport for NSW

Pendle Hill Station

Construction Noise Contours Area 8

APPENDIX C