NSW GOVERNMENT

Redfern Station Upgrade – New Southern Concourse

Technical report 4 - Noise and vibration

Artist's impression of the proposed Redfern Station Upgrade - New Southern Concourse. Indicative only, subject to detailed design.

Transport for NSW | May 2020

Redfern Station Upgrade - New Southern Concourse

Technical report - Noise and vibration

Client: Transport for NSW

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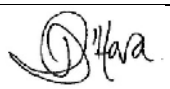
2	22-May-2020	Final	Rachel O'Hara Principal Environmental Scientist (CEnvP)	

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Abbreviations

Term	Meaning
AADT	Annual Average Daily Traffic
ABL	Assessment Background Level
AVATG	*Assessing Vibration: A Technical Guideline*
CNVMP	Construction Noise and Vibration Management Plan
CNVS	*Construction Noise and Vibration Strategy*
dB	Decibel
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DPIE	Department of Planning, Industry and Environment
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000* (NSW)
Heritage Act	*Heritage Act 1977* (NSW)
ICNG	*Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009).
NATA	National Association of Testing Authorities
NSW	New South Wales
NCA	Noise Catchment Area
NML	Noise Management Level
NPfI	*Noise Policy for Industry*
OEH	NSW Office of the Environment and Heritage
OOHW	Out-of-Hours Works
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
RBL	Rating Background Level
RNP	*Road Noise Policy*
SEARS	Secretary's Environmental Assessment Requirements
TAP	Transport Access Program
TfNSW	Transport for NSW
VDV	Vibration Dose Value

Definitions

Term	Meaning
A-weighted decibels [dB(A)]	The A-weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Airborne noise	Airborne noise is sound transmitted through the air/atmosphere, e.g. conversation between people.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Ancillary facility area	Areas required for temporarily storing materials, plant and equipment and providing space for other ancillary facilities, such as site offices, during construction.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Community	A group of people living in a specific geographical area or with mutual interests that could be affected by the Project.
Concept design	Broadly refers to the process that the Construction Contractor undertakes (should the Project proceed) to refine the scoping design to a design suitable for construction (subject to Transport for New South Wales acceptance).
Construction	Includes all physical work required to construct the Project and also includes construction planning such as the development of construction management plans.
Day	The period from 7:00 am to 6:00 pm Monday to Saturday and 8:00 am to 6:00 pm Sundays and public holidays.
Decibel [dB]	The measurement unit of sound.

Term	Meaning
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: 0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/subway train 110 dB(A) Rock concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 plane take off at 250 metres
Detailed design	Detailed design broadly refers to the process that the Construction Contractor undertakes (should the Project proceed) to refine the concept design to a design suitable for construction (subject to Transport for New South Wales acceptance).
Down-side	Down-side refers to the direction of travel away from Central Station.
Equivalent continuous sound level [L_{eq}] and A-weighted equivalent continuous [$L_{Aeq(15min)}$]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy. The INCG defines $L_{Aeq(15min)}$ as 'the A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as industry, road, rail and the community.
Evening	The period from 6:00 pm to 10:00 pm Monday to Sunday and public holidays.
Feasible and reasonable	Consideration of best practice taking into account the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. 'Feasible' relates to engineering considerations and what is practical to build. 'Reasonable' relates to the application of judgement in arriving at a decision, taking into account mitigation benefits and cost of mitigation versus benefits provided, community expectations and nature and extent of potential improvements.
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ground-borne noise	Ground-borne noise is noise generated by vibration transmitted through the ground into a structure, e.g. tunnelling works affected residential building above.
Heavy vehicle	A vehicle what has a gross vehicle mass (GVM) or aggregate trailer mass (ATM) of more than 4.5 tonnes.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.

Term	Meaning
L_{10}	The sound pressure level exceeded for 10 per cent of the measurement period. For 10 per cent of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90 per cent of the measurement period. For 90 per cent of the measurement period it was louder than the L_{90}.
Light vehicle	A vehicle up to a B99 in size. A B99 vehicle is the 99th percentile vehicle size.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
Methodology	The method for analysis and evaluation of the relevant subject matter.
Night	The period from 10:00 pm to 7:00 am Monday to Saturday and 10:00 pm to 8:00 am Sundays and public holidays.
Noise intensive works	Works which include the use of power saws for the cutting of timber, masonry and steel; grinding of metal, concrete or masonry; rock/line drilling; bitumen milling and profiling; jack hammering, rock hammering and rock breaking; or impact piling.
Opal card	The integrated ticketing smartcard introduced by Transport for New South Wales.
Out-of-hours works	Defined as works outside standard construction hours (i.e. outside of 7:00 am to 6:00 pm Monday to Friday, 8:00 am to 1:00 pm Saturday and no work on Sundays/public holidays).
Project area	The Project area comprises the overall potential area of direct disturbance by the Project, which may be temporary (for construction) or permanent (for operational infrastructure) and extend below the ground surface.
Proponent	A person or body proposing to carry out an activity under Division 5.1 of the *Environmental Planning and Assessment Act 1979* - in this instance, Transport for New South Wales.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.
Secretary's Environmental Assessment Requirements (SEARs)	Requirements and specifications for an environmental assessment prepared by the Secretary of the Department of Planning, Industry and Environment under section 5.16 of the EP&A Act.
Sensitive receiver/receptor	Includes residences, educational institutions (including preschools, schools, universities, TAFE colleges), health care facilities (including nursing homes, hospitals), religious facilities (including churches), child care centres, passive recreation areas (including outdoor grounds used for teaching), active recreation areas (including parks and sports grounds), commercial premises (including film and television studios, research facilities, entertainment spaces, temporary accommodation such as caravan parks and camping grounds, restaurants, office premises, retail spaces and industrial premises).
Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Special audible characteristics	Noise with characteristics that can cause annoyance and disturbance, containing noticeable factors such as tonality, low frequency noise, impulsive or intermittent noise events
Sydney Trains	The provider of metropolitan train services for Sydney.

Term	Meaning
The Project	The construction and operation of the Redfern Station Upgrade – New Southern Concourse.
Track possession	Track possession means the temporary closure of part of the railway network for a specified period of time for the purposes of carrying out repair, maintenance or upgrading work on or adjacent to the railway network, during which no trains operate.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Up-side	Up-side refers to the direction of travel towards Central Station.
Vibration intensive works	Works which use vibration intensive equipment such as jack hammers, piling rigs and rock breakers.

Executive Summary

TfNSW is seeking approval to construct and operate an upgrade of Redfern Station (Redfern Station Upgrade – New Southern Concourse) ('the Project') as a component of the Transport Access Program (TAP). TAP is a NSW Government initiative to provide a better experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure across NSW.

The Project involves the construction of a new pedestrian concourse to the south of the existing Lawson Street concourse providing both lift and stair access to Platforms 1-10. The new pedestrian concourse would provide a new connection across the railway corridor, extending between Little Eveleigh Street and Marian Street in the suburbs of Redfern and Eveleigh and include associated interchange upgrades.

Subject to approval, the Project is expected to commence in late 2020/early 2021 and take up to 18 months to construct, with construction undertaken within both standard hours and out-of-hours periods. Works outside standard hours would be required to minimise disruptions to traffic, pedestrians, nearby residents and businesses, and also for constructability, safety, continuity of rail services reasons or to meet approval requirements (e.g. Road Occupancy Licence).

This Noise and Vibration Impact Assessment report provides an assessment of potential noise and vibration impacts from both the construction and operational phases of the Project. Relevant guidelines and assessment procedures have been followed to ensure all applicable requirements have been considered. The Secretary's Environmental Assessment Requirements (SEARs) and agency comments issued for the Project have also been referenced in this assessment to ensure that all potential impacts have been adequately considered.

Background noise levels have been monitored at a total of five locations to identify the existing noise environment throughout the Project area. The existing noise environment allows this assessment to define appropriate construction noise management levels and operational noise criteria.

A construction noise assessment has been conducted in accordance with the *Interim Construction Noise Guideline* (DECC, 2009) and the *Construction Noise and Vibration Strategy* (TfNSW, 2019). Five distinct construction stages were used in a computer-based noise model to determine the predicted noise levels generated from the Project. Construction noise impacts were assessed at residential receivers surrounding the Project, as well as non-residential receivers.

The assessment of noise associated with the construction of the Project indicates some exceedances of the noise management levels at the most affected sensitive receivers during certain activities, during both the day and night times. The magnitude and number of exceedances are detailed in this report.

Measures have been recommended to mitigate the construction noise impact at nearby sensitive receivers. The implemented measures would ultimately be selected by the construction contractor and be largely dependent on the construction strategy and work undertaken. Specific noise management and mitigation measures would be detailed in a Construction Noise and Vibration Management Plan. The recommended mitigation measures that may be implemented include:

- effective community consultation
- induction and training of construction site workers
- use of noise barriers, including along key locations on Little Eveleigh Street and Marian Street
- noise monitoring
- appropriate selection and maintenance of equipment, and use of at-source noise mitigation
- scheduling of work for less sensitive time periods
- situating plant in less noise sensitive locations
- construction traffic management
- respite periods.

Minimum working distances for vibration intensive construction works have been presented. Equipment size would be selected by the construction contractor and would take into account the minimum working distances and the distance between the area of construction and the nearest sensitive receiver. If works need to be undertaken within the minimum working distances recommended, building condition surveys would be completed and site specific minimum working distances established. Vibration monitoring would also be undertaken.

Construction traffic would increase the road traffic noise level in some areas, however this is not expected to increase by more than2 dB(A). An increase of 2 dB(A) or less is compliant with the traffic noise increase criterion in the *Road Noise Policy* (DECCW, 2011).

Cumulative construction noise impacts may occur as a result of concurrent construction stages of the Project being undertaken or other major projects occurring within proximity to the Project. Consultation would be undertaken with the proponents of other projects to minimise potential impacts where feasible and reasonable.

An operational noise assessment has been completed in accordance with the *Noise Policy for Industry* (EPA, 2017) and the *Noise Guide for Local Government* (EPA, 2013a). The major operational noise sources include car parking activities, mechanical plant, Opal card readers and commuters. The assessment has found that noise levels from car parking activities would comply with the applicable criteria at most affected noise sensitive receivers, however exceedances of up to 2 dB(A) of the Project specific L_{Aeq} noise level criteria may occur during the night-time period at the rear/western side of nearby sensitive receivers in Little Eveleigh Street. At-receiver treatment has been recommended to address these potential exceedances.

Although the final selection of mechanical plant is subject to detailed design standard noise controls such as appropriate selection and placement of mechanical plant and the inclusion of attenuation measures such as duct lining/attenuators would be adequate to reduce noise levels to meet the *Noise Policy for Industry* criteria.

Noise levels from Opal card readers were found to comply with applicable criteria during both the daytime and night-time periods.

While nearby residential receivers close to the Project would experience a noticeable increase in noise levels from commuters compared to existing conditions, the results of an ‘offensive noise test’ from the *Noise Guide for Local Government* concluded that this noise would be unlikely to be ‘offensive’ to nearby residential receivers.

The operational phase of the Project would not include any sources of vibration likely to exceed the relevant criteria, and would not give rise to any significant vibration.

1. Introduction

1.1 Project overview

Transport for NSW (TfNSW) is the lead agency for the integrated delivery of public transport services across all modes of transport in NSW and is responsible for the delivery of projects within the Transport Access Program (TAP). TAP is a NSW Government initiative to provide a better experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure across NSW.

TfNSW is seeking approval to construct and operate an upgrade of Redfern Station (Redfern Station Upgrade – New Southern Concourse) ('the Project') as a component of the TAP. The Project involves the construction of a new pedestrian concourse to the south of the existing Lawson Street concourse providing both lift and stair access to Platforms 1-10. The new pedestrian concourse would provide a new connection across the railway corridor, extending between Little Eveleigh Street and Marian Street in the suburbs of Redfern and Eveleigh and include associated interchange upgrades.

The key features of the Project include:

- a six metre wide concourse between Little Eveleigh Street and Marian Street
- new stair and lift access from the new concourse to Platforms 1 to 10
- an upgraded station entrance at Marian Street including station services and customer amenities
- a new station entrance at Little Eveleigh Street including station services and customer amenities
- formalisation of a shared zone on Little Eveleigh Street, including:
  - safety improvements to vehicle, cyclist and pedestrian interactions
  - improvements to streetscape such as landscaping, lighting, drainage and pavements
  - relocation of approximately 20 parking spaces (including 18 resident/ restricted parking spaces, one accessible parking space and one car share scheme parking space)
  - utility adjustments
- upgrade of Marian Street/Cornwallis Street/Rosehill Street area, including:
  - extension of existing shared zone including part of Rosehill Street
  - safety improvements to vehicle, cyclist and pedestrian interactions including footpath widening
  - improvements to streetscape such as lighting, drainage, landscaping and pavements as well as utility adjustments
  - changes to street parking arrangements including removal of approximately 16 parking spaces (including relocation of one car share scheme parking space)
- operation of the Project.

Other components of the Project include:

- relocation of the shuttle bus zone from Little Eveleigh Street to Lawson Street
- kiss and ride on Lawson Street, and associated footpath upgrade
- kiss and ride on Gibbons Street, and associated footpath upgrade
- footpath widening on Ivy Street
- relocation of a building on Platform 1 to accommodate the concourse
- repurposing, relocations and alterations to platform building features and other platform features, including privacy walls, doors, screens and roofing, platform seats and electrical equipment

- addition of platform canopies
- platform resurfacing on all platforms and associated drainage alterations
- installation of station operational components and infrastructure including:
  - wayfinding and signage
  - tactile ground surface indicators (TGSI)
  - rubbish bins
  - CCTV
  - passenger information system (e.g. passenger information display, public address and hearing loops)
  - emergency equipment (e.g. for fire and life safety)
- service relocations and upgrades including:
  - relocation of overhead wiring structures
  - installation of a new rail signal between Platforms 1 and 2.

The Project's context and location is provided in Figure 1, and the Project area and an overview of the key features are shown in Figure 2.

Subject to planning approval, construction is anticipated to commence following Project approval in late 2020/early 2021 and would take approximately 18 months to complete.

For further details on the Project, please refer to Chapter 5 of the Environmental Impact Statement (EIS).

The Project is subject to assessment and approval by the Minister for Planning and Public Spaces under Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This technical report provides an assessment of the potential noise and vibration impacts of the Project and addresses the requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) (the 'Secretary's Environmental Assessment Requirements' or SEARs, 20 December 2020) (refer Section 1.3).

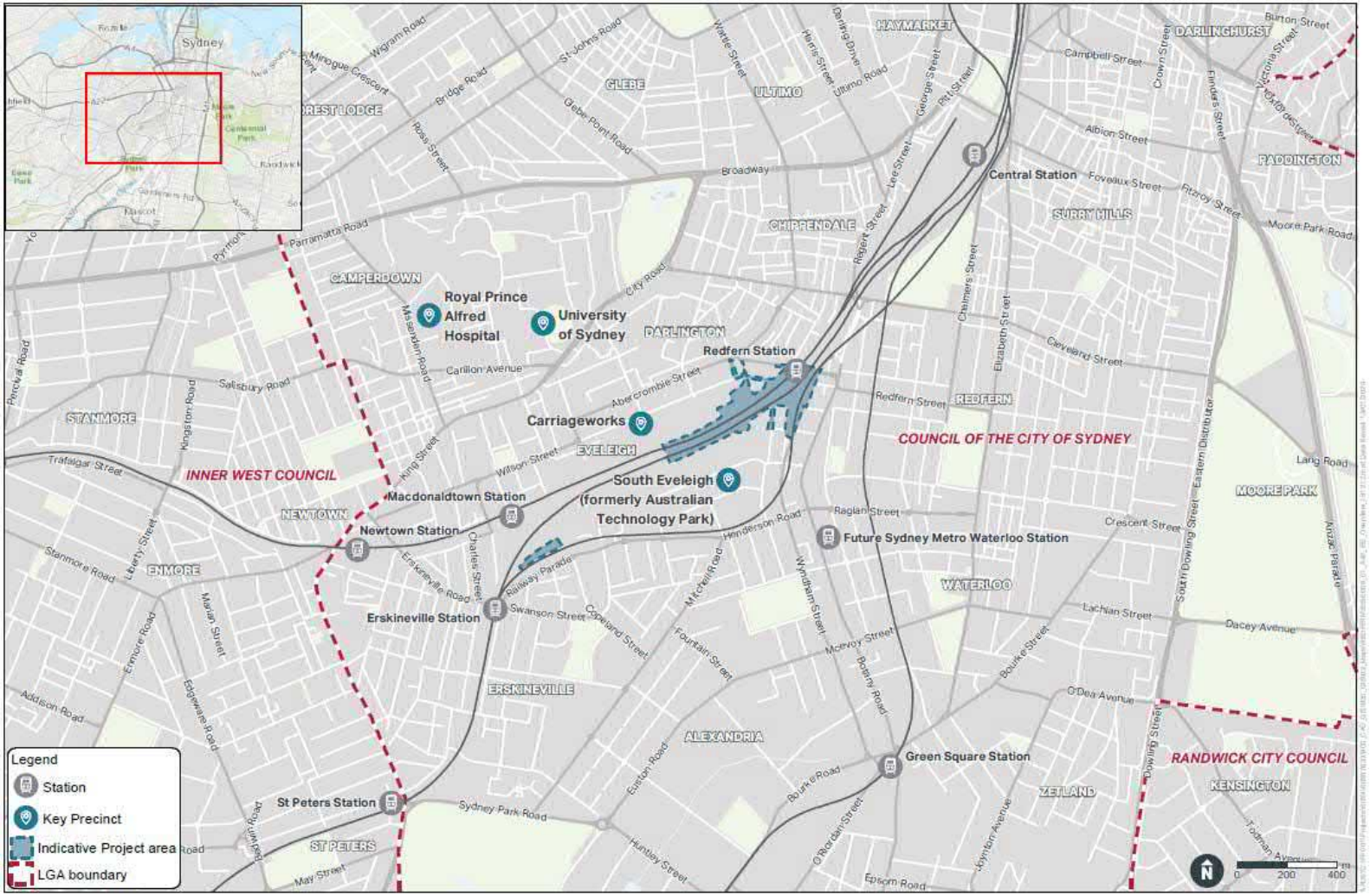


Figure 1 Project overview and location

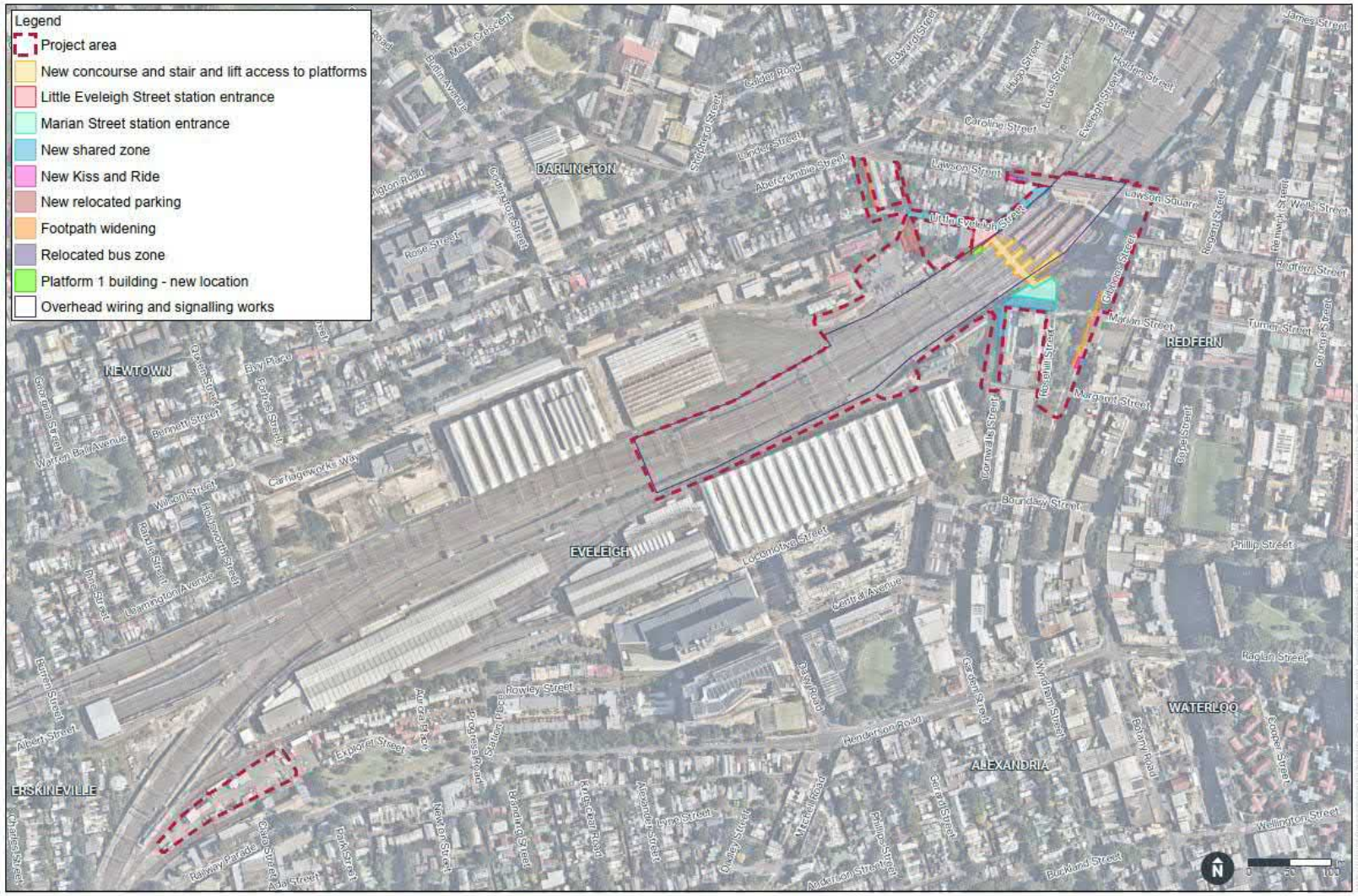


Figure 2 Project area and overview of key features

1.2 Purpose and scope of this technical report

This technical report (Noise and Vibration Impact Assessment), is one of a number of technical documents that forms part of the EIS. The purpose of this technical report is to identify potential impacts of the Project and to outline mitigation measures relating to noise and vibration during construction and operation of the Project. This report addresses the relevant SEARs as described in Section 1.3.

The objectives of the technical report are to:

- establish the existing background noise levels in the vicinity of the Project
- establish construction noise management levels and vibration limits that would apply to the Project
- predict noise and vibration levels at nearby residential and other sensitive receivers due to the construction of the Project
- predict environmental noise and vibration levels at nearby residential and other sensitive receivers due to operation of the Project
- predict noise levels from additional off-site construction traffic generated by the Project
- recommend mitigation measures, where necessary, to reduce and manage noise and vibration impacts from the Project to comply with established noise management levels and vibration limits.

1.3 Secretary's Environmental Assessment Requirements

The SEARs relating to Noise and Vibration, and where these requirements are addressed in this technical report, are outlined in Table 1.

Table 1 Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements		Where addressed
1.	Construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must consider cumulative impacts from nearby key infrastructure projects. The assessment must justify impacts to receivers including consideration of sleep disturbance (including the number of noise-awakening events), and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	Section 5 and 6[1]
2.	Construction noise and vibration including:	
a.	the nature of construction activities (including transport, tonal or impulsive noise-generating works, as relevant)	Section 5.1, 5.3 and 5.8
b.	the intensity and duration of noise (both air and ground borne) and vibration impacts	Section 5.1 and 5.5
c.	identification of receivers, existing and known future, during construction	Section 2.1 Section 5.6.2
d.	the sensitivity of receivers to the level of impact	Section 2.3 and 2.4
e.	the need to balance: i. timely conclusion of noise and vibration-generating works with periods of receiver respite; ii. the need to work at night and during planned rail possessions; and iii. other factors that may influence the timing and duration of construction activities	Section 5.1 and 7.

Secretary's Environmental Assessment Requirements		Where addressed
f.	noise impacts of out-of-hours works (including utility works), the activities to be undertaken, their estimated duration and justification in terms of the *Interim Construction Noise Guideline* (DECC, 2009)	Section 5.1, and 5.5.1
g.	cumulative noise and vibration including project impacts and concurrent construction activities within the proposal and the construction of other relevant development in the vicinity	Section 5.6
h.	details and analysis of the predicted effectiveness of mitigation measures to adequately manage identified impacts, including impacts as identified in (g), and any potential residual noise and vibration impacts following application of mitigation measures	Section 7
i.	a description of how feedback received during preparation of the Environmental Impact Statement has been taken into account (and would be taken into account following exhibition of the Environmental Impact Statement) in the design of mitigation measures, including any tailored mitigation, management and communication strategies for sensitive receivers.	Section 7
3.	operational noise and vibration impacts resulting from use of the infrastructure on the amenity of local residents.	Section 6
1.	Construction and operation noise and vibration impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage) in accordance with relevant guidelines.	Section 5.9

Notes:

1. No blasting is proposed as part of the Project.

1.4 Policies and guidelines

The following policies and guidelines are relevant for this assessment:

- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change, 2009
- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation, 2006
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water, 2011
- *Noise Policy for Industry*, Environment Protection Authority, 2017
- *Noise Guide for Local Government*, Environment Protection Authority, 2013a
- *Rail Infrastructure Noise Guideline*, Environment Protection Authority, 2013b
- *Development Near Rail Corridors and Busy Roads – Interim Guideline*, Department of Planning, 2008
- *Construction Noise and Vibration Strategy* (CNVS), Transport for NSW, 2019
- DIN Standard 4150: Part 3 2016 *Vibration in Buildings - Effects on Structures*, 1999
- British Standard 7385: Part 2 1993 *Evaluation and Measurement of Vibration in Buildings*, 1993
- British Standard 6472: *Evaluation of human exposure to vibration in buildings (1-80 Hz),* 1992
- Australian Standard AS 2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites*, 2010
- Australian Standard AS 1055-2018 – *Acoustics—Description and measurement of environmental noise*, 2018

- International Standard ISO 9613-2:1996 - *Acoustics -- Attenuation of sound during propagation outdoors - Part 2: General method of calculation*
- Australia Standard AS IEC 61672.1-2019 - *Electroacoustics – Sound level meters Specifications*
- British Standard 5228: Part 1 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise*, 2009 including Amendment 1, 2014
- Bavarian State Office for the Environment's (Bayerishes Landesamt für Umwelt/BayLfU) *Parking Area Noise,* 2007
- *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration,* Australian and New Zealand Environment Council (ANZEC), 1990.

Definitions for acoustic terminology used within this report can be found in the Definitions section at the beginning of this report.

2. Existing acoustic environment

2.1 Site description

Redfern Station is located within an urban environment. The Project is directly surrounded by a mix of residential, commercial and industrial receivers. The closest residential receivers are located adjacent to the railway station around 20 metres from the Project on Little Eveleigh Street and also on Marian Street. A number of residential/mixed use developments are under construction around the Project. Further details of the developments that are located within 500 metres of the Project are presented in Section 5.6.2. The Project area and the surrounding environment are shown in Figure 2.

2.1.1 Noise catchment areas

To assist in determining noise management levels for the receivers surrounding the Project, five noise catchment areas (NCAs) were identified. For the purposes of undertaking a noise impact assessment the noise environment at each of the residential receivers within a NCA is considered to have a similar noise environment, considering the proximity to existing major noise sources. Each NCA is shown in Figure 3.

Noise sensitive receivers other than residential receivers are listed in Table 2.

Table 2 Notable sensitive receivers surrounding the Project area (non-residential)

Noise catchment area	Receiver	Receiver type
NCA 1	South Sydney Rotary Park	Passive recreation
NCA 1	Solander Park	Passive recreation
NCA 1	St Marys Catholic Primary School	Educational facility
NCA 1	Ethel Street Playground	Passive recreation
NCA 2	Hollis Park	Passive recreation
NCA 2	Darlington Public School	Education
NCA 2	Saint Michael the Archangel Melkite Cathedral	Place of worship
NCA 2	University of Sydney	Educational facility
NCA 2	Church of the Assumption of Our Lady	Place of worship
NCA 2	TAFE NSW - Eora	Educational facility
NCA 2	Charles Kernan Reserve	Passive recreation
NCA 2	Hugo Street Reserve	Passive recreation
NCA 2	Redfern community centre/playground	Passive recreation
NCA 3	Key College	Educational facility
NCA 4	Cathedral of the Annunciation of Our Lady	Place of worship
NCA 4	Prince Alfred Park	Passive recreation
NCA 4	Gibbons Street Reserve[1]	Passive recreation
NCA 4	Carriage works	Passive recreation
NCA 5	Reconciliation Park	Passive recreation
NCA 5	St Vincent de Paul's Catholic Church Redfern	Place of worship
NCA 5	South Eveleigh Playground	Passive recreation
NCA 5	Redfern Park	Passive recreation
NCA 5	Alexandria Park	Passive recreation

Noise catchment area	Receiver	Receiver type
NCA 5	Alexandria Childcare Centre	Childcare centre

Notes:

1. Gibbons Street Reserve would be used as a construction compound for the Project.

2.1.2 Heritage items

There are a number of heritage listed items located in the vicinity of the Project. These heritage items are listed in the *New South Wales State Heritage Register* and include the Eveleigh Chief Mechanical Engineers Office, Eveleigh Railway Workshops and Machinery, and Redfern Railway Station Group.

Refer to Technical report 5: Non-Aboriginal Heritage of the EIS for more information on these heritage listings and their significance.

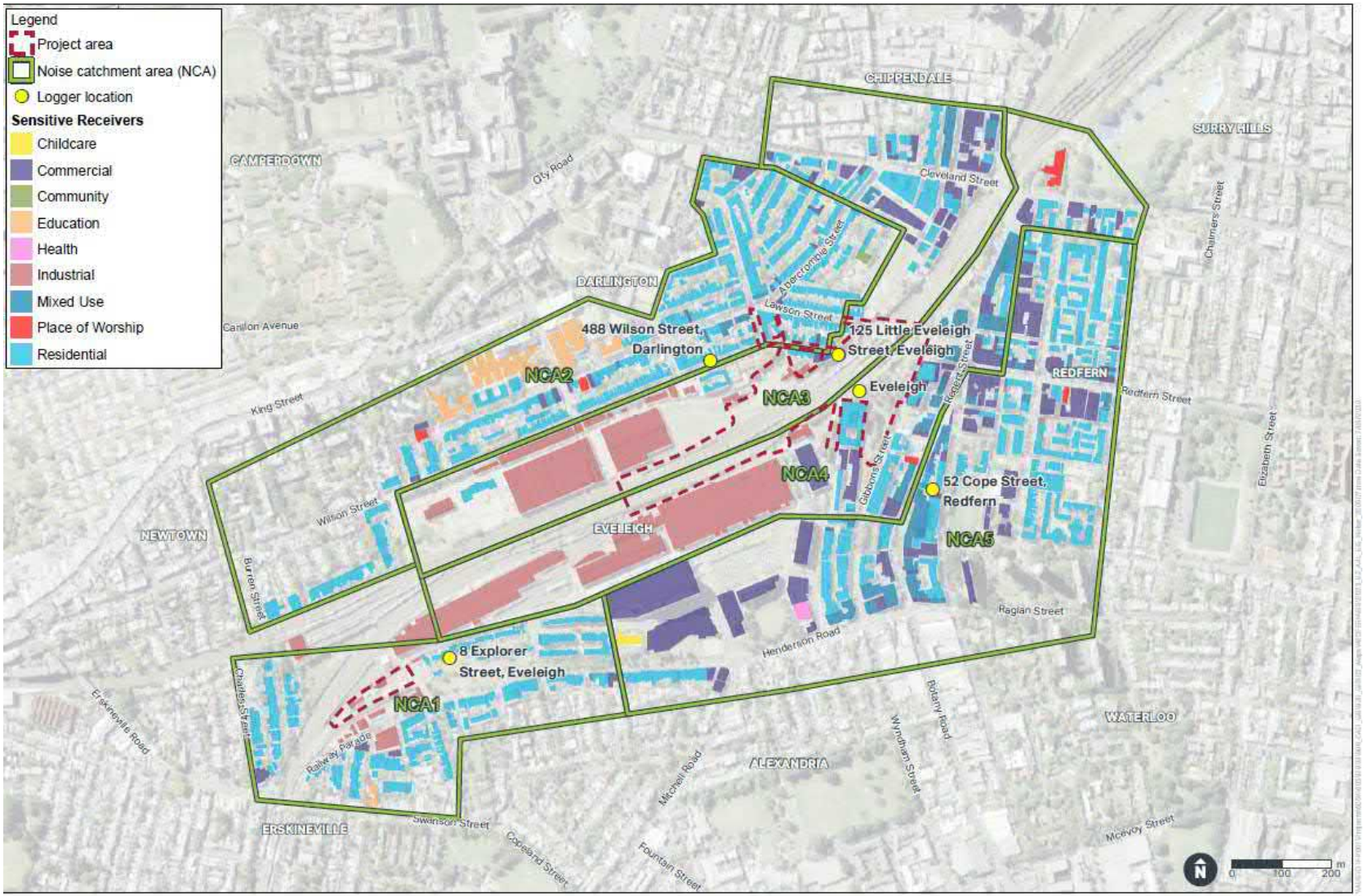


Figure 3 Noise catchment areas and logger locations

2.2 Noise measurement methodology

Long term unattended and short term attended noise measurements were undertaken to establish the existing ambient and background noise environment at potentially affected receivers around the Project. Measurements were made using noise loggers at five locations. The locations of the five noise loggers are shown in Figure 3.

The acoustic instrumentation employed during unattended and attended noise measurements comply with the requirements of *AS IEC 61672.1-2019 Electroacoustics – Sound level meters Specifications* and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

2.2.1 Unattended noise measurements

The noise loggers were placed at representative locations around the Project area as listed in Table 3 and shown in Figure 3.

The noise loggers were calibrated prior to and after the monitoring period with a drift in calibration not exceeding ±0.5 dB(A).

Table 3 Unattended noise monitoring details

NCA	Logger	Location	Period	Logger Model	Logger Serial number
1	1	8 Explorer Street, Eveleigh	11 November to 21 November 2019	Rion NL52	876010
2	2	488 Wilson Street, Darlington	11 November to 21 November 2019	Rion NL52	553967
-	3	125 Little Eveleigh Street, Eveleigh	22 November to 2 December 2019	Rion NL21	00265112
3 & 4	4[1]	Marian Street, Eveleigh (TfNSW land opposite 'The Watertower')	11 November to 21 November 2019	ARL-315	15-299-444
5	5	52 Cope Street, Redfern	20 November to 2 December 2019	Svan 957	23855

Notes:

1. *The noise environments within NCA3 and NCA4 were deemed to be very similar. The logging results of logger 4 were used for both NCA 3 and NCA 4 to better interface with the adjacent NCAs, i.e. minimise differences in criteria for adjacent NCAs.*

The noise environment at each of the residential receivers within a NCA is considered to have a similar noise environment to the unattended monitoring location within that NCA. As such, each of the residential receivers is assigned the same background noise level and construction noise management level.

In accordance with the *Noise Policy for Industry* (EPA, 2017), noise monitoring affected by adverse weather conditions or extraneous noise events is excluded from the monitoring data. The *Noise Policy for Industry* advises that data may be affected where adverse weather, such as wind speeds higher than 5 m/s or rain, occurs. Weather data was acquired from the Bureau of Meteorology's Canterbury weather station (station number 94766) located around seven kilometres west of the Project.

The logger measured noise levels over the sample period and then determined L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} noise levels are the levels exceeded for 1%, 10% and 90% of the measurement period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the *Noise Policy for Industry* for each

monitoring location. The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring period. Table 4 presents the RBLs for each assessment period for each NCA.

2.2.2 Attended noise measurements

Attended noise measurements were conducted at the five unattended noise monitoring locations on 11 November 2019 and 2 December 2019. An additional location was also used to take attended measurements at a receiver on Little Eveleigh Street (close to the station and near to where the new station entrance on Little Eveleigh Street would be located) on 11 December 2019. The measurements were conducted over 15 minute periods. Weather conditions were sunny on the days of monitoring, with no wind.

Attended noise measurements were conducted using a Brüel & Kjær Type 2250 sound level meter. The sound level meter used is designated as a Class 1 instrument and has accuracy suitable for laboratory and field use. The sound level meter was calibrated before and after the measurements with no drift in calibration exceeding ±0.5 dB(A).

2.3 Noise measurement results

2.3.1 Unattended noise measurements

Table 4 presents the existing overall representative L_{Aeq} ambient noise level and the background L_{A90} noise levels for the day, evening and night-time periods, in accordance with the *Noise Policy for Industry*. The overall representative L_{Aeq} noise levels were determined by logarithmically averaging each assessment period for the entire monitoring period.

The results for each day and the graphical noise logging results are presented in Appendix A.

Table 4 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

NCA	Logger	RBL L_{A90} dB(A)			Log Average L_{Aeq} dB(A)		
		Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
1	1	42	37	32	54	53	46
2	2	41	39	35	57	53	48
-	3	54	49	41	64	62	59
3/4	4[2]	53	51	39	61	58	57
5	5	44	44[3]	37	53	54	48

Notes:

1. *Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays and Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday and Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays and Public Holidays.*
2. *The logging results of logger 3 were used for both NCA 3 and NCA 4 to better interface with the other NCAs. i.e. minimise differences in criteria for adjacent NCAs.*
3. *The evening level was higher than the daytime level, and so it has been set to the daytime level as recommended by the Noise Policy for Industry.*

2.3.2 Attended noise measurements

The results of the attended noise monitoring are presented in Table 5.

Table 5 Attended noise measurements

Location	Date	Time	L_{Aeq} dB(A)	L_{A90} dB(A)	Comments
1	11/11/2019	12:28	56	45	Noise environment controlled by nature. Regular light vehicle pass by along Henderson Road generally inaudible especially in presence of a slight breeze. Plane pass by is dominant when passing over. Plane passbys were fairly frequent, around five in the 15 minute measurement period. Bird calls in the distance heard intermittently throughout measurement period. Train horns could be heard at times. Sunny with slight breeze at times and minimal clouds.
2	11/11/2019	10:38	56	42	Noise environment dominated by industrial hum to the south. Bird and insect calls heard intermittently throughout measurement period. Pedestrians and cyclist passbys fairly frequent. Plane passbys fairly frequent during the 15 minute measurement period (more than five). Helicopter passby ~72 dB(A) and car passby ~62dB(A) also recorded. Sunny with very slight breeze at times and minimal clouds.
3	2/12/2019	11:32	58	50	Noise environment dominated by urban hum, predominantly from Redfern Station. Door buzzers closing ~ 58-60 dB(A). Train pulling away ~ 60 dB(A). People talking on platform ~ 50 dB(A). Aircraft flyover ~ 58-62 dB(A). Pedestrian foot traffic sporadic. Sunny with mild breeze at times and minimal clouds.
4	11/11/2019	11:26	59	53	Noise environment dominated by station activities and road traffic noise from Gibbons Street. Trains pulling away ~63 dB(A). Door buzzers closing ~59 dB(A). Insect calls heard intermittently throughout measurement. Plane passbys quite frequent. Banging from construction site to the north on other side of station audible similarly, the construction site to east (corner Gibbons Street and Marian Street). Sunny with mild breeze at times and minimal clouds.

Location	Date	Time	L_{Aeq} dB(A)	L_{A90} dB(A)	Comments
5	2/12/2019	11:03	51	46	Noise environment dominated by light urban hum, mostly road traffic from Regent Street. Train horn barely audible. Aircraft noise clearly audible. Distant leaf blower or whipper snipper just audible. Occasional wind gusts ~ 52-53 dB(A). Helicopter flyover ~ 63 dB(A). Sirens ~ 55-58 dB(A). Sunny with mild breeze at times.
Additional location on Little Eveleigh Street	11/11/2019	09:51	54	46	Noise environment dominated by industrial hum to the east towards Redfern Station which fluctuates in loudness; almost sounds like mobile plant at times. Sunny with very slight breeze at times and minimal clouds. Bird and insect calls heard throughout measurement period. Pedestrians and cyclist passbys fairly frequent. Some hammering heard at times to east. Plane passbys. Car pass by ~ 63 dB(A).

2.4 Existing noise environment summary

The acoustic environment in NCA 1, 2 and 5 are generally dominated by local vehicle traffic with receivers also affected by rail noise depending on proximity. The acoustic environment within NCA 3 and 4 is generally dominated by rail noise as well as noise associated with the operation of Redfern Station. Natural sounds are also audible throughout all NCAs. These characteristics are typical of an urban environment.

3. Construction noise and vibration criteria

3.1 Construction activity noise criteria

3.1.1 Interim Construction Noise Guideline

The *Interim Construction Noise Guideline* (DECC, 2009) is the principal guideline for the assessment and management of construction noise in NSW. As the proposed works are expected to continue for a period of more than three weeks and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on 'representative construction scenarios, has been carried out for the Project.

Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using environmental noise modelling software and compared to the noise management levels (NML), derived in accordance with the *Interim Construction Noise Guideline*.

Where an exceedance of the noise management levels is predicted, the *Interim Construction Noise Guideline* advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as provide contact details to facilitate feedback from affected residents during construction.

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

The construction noise management levels (NML) for the residential and other sensitive land uses are detailed in Table 6, Table 7 and Table 8.

Table 6 ***Interim Construction Noise Guideline*** **Residential noise management levels**

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm; Saturday 8:00 am to 1:00 pm; No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 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 dB(A) above the noise affected level, the proponent should negotiate with the community • for guidance on negotiating agreements see section 7.2.2 of the *Interim Construction Noise Guideline*.

Notes:

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

The *Interim Construction Noise Guideline* (DECC, 2009) defines what is considered to be feasible and reasonable as follows:

- *Feasible*

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

- *Reasonable*

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Table 7 presents the NMLs applicable to residential receivers nearby to the Project.

Table 7 Construction noise management levels – Residential receivers

Noise catchment area	Period	RBL, L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out-of-hours noise management levels, $L_{Aeq,15min}$, dB(A)
1	Day	42	52 (75 – highly noise affected level)	47
	Evening	37	-	42
	Night	32	-	37
2	Day	41	51 (75 – highly noise affected level)	46
	Evening	39	-	44
	Night	35	-	40
3	Day	53	63 (75 – highly noise affected level)	58
	Evening	51	-	56
	Night	39	-	44
4	Day	53	63 (75 – highly noise affected level)	58
	Evening	51	-	56
	Night	39	-	44
5	Day	44	54 (75 – highly noise affected level)	49
	Evening	44	-	49
	Night	37	-	42

Table 8 presents the NMLs applicable to other noise sensitive receivers such as educational facilities, places of worship and commercial receivers (as identified in Table 2).

Table 8 Construction noise management levels – Other receivers

Land use	Noise management levels, $L_{Aeq,15min}$ (applies when properties are in use) (external)
Commercial premises (including offices, retail outlets)	70 dB(A)
Industrial receivers	75 dB(A)
School classrooms	55 dB(A)[1]
Places of worship	55 dB(A)[1]
Childcare centre	55 dB(A)[1]

Notes:

1. *This external noise management level is based upon a 45 dB(A) internal noise management level and a 10 dB(A) reduction from outside to inside through an open window.*

3.1.2 Sleep disturbance criteria

The *Interim Construction Noise Guideline* requires a sleep disturbance analysis where construction works are planned to extend over more than two consecutive nights. The L_{Amax} noise levels and number of expected L_{Amax} noise events should be predicted in order to determine the likelihood of potential sleep disturbance.

The EPA recommends that to minimise the risk of sleep disturbance during the night-time period (10:00 pm to 7:00 am), the $L_{Amax,}$ noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB(A). If this screening criterion is found to be exceeded, then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

Sleep disturbance research presented in the *NSW Road Noise Policy* (DECCW, 2011) concludes that *'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides approximately 10 dB(A) in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 9.

Table 9 Sleep disturbance criteria

Noise catchment area	Background noise level	Sleep disturbance criteria (external) L_{Amax}, dB(A)	
	(L_{A90}), dB(A)	Screening level	Awakening reaction
1	32	47	65
2	35	50	65
3	39	54	65
4	39	54	65
5	37	52	65

3.2 Construction traffic noise criteria

To assess noise impacts from construction traffic an initial screening test should be undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A), in line with the *Road Noise Policy*. Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation should be considered for those receivers affected. The *Road Noise Policy* does not require assessment of noise impact to commercial or industrial receivers. Section 5.8 presents the construction traffic noise assessment.

3.3 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 10.

Table 10 Standards/guidelines used for assessing construction vibration

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

Notes:

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

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

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

3.3.1 Structural damage

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

The German Standard (DIN 4150) provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 11. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 11 DIN 4150: Structural damage safe limits for building vibration

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

Notes:

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

3.3.2 Human comfort

The assessment of intermittent vibration outlined in the *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 12. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 12 Preferred and maximum vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1] Preferred	Daytime Max	Night time Preferred	Night time Max
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions, commercial premises and places of worship	0.4	0.8	0.4	0.8
Workshops or factory environments	0.8	1.6	0.8	1.6

Notes:

1. Day is defined as 7:00 am to 10:00 pm. Night is defined as 10:00 pm to 7:00 am.

4. Operational noise criteria

The Project comprises the installation of lifts, new station entrances, a new services building, and a car park. It does not include any changes to rail movements. It is also noted that additional commuters would access the upgraded station from streets close to the new station entrances.

Operational noise from the Project has been considered for compliance with the *Protection of the Environment Operations Act 1997* (PoEO Act). The main acoustic requirement of the PoEO Act is to ensure that 'noise is not offensive'. The definition for offensive noise is provided in the Dictionary in the PoEO Act and states:

Offensive noise is:

a. that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

1. is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

2. interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

3. that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

Noise emissions from the use of the Project has the potential to adversely affect surrounding noise sensitive receivers, particularly nearby residents.

The *Noise Policy for Industry* (EPA, 2017) provides guidance in relation to acceptable noise limits for industrial noise emissions, which includes, but is not limited to, noise emissions from mechanical plant.

Noise from the commuters using the station does not fall under the *Noise Policy for Industry*. However the EPA's *Noise Guide for Local Government* (EPA, 2013a) provides a checklist of considerations to determine whether the noise is likely to be offensive (refer Section 4.1.4).

4.1 Industrial noise

The assessment procedure in the *Noise Policy for Industry* has two components:

- controlling **intrusive** noise impacts in the short term for residences
- maintaining noise level **amenity** for residences and other land uses.

Both components are assessed at the boundary of the noise sensitive receiver site. These criteria apply to environmental noise emissions from any plant installed as part of the Project, and for residential receivers represent the lower of the intrusive and amenity criteria.

4.1.1 Intrusive noise impacts

The *Noise Policy for Industry* states that the noise from any single noise source should not be greatly above the prevailing background noise level. Industrial noise sources are generally considered acceptable if the A-weighted equivalent continuous sound pressure level of noise from the source, measured over a 15 minute period ($L_{Aeq,15\ min}$) does not exceed the Rating Background Level (RBL) by more than 5 dB(A) for the period under consideration. This is termed the Intrusiveness Criterion.

The RBL is the background noise level to be used for assessment purposes and is determined by the methods given in the *Noise Policy for Industry*.

The RBL and the respective intrusive criteria for the day, evening and night periods are provided in Table 13.

Table 13 Intrusive criteria

Location	Period	RBL (L_{A90}), dB(A)	Intrusiveness criteria (RBL+5), dB(A)
NCA 1 Residential receivers	Day	42	47
	Evening	37	42
	Night	32	37
NCA 2 Residential receivers	Day	41	46
	Evening	39	44
	Night	35	40
NCA 3 Residential receivers	Day	53	58
	Evening	51	56
	Night	39	44
NCA 4 Residential receivers	Day	53	58
	Evening	51	56
	Night	39	44
NCA 5 Residential receivers	Day	44	49
	Evening	44	49
	Night	37	42

4.1.2 Protecting amenity

To limit continuing increase in noise levels, the maximum ambient noise level within an area from all industrial noise sources should not normally exceed the recommended amenity noise levels specified in the *Noise Policy for Industry* and presented in column four of Table 14. That is the noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the "background creep" or "amenity criterion".

The project amenity level is equal to the recommended amenity noise level minus 5 dB(A). Therefore, the relevant noise amenity level from Table 14 is assigned as the project amenity noise level. The project amenity level is then converted to a 15 minute period by adding 3 dB(A).

NCA 3 and NCA 4 are subject to high traffic levels during the night-time period therefore the Project amenity level has been adjusted in accordance with the *Noise Policy for Industry*.

Table 14 Amenity criteria

Type of receiver	Indicative noise amenity area	Time of day	Recommended amenity noise level[1], dB(A)	Project amenity noise level, dB(A)	
			$L_{Aeq\ (period)}$	$L_{Aeq\ (period)}$	$L_{Aeq\ (15\ minute)}$
NCA 1 Residential receivers	Urban	Day	60	55	58
		Evening	50	45	48
		Night	45	40	43
NCA 2 Residential receivers	Urban	Day	60	55	58
		Evening	50	45	48
		Night	45	40	43
NCA 3 Residential receivers	Urban	Day	60	55	58
		Evening	50	45	48
		Night	45	42[3]	45
NCA 4 Residential receivers	Urban	Day	60	55	58
		Evening	50	45	48
		Night	45	42[3]	45
NCA 5 Residential receivers	Urban	Day	60	55	58
		Evening	50	45	43
		Night	45	40	38
Commercial premises	All	When in use	65	65	68
School classroom[2]	All	When in use	45	45	48
Place of worship[2]	All	When in use	50	50	53
Childcare[2]	All	When in use	45	45	48

Notes:

1. *Specified in Table 2.2 of the Noise Policy for Industry*
2. *External noise levels are based on internal criteria with a 10 dB(A) reduction from outside to inside through an open window.*
3. *Area dominated by high levels of rail traffic noise, therefore project amenity level = existing $L_{Aeq(period,\ traffic)}$ minus 15 dB*

4.1.3 Environmental noise emission criteria summary

A summary of the Project specific noise level criteria is presented in Table 15 below in accordance with the *Noise Policy for Industry* (EPA, 2017). These criteria apply to environmental noise emissions from the use of the proposed carpark and any plant and public announcement system installed as part of the Project and for residential receivers represent the lower of the intrusive and amenity criteria.

Table 15 Summary of environmental noise emission criteria

Location	Time of day	Project specific noise levels criteria[1] L_{Aeq}, dB(A)
NCA 1	Day	47
	Evening	42
	Night	37
NCA 2	Day	46
	Evening	43
	Night	38
NCA 3	Day	58
	Evening	48
	Night	44
NCA 4	Day	58
	Evening	48
	Night	44
NCA 5	Day	49
	Evening	43
	Night	38
Commercial premises	When in use	68
Community hall	When in use	58
School classroom	When in use	48

Notes:

1. *These criteria represent the lower of the intrusive and amenity criteria presented in Table 13 and Table 14 respectively.*

4.1.4 Maximum noise level assessment

The *Noise Policy for Industry* requires the potential for sleep disturbance to be assessed by considering maximum noise levels events during the night-time period.

Where the subject development/premises night-time noise levels at a residential location exceed the following screening levels a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB(A), whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB(A), whichever is the greater,

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 16.

Table 16 Night-time sleep disturbance screening levels

Location	Measured night-time RBL, $L_{A90,\ 15\ mins}$ dB(A)	Sleep disturbance screening levels, dB(A)	
		$L_{Aeq,15min}$	L_{AFmax}
NCA 1 Residential receivers	32	40	55
NCA 2 Residential receivers	35	40	55
NCA 3 Residential receivers	39	44	59
NCA 4 Residential receivers	39	44	59
NCA 5 Residential receivers	37	42	57

4.2 Non-industrial noise

As noted above noise from the additional commuters using the station/shared zone does not fall under the *Noise Policy for Industry*. The EPA's *Noise Guide for Local Government* (EPA, 2013b) provides the following checklist of considerations to determine whether noise is offensive:

1. Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?
2. Does the noise include characteristics that make it particularly irritating?
3. Does the noise occur at times when people expect to enjoy peace and quiet?
4. Is the noise atypical for the area?
5. Does the noise occur often?
6. Are a number of people affected by the noise?

5. Construction noise and vibration assessment

5.1 Construction stages and scheduling

In consultation with TfNSW, seven distinct construction stages, each consisting of a number of construction activities, have been considered for the Project. These would be confirmed by the construction contractor prior to construction commencing and further assessment would be undertaken if required. These work stages are described in Table 17. Five of the work stages have been assessed as representative construction scenarios for the Project. Further information on construction stages is provided in Chapter 5 of the EIS. The majority of works would be undertaken during standard daytime construction hours as specified in the *Interim Construction Noise Guideline* where reasonable and feasible to do so. Standard construction hours are:

- Monday to Friday 7:00 am to 6:00 pm;
- Saturday 8:00 am to 1:00 pm; and
- no work on Sundays and public holidays.

However, work outside standard hours (out-of-hours work) would be required for some construction stages to minimise disruptions to traffic, pedestrians, nearby residents and businesses, and also for constructability, safety (particularly within a live rail environment), continuity of rail services reasons or to meet approval requirements (e.g. Road Occupancy Licence).

Section 2.3 of the *Interim Construction Noise Guideline* describes five categories of works that might be undertaken outside of standard hours, as follows:

1. *the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads*
2. *emergency work to avoid the loss of life or damage to property, or to prevent environmental harm*
3. *maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours*
4. *public infrastructure works that shorten the length of the project and are supported by the affected community*
5. *works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.*

Some out-of-hours works (OOHW) for the Project would fall within categories 1 to 3. Most OOHW for the Project would also fall into Category 5, as some activities by their nature and location, including concourse and lift installation and some work on platforms, would be required to be undertaken during a standard rail shutdown (i.e. rail possession). It is anticipated that the works requiring rail shutdown would be undertaken over approximately 20 scheduled rail possession periods with continual work from Friday to early on Monday mornings. Approximately two additional (non-standard) rail possession periods are proposed including a possession across the 2020 and 2021 Christmas periods. During these possessions, existing standard protocols would be implemented to minimise impacts to the community, including providing alternative transport arrangements and notifications. There is also the potential for mid-week night work to be required throughout various stages of the Project depending on the activity required.

Certain construction activities, such as overnight concrete pours, would also out of necessity be undertaken outside of the standard construction hours so as to facilitate design and construction quality requirements (i.e. performing the concrete pour continuously). Other works that can be undertaken so as to be inaudible at the nearest residential receivers may also be performed during OOHW periods.

Table 17 Construction stages and scheduling

Construction stage and duration	Activities	Scheduling[1]
Stage 1: Site establishment and enabling works (two months)	• clearing of ancillary facility areas/construction areas • installation of site offices and utility connections within the ancillary facility areas • erection of hoarding and fencing • undertrack crossing pipes for concrete supply.	Standard hours which may extend to Period 2 OOHW
Stage 2: Building modification works (six months)	• station and station entrance reconfiguration works • demolition of existing structures • installation of foundations for new concourse • services and fit-out works and electrical works (including any re-directed services/utilities).	Standard hours which may extend to Period 1 OOHW
Stage 3: Utility and overhead wiring relocations/ adjustments (ten months)	• installation of two padmount transformers in a new services building at the Marian Street entrance • re-route clashing utilities in corridor for impacted infrastructure • temporary diversion of low voltage line and other affected services • re-route any remaining clashing utilities.	Standard hours, Period 1 OOHW and during a possession (Period 2 OOHW)
Stage 4.1: Main construction works – Station entrances (eight months over an 18 month period)[2]	• removal of sections of the interior and exterior of the building • station entrance fit-out works and electrical works • clearing of existing vegetation • levelling of site with engineered fill • piling for station entrance infrastructure and construction of station services building.	Standard hours which may extend to Period 1 OOHW
Stage 4.2: Main construction works – Installation of concourse (18 months)[2]	• temporary earthworks and dismantling of fencing and barriers to allow piling rigs to reach desired location • mobilisation of piling rigs to access lift and stair locations • installation of reinforced concrete piles, foundations and support structures • site set up of cranes • installation of concourse including lifting of pre-cast concrete sections by crane • construction of foundation slab including excavation for lifts • removal of existing fencing and barriers • excavation of lift shaft well and establishment of foundations and formworks • insertion of piles at the both locations for new lift foundation • construction of lift shafts • installation of lifts • installation of drainage systems installation of cladding, fixtures, lighting, signage and CCTV cameras for the lift areas.	Standard hours, Period 1 OOHW and during a possession (Period 2 OOHW)

Construction stage and duration	Activities	Scheduling[1]
Stage 5: Roadworks (Little Eveleigh Street/Ivy Street, and Marian Street/ Cornwallis Street/Rosehill Street, Lawson Street and Gibbons Street) (nine months)	• construction of shared zone on Marian Street and Little Eveleigh Street • upgrade of Marian Street/Cornwallis Street/Rosehill Street area • construction of residential offset parking • installation of signage, pedestrian crossings and tactile ground surface indicators as required • milling/paving and road network upgrades of proposed Shared Zones and roadways • improvements to streetscape such as landscaping, lighting, drainage and kerb realignments.	Standard hours which may extend to Period 2 OOHW
Stage 6: Demobilisation[3]	• dismantling of existing ancillary facility areas/hoarding areas.	Standard hours
Stage 7 Testing and commissioning[3]	• testing electrical, communications and signalling components • commissioning of new lifts.	Standard hours, Period 1 OOHW and during a possession (Period 2 OOHW) (however no noisy work that is audible at sensitive receivers would be undertaken during OOHW)

Notes:

1. *Construction hours are as follows:*
    a. *Standard hours - Weekdays 7:00 am to 6:00 pm and Saturday 8:00 am to 1:00 pm*
    b. *Period 1 out-of-hours works (OOHW) are Weekdays 6:00 pm to 10:00 pm, Saturday 7:00 am to 8:00 am and 1:00 pm to 10:00 pm and Sunday/Public holiday 8:00 am to 6:00 pm*
    c. *Period 2 out-of-hours works (OOHW) are Weekdays 10:00 pm to 7:00 am, Saturday 10:00 pm to 8:00 am and Sunday/Public holiday 6:00 pm to 7:00 am.*
2. *For the purpose of noise modelling, Stage 4.1 and Stage 4.2 have been represented by a single scenario Stage 4.*
3. *Construction stages 6 and 7 would not generate construction noise levels higher than the other stages, therefore these stages have not been modelled. Noise mitigation measures as identified for other stages would be implemented.*

5.2 Construction ancillary facilities

Three construction ancillary facilities are proposed for the construction of the Project as outlined below and shown on Figure 4.

- Ancillary facility 1 - The Eveleigh Maintenance Centre would be utilised as site offices and an administration centre for the Project. This would include the establishment of several site sheds and car parking facilities.
- Ancillary facility 2 - This area is currently owned by Sydney Trains and would be partly utilised as a construction laydown area. This laydown area would be accessed from Carriageworks Way and would provide construction parking facilities and rail corridor access. It is anticipated that some components of the concourse would be assembled here prior to installation within the rail corridor.
- Ancillary facility 3 - Part of Gibbons Street Reserve would be used as a laydown area for construction equipment and infrastructure and would be accessed from Gibbons Street. The existing Sydney Trains carpark on Marian Street would be utilised for a site office compound and

an administration centre for the Project. This would include the erection of several site sheds and car parking facilities. The Project would also utilise a storage area underneath the existing carpark on Marian Street for site facilities and the storage of construction equipment and materials.

Note that the assessment for Stage 1: Site establishment and enabling works includes the ancillary facility areas (i.e. noise sources have been modelled from within the ancillary facility areas). Based on the anticipated plant and equipment to be used, it is expected that noise levels from ongoing construction activities within the ancillary facility areas would be consistent with or less than the noise levels assessed for the Stage 1 works. However, as the ancillary facility areas would be used for the entire Project construction period there may be some cumulative noise impact from the noise generated from the ancillary facilities and works from other Project stages; potential cumulative noise impacts are addressed further in Section 5.6.1.

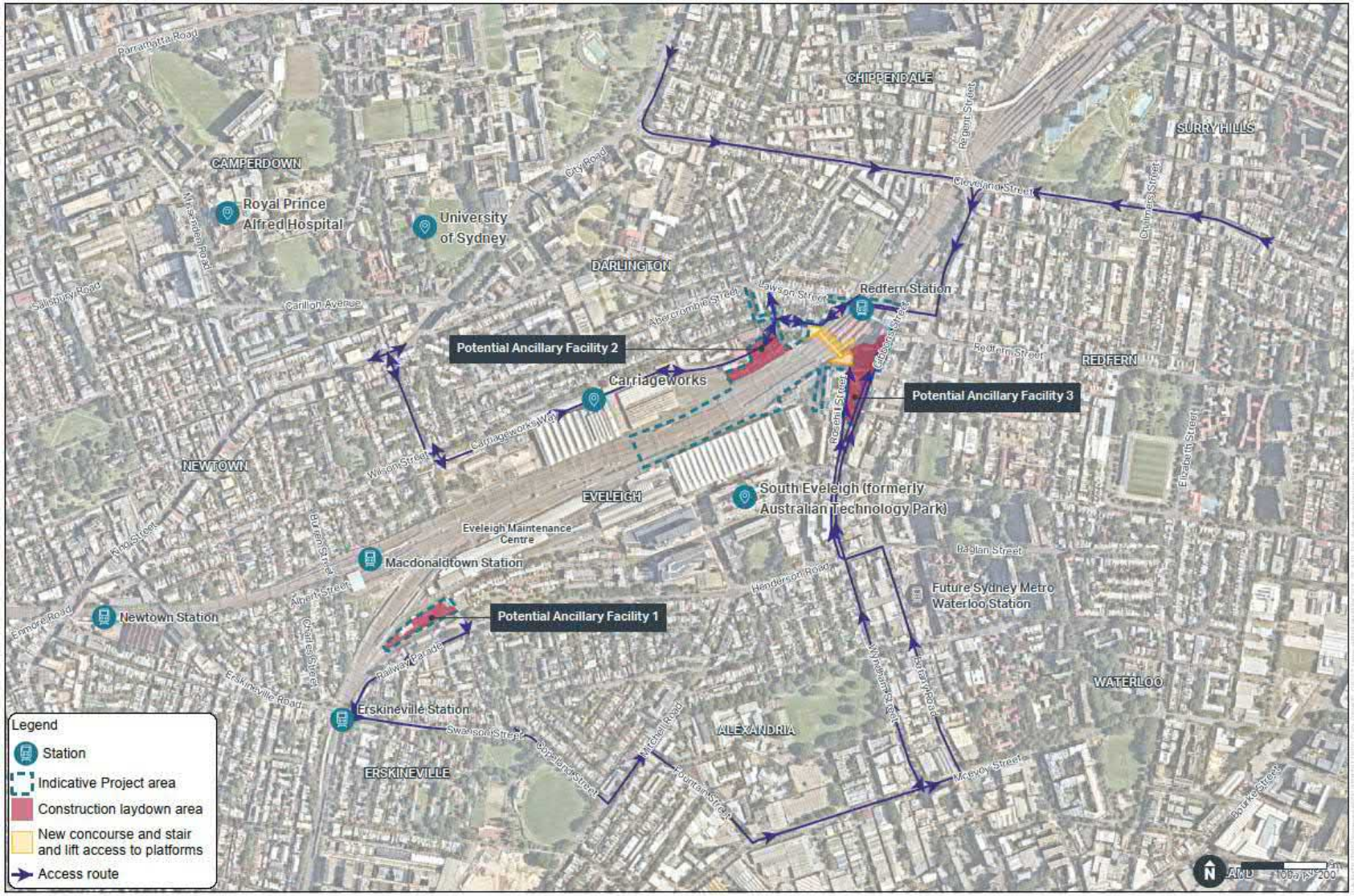


Figure 4 Ancillary infrastructure and construction access route

5.3 Construction noise sources

Noise sources and their respective L_{Aeq} sound power levels for each work package are shown in Table 18. These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites* and BS5228: Part 1 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise*. All equipment is assumed to be modern and in good working order.

Table 18 Equipment sound power levels per construction work package

Construction stage	Equipment	Sound Power Level, dB(A)	
		L_{Aeq}	L_{max}
Stage 1: Site establishment and enabling works[1] (two months)	Bobcat	104	112
	Crane trucks (semi-trailer and tipper)	108	116
	Excavator (20 tonne)	98	106
	Generator	101	104
	Hand tools	94	102
	Lighting tower	95	98
	Power tools	97	105
	Bored piling rig[2]	103	111
Stage 2: Building modification works (six months)	Bored piling rig	103	111
	Concrete pump	106	109
	Concrete truck	106	114
	Crane trucks (semi-trailer and tipper)	108	116
	Demolition saw[3]	115	123
	Excavator (20 tonne)	98	106
	Grinder[2]	113	121
	Hand tools	94	102
	Impact drill[2]	112	120
	Jack hammer[3]	113	121
	Nail gun	90	98
	Power tools	97	105

Construction stage	Equipment	Sound Power Level, dB(A)	
		L_{Aeq}	L_{max}
Stage 3: Utility and overhead wiring relocations/ adjustments (ten months)	Bored piling rig	103	111
	Concrete pump	106	109
	Concrete truck	106	114
	Crane trucks (semi-trailer and tipper)	108	116
	Demolition saw[3]	115	123
	Excavator (20 tonne)	98	106
	Hand tools	94	102
	Lighting tower	95	98
	Power tools	97	105
Stage 4.1: Main construction works – Station entrances (eight months over an 18 month period)[2] Stage 4.2: Main construction works – Installation of concourse (18 months)[2]	Bobcat	104	112
	Bored piling rig	103	111
	Concrete pump	106	109
	Concrete truck	106	114
	Crane(450 tonne)	106	114
	Crane trucks (semi-trailer and tipper)	108	116
	Demolition saw[3]	115	123
	Excavator (20 tonne)	98	106
	Excavator (with auger)	103	111
	Franna crane	93	101
	Generator	101	104
	Grinder[3]	113	121
	Hand tools	94	102
	Hydreama/hirail	94	102
	Impact drill[2]	112	120
	Jack hammer[2]	113	121
	Lighting tower	95	98
	Manitou (forklift)	92	100
	Mini excavator	94	102
	Mobile crane	104	112
	Nail gun	90	98
	Power tools	97	105

Construction stage	Equipment	Sound Power Level, dB(A)	
		L_{Aeq}	L_{max}
Stage 5: Roadworks (Little Eveleigh Street/Ivy Street, and Marian Street/ Cornwallis Street/Rosehill Street, Lawson Street and Gibbons Street) (nine months)	Bobcat	104	112
	Concrete pump	106	109
	Concrete truck	106	114
	Coring machine[3]	115	123
	Crane trucks (semi-trailer and tipper)	108	116
	Excavator (20 tonne)	98	106
	Hand tools	94	102
	Jack hammer[3]	113	121
	Lighting tower	95	98
	Line marking truck	102	110
	Mobile crane	104	112
	Plate compactor	108	116
	Power tools	97	105
Stage 6: Demobilisation	Excavator (20 tonne)	98	106
	Generator	101	104
	Crane trucks (semi-trailer and tipper)	108	116
	Hand tools	94	102
	Lighting tower	95	98
	Power tools	97	105
Stage 7: Testing and Commissioning	Hand tools	94	102
	Lighting tower	95	98
	Power tools	97	105

Notes:

1. *A chainsaw and mulcher may also be used at this stage however they have not been included in the 'Site establishment and enabling works' modelling as their use is not typical of this construction stage and would be for limited duration at certain locations during daytime only*
2. *Assumes that the piling rig would not be located adjacent to the other equipment listed in Stage 1. i.e. the same noise sensitive receivers would not be equally affected by the piling rig and the other equipment at any one time*
3. *A +5 dB(A) correction has been added in accordance with the Construction Noise and Vibration Strategy (TfNSW, 2018) to account for noise with special audible characteristics.*

5.4 Modelling and conditions

To assess noise impacts from the Project during construction, a noise model was created to include representative construction scenarios.

The construction of the Project has been modelled in SoundPLAN Version 8.0. The following features were included in the noise model:

- ground topography
- ground absorption and reflection

- buildings (residential and commercial)
- receivers (shown in Figure 3)
- construction noise sources (listed in Table 18).

Noise emissions from the construction sites have been modelled using an implementation of the CONCAWE[1] algorithms in the SoundPLAN noise propagation software with neutral metrological conditions.

5.5 Construction noise assessment

The identified residential and non-residential receivers have been assessed against the standard hours and the out-of-hours noise management levels as appropriate. Note that the identified receivers are based on residential buildings impacted, and each receiver/building may contain more than one resident. The level of impact may change depending on the final construction methodology and further assessment would be undertaken if required.

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

As there is expected to be some overlap in the construction stages, cumulative noise impacts may occur which can cause an increase of up to 3 dB(A) of the highest noise level predicted for any construction stage. This is based on the combination of the highest noise levels from two stages. Mitigation measures have been specified in Section 7 which may reduce the impact of these exceedances on receivers.

Noise results are presented in Table 19 and Table 20 and graphically in Appendix B.

1 CONCAWE – The oil companies' international study group for conservation of clean air and water – Europe (established in 1963) Report 4/81 "The propagation of noise from petroleum and petrochemical complexes to neighbouring communities".

Table 19 Number of residential buildings where noise levels may exceed NMLs for each construction stage

Stage	Number of residential buildings where noise levels may exceed NML[1]											
	Standard Hours			Out-of-hours – Daytime				Out-of-hours – Night time				Highly Noise Affected level, 75 dB(A)
	1-10 dB(A)	11-20 dB(A)	> 20 dB(A)	1-5 dB(A)	6-15 dB(A)	16-25 dB(A)	> 25 dB(A)	1-5 dB(A)	6-15 dB(A)	16-25 dB(A)	> 25 dB(A)	
NCA 1												
Stage 1	27	1	0	44	27	1	0	62	120	27	1	0
Stage 2	0	0	0	0	0	0	0	-	-	-	-	0
Stage 3	0	0	0	0	0	0	0	5	3	0	0	0
Stage 4.1/4.2	0	0	0	0	0	0	0	11	2	0	0	0
Stage 5	0	0	0	5	0	0	0	3	18	0	0	0
NCA 2												
Stage 1	6	0	0	10	6	0	0	70	26	1	0	0
Stage 2	9	14	11	42	9	14	11	-	-	-	-	7
Stage 3	89	0	0	63	89	0	0	149	154	25	0	0
Stage 4.1/4.2	35	12	5	70	35	12	5	208	130	24	9	4
Stage 5	220	84	101	125	220	84	101	140	248	174	141	74
NCA 3												
Stage 1	0	0	0	0	0	0	0	4	20	0	0	0
Stage 2	11	2	3	1	11	2	3	-	-	-	-	5
Stage 3	6	6	0	20	6	6	0	12	13	20	9	5
Stage 4.1/4.2	10	3	0	5	10	3	0	14	29	13	5	3
Stage 5	2	4	20	9	2	4	20	7	30	8	24	24

Stage	Number of residential buildings where noise levels may exceed NML[1]											
	Standard Hours			Out-of-hours – Daytime				Out-of-hours – Night time				Highly Noise Affected level, 75 dB(A)
	1-10 dB(A)	11-20 dB(A)	> 20 dB(A)	1-5 dB(A)	6-15 dB(A)	16-25 dB(A)	> 25 dB(A)	1-5 dB(A)	6-15 dB(A)	16-25 dB(A)	> 25 dB(A)	
NCA 4												
Stage 1	5	0	0	6	5	0	0	12	9	9	2	0
Stage 2	0	0	0	2	0	0	0	-	-	-	-	0
Stage 3	4	0	0	8	4	0	0	9	26	9	0	0
Stage 4.1/4.2	1	0	0	8	1	0	0	15	18	4	1	0
Stage 5	14	1	1	11	14	1	1	34	14	24	3	2
NCA 5												
Stage 1	0	0	0	7	0	0	0	15	10	0	0	0
Stage 2	0	0	0	6	0	0	0	-	-	-	-	0
Stage 3	0	0	0	7	0	0	0	18	8	0	0	0
Stage 4.1/4.2	0	0	0	5	0	0	0	21	7	0	0	0
Stage 5	24	0	0	35	24	0	0	82	64	12	0	0

Notes:

1. These numbers are not cumulative through the ranges of noise emissions shown

5.5.1 Summary of impacts at residential receivers

Construction noise levels are predicted to exceed noise management levels during standard hours and out-of-hours across all construction stages with varying levels of exceedances.

During the daytime, the largest number of exceedances occur during Stage 5 – Roadworks, due to works occurring on Little Eveleigh Street, Ivy Street, Marian Street, Cornwallis Street, and Rosehill Street. The greatest number of exceedances of the noise management levels would occur at receivers in NCA 2, where a number of residential buildings are predicted to be 'highly affected' at times due to the close proximity of the works.

During the night-time out-of-hours works, the largest number of exceedances occur during Stage 5 – Roadworks. The greatest number of exceedances of the noise management levels would occur at receivers in NCA 2. Stage 5 – Roadworks affect the most receivers as the works are progressive.

Stage 1: Site establishment and enabling works

Site establishment and enabling works would occur over approximately eight weeks at the beginning of the construction program. Sensitive receivers near to these works would experience elevated noise levels during the works. 39 buildings during standard construction hours, 106 buildings during works outside of standard construction hours and 388 buildings during night-time out-of-hours works across the Project area may be exposed to noise levels above the noise management levels. No buildings are predicted to be exposed to noise levels which would highly noise affect receivers i.e. experience noise levels above 75 dB(A).

Stage 2: Building modification works

Building modification works would be undertaken over various stages of the Project which includes a number of components as listed in Table 17. The works would be carried out over a period of six months from the beginning of the construction program. Sensitive receivers near to the building modification construction works would experience elevated noise levels during these works. 50 buildings during standard construction hours and 101 buildings during daytime works outside of standard construction hours across the Project area may be exposed to noise levels above the noise management levels. 12 buildings are predicted to be exposed to noise levels which would highly noise affect receivers.

Stage 3: Utility and overhead wiring relocations/adjustments

Overhead wiring relocations/adjustments would occur over a period of ten months from the beginning of the construction program during rail possession periods and not as continuous work. It is noted that Stage 3 works are progressive and that the overall noise impact on residents would vary depending on location of the works. Sensitive receivers near to the overhead wiring relocations/adjustments would experience elevated noise levels during these works. 105 buildings during standard construction hours, 203 buildings during day-time out-of-hours works and 460 buildings during night-time out-of-hours works across the Project area may be exposed to noise levels above the noise management levels. Five buildings are predicted to be exposed to noise levels which would highly noise affect receivers.

Stage 4: Main construction works

Main construction works would occur over the entire duration of the construction program. This is broken down into eight months for station entrance works and 18 months for the installation of the concourse. Sensitive receivers near to the main construction works would experience elevated noise levels during these works. 66 buildings during standard construction hours, 154 buildings during day-time out-of-hours works and 511 buildings during night-time out-of-hours works across the Project area may be exposed to noise levels above the noise management levels. Seven buildings are predicted to be exposed to noise levels which would highly noise affect receivers.

Stage 5: Roadworks

Roadworks would occur over a period of nine months midway through the construction program. It is noted that Stage 5 works are progressive and that the overall noise impact on residents would vary depending on location of the works. The predicted noise levels for these scenarios are therefore worst case noise levels, and represent the period where the works come closest to each receiver. Sensitive

receivers near to the roadworks would experience elevated noise levels during these works. 471 buildings during standard construction hours, 656 buildings during day-time out-of-hours works and 1,026 buildings during night-time out -of-hours works across the Project area may be exposed to noise levels above the noise management levels. A total of 100 buildings are predicted to be exposed to noise levels which would highly noise affect receivers.

5.5.2 Summary of Impacts on non-residential receivers

Construction noise levels are predicted to exceed the noise management levels at non-residential receivers across all construction stages with varying levels of exceedances. These non-residential sensitive receivers include a number of Sydney Trains' properties, and some commercial offices/shops/cafes. The greatest number of exceedances of the noise management levels for non-residential receivers is during Stage 5 – Roadworks due to the close proximity and progressive nature of the works. Key noisy activities of Stage 5 include the use of concrete saws, breakers and jack hammers. It should be noted that the overall noise impact would vary depending on location of the works and receivers would not be impacted for the full duration of the Stage 5 – Roadworks.

Table 20 Number of non-residential sensitive receivers where noise levels exceed the NMLs

Stage	Number of other buildings where noise levels are exceeding the noise management levels across the Project area		
	1-10 dB	11-20 dB	> 20 dB
Stage 1	5	0	0
Stage 2	0	3	2
Stage 3	2	0	0
Stage 4.1/4.2	2	1	2
Stage 5	6	0	5

5.6 Cumulative construction noise impacts

5.6.1 Project construction stages

While most construction activities are expected to occur at distinct scheduled times and at different locations, it is possible that noisy construction activities for the Project may occur at the same time in close proximity to each other. This may include works at the new station entrances on Marian Street and Little Eveleigh Street (Stage 2) in conjunction with utility and overhead wiring relocations/adjustments (Stage 3) and the Main Construction works (Stage 4). In these cases, it is possible that an increase of up to 3 dB(A) of the highest noise level predicted for any construction stage may occur (assuming that at any one location equal noise levels from two stages of works are experienced). This may increase the number of receivers where noise levels would be greater than 20 dB(A) above the NMLs.

Similarly, there is an overlap of the program of construction works between Stage 3, Stage 4 and Stage 5. Noise from use of the construction ancillary facility areas may also contribute to construction noise at receivers, however it is likely that the other construction stages would dominate cumulative noise levels, and any increase in the overall noise level from the Project would be less than 3 dB(A).

Overlapping construction stages and identification of any receivers subject to increased noise levels would be determined during detailed design. Any additional mitigation measures (as per Table 29) subsequently required would also be identified during detailed design.

5.6.2 Other construction projects

A review of surrounding projects has been undertaken in Chapter 23 of the EIS. Proposed projects (approved and under construction) identified in the vicinity of the Project include:

- Sydney Metro City & Southwest - Waterloo Over Station Development: Construction of an over station development comprising mixed use buildings integrated with the future Waterloo Station. Waterloo Station is part of the new standalone Sydney Metro rail network. The site is

approximately 310 metres to the south east of the Project area. Construction is proposed to be completed around 2025.

- Pemulwuy Student Accommodation: Construction of student accommodation including affordable housing for 62 families, a gymnasium, commercial and retail space, a gallery, student accommodation, and childcare centre. The site is adjacent to the Project area. Construction is to be completed around 2022.
- 1 Lawson Square, Redfern: Construction of alterations and additions to two existing commercial towers at 1 Lawson Square. The site is located adjacent to the Project area. Construction is proposed to be completed around 2022.
- Social housing, 11 Gibbons Street, Redfern: Construction of an 18-storey social housing development, comprising 160 social and affordable housing units, retail/commercial space, communal open spaces and public domain works. The site is adjacent to the Project area. Construction is proposed to be completed mid-2021.
- 90-102 Regent Street, Redfern - Student Accommodation: Proposed mixed use development (18-storey building) comprising retail premises and student accommodation with ancillary facilities and works at 90-102 Regent Street. The site is within 60 metres of the Project area. SEARs were issued on 27 November 2019.
- The Regent Hotel, 56-58 Regent Street, Redfern: Proposed redevelopment to build a 21-storey hotel. The site is around 50 metres to the east of the Project area. SEARs were issued on 29 August 2018.
- Mixed use development (including retail and residential) at No. 48 Regent Street, Redfern: Proposed mixed use development comprising retail, boarding rooms and communal living areas. The site is approximately 50 metres east of the Project area. Development approval was granted on 21 March 2019.

Assuming that the noisiest stages of any other construction project were to coincide with the construction of this Project, the greatest increase in noise levels from either project would be a maximum of 3 dB(A) on the levels presented in this assessment, where this Project is the dominant source of construction noise. Where receivers are impacted to a greater extent by other construction projects, then overall construction noise levels at any receiver could be increased by as much as 3 dB(A) from those projects' noise levels. In the case of construction traffic noise, traffic serving other sites are unlikely to use the same local roads as this Project therefore no cumulative impacts would occur. Where major roads are in use by construction traffic from several sites cumulative increases are unlikely to increase by more than 2 dB(A) due to the existing high volumes of traffic on these roads. An increase in noise levels of around 3dB(A) is barely noticeable.

The cumulative noise impacts of nearby major projects would be further considered by the construction contractor when a detailed construction schedule becomes available for the Project. Consultation would be undertaken with other contractors where relevant to manage cumulative impacts on sensitive receivers within common areas. Feasible and reasonable mitigation measures would be detailed in the Construction Noise and Vibration Management Plan (refer Section 7.3).

5.7 Sleep disturbance assessment

While construction works would be mostly undertaken during standard construction hours, some works outside of standard construction hours would be required to minimise disruptions to traffic, pedestrians, nearby residents and businesses, and also for constructability, safety, continuity of rail services reasons or to meet approval requirements (e.g. Road Occupancy Licence). This section provides an assessment of the potential for sleep disturbance due to these out-of-hours night works.

Table 21 presents the predicted maximum L_{Amax} noise levels. The predicted L_{Amax} noise levels indicate that the awakening reaction criterion may be exceeded during the night-time construction works. Where the awakening reaction criterion is exceeded, consideration should be given to reasonable and feasible mitigation measures.

Stage 1: Site establishment and enabling works

Noise levels at 399 residential buildings within all NCAs are predicted to exceed the sleep disturbance screening level criteria, and noise levels at approximately 57 residential buildings within NCAs 1, 2, 3 and 4 are predicted to exceed the awakening reaction criteria during this stage. The highest impacts are expected during truck movements involving crane trucks entering and leaving the Project area.

It is noted that as the works are planned to occur during the night-time for both rail possessions and non-rail possession nights, there is a likelihood for cumulative noise impacts to occur where the possessions overlap with planned rail maintenance. As noted in Section 5.6 this can cause an increase of up to 3 dB(A) of the highest noise level predicted for any construction stage and potentially increase the number of impacted buildings

Stage 3: Utility and overhead wiring relocations/adjustments

Noise levels at 361 residential buildings within all NCAs are predicted to exceed the sleep disturbance screening level criteria, and noise levels at approximately 68 residential buildings within NCAs 2, 3 and 4 are predicted to exceed the awakening reaction criteria during this stage. The highest impacts are expected during steel works (e.g. steel cutting, construction using power tools). As works for this stage would progress throughout the Project area, it is expected that this is a good indication of the number of exceedances of the awakening reaction at any one time. However any one building is not likely to be affected for the whole duration of this stage, due to the movement of the works.

It is noted that as the night-time works are planned to occur during rail possessions, cumulative noise impacts may arise where the possessions overlap with planned rail maintenance. As noted in Section 5.6 this may cause an increase of up to 3 dB(A) of the highest noise level predicted for any construction stage and potentially increase the number of impacted buildings.

Stage 4.1/4.2: Main construction works – installation of concourse

Noise levels at approximately 127 residential buildings within NCAs 1, 2, 3 and 4 are predicted to exceed the screening level criteria, and noise levels at 15 residential buildings within NCAs 2, 3 and 4 are predicted to exceed the awakening reaction criteria during this stage. The highest impacts are expected during hammering and excavation for the concourse support structures.

It is noted that as the works are planned to occur during the night-time for both rail possessions and non-rail possession nights, cumulative noise impacts may occur where the possessions overlap with planned rail maintenance. As noted in Section 5.6 this can cause an increase of up to 3 dB(A) of the highest noise level predicted for any construction stage and potentially increase the number of impacted buildings.

Stage 5: Roadworks

Noise levels at 559 residential buildings within all NCAs are predicted to exceed the sleep disturbance screening level criteria, and noise levels at approximately 178 residential buildings within NCAs 2, 3 and 4 are predicted to exceed the awakening reaction criteria during this stage. The highest impacts are expected during hammering and coring for the construction of the shared zones on Marian Street and Little Eveleigh Street. As works for this stage would progress throughout the Project area, it is expected that this is a good indication of the number of exceedances of the awakening reaction at any one time. However any one building is not likely to be affected for the whole duration of this stage, due to the movement of the works.

It is noted that as the works are planned to occur during the night-time for both rail possessions and non-rail possession nights, cumulative noise impacts may occur where the possessions overlap with planned rail maintenance. As noted in Section 5.6 this can cause an increase of up to 3 dB(A) of the highest noise level predicted for any construction stage and potentially increase the number of impacted buildings.

Table 21 Number of residential buildings where noise levels may exceed sleep disturbance criteria

Stage	Number of residential buildings where noise levels may exceed the sleep disturbance screening level and/or the awakening reaction level	
	Sleep disturbance screening level L_{Amax}, dB(A)	Awakening reaction level L_{Amax}, dB(A)
NCA 1		
Stage 1: Site establishment and enabling works	219	23
Stage 3: Utility and overhead wiring relocations/adjustments	12	0
Stage 4.2: Main construction works – Installation of concourse	3	0
Stage 5: Roadworks	5	0
NCA 2		
Stage 1: Site establishment and enabling works	90	4
Stage 3: Utility and overhead wiring relocations/adjustments	243	16
Stage 4.2: Main construction works – Installation of concourse	72	2
Stage 5: Roadworks	422	141
NCA 3		
Stage 1: Site establishment and enabling works	29	13
Stage 3: Utility and overhead wiring relocations/adjustments	45	35
Stage 4.2: Main construction works – Installation of concourse	37	10
Stage 5: Roadworks	51	26
NCA 4		
Stage 1: Site establishment and enabling works	31	17
Stage 3: Utility and overhead wiring relocations/adjustments	43	17
Stage 4.2: Main construction works – Installation of concourse	15	3
Stage 5: Roadworks	40	11
NCA 5		
Stage 1: Site establishment and enabling works	30	0
Stage 3: Utility and overhead wiring relocations/adjustments	18	0
Stage 4.2: Main construction works – Installation of concourse	0	0
Stage 5: Roadworks	41	0

5.8 Construction traffic assessment

Construction traffic would generally not exceed 20 heavy vehicle movements per day at peak construction periods, with the most movements anticipated during the modification of 125-127 Little Eveleigh Street and during roadworks on Little Eveleigh Street and Marian Street. Additionally, up to 40 light vehicle movements per day are anticipated (not including worker transport to and from site).

Key access routes to the construction areas include Cleveland Street, Regent Street, Wyndham Street/Gibbons Street and Lawson Street. Closer to the Station, Little Eveleigh Street, and the Marian Street/Cornwallis Street/Rosehill Street loop would be used to access construction ancillary facility areas 2 and 3. The access route for ancillary facility 1 would include Wyndham Street, Botany Road, McEvoy Street, Fountain Street, Mitchell Road, Copeland Street/Swanson Street and Railway Parade.

Road traffic noise levels during construction are unlikely to increase by more than 2 dB(A) on Cleveland Street, Regent Street, Wyndham Street/Gibbons Street, Lawson Street, Botany Road, McEvoy Street, Fountain Street, Mitchell Road, Copeland Street/Swanson Street. This is due to the existing high volumes of traffic on these roads and the small percentage increase due to construction traffic.

Whilst the existing AADT traffic volumes on Little Eveleigh Street and the Marian Street/Cornwallis Street/Rosehill Street are estimated to be around 300 and 150 respectively, road traffic levels are also unlikely to increase by more than 2 dB(A) due to the low volumes of the construction traffic generated. It is also noted that traffic speeds during the construction period may be reduced, which would generally lessen the level of noise generated. Therefore no further assessment of construction traffic noise is required, in accordance with the *Road Noise Policy*.

To minimise the construction traffic noise levels and reduce the risk of negative impacts occurring, construction traffic management (including vehicle movements generated by the Project) would be considered as part of the CNVMP.

5.9 Construction vibration assessment

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

- jackhammer
- bored piling rig
- plate compactor.

The minimum working distances of these items of equipment from receivers are shown in Table 22, which is based on recommendations of the *Construction Noise and Vibration Strategy* (TfNSW, 2018). If these minimum working distances are complied with, no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage.

A number of heritage-listed items within the Project area may be within the minimum working distances for vibration intensive works, including the following:

- Platform 1 and 10 Retaining walls
- Platform 1 Office Building
- Engine Dive and Ventilation Shafts
- Telecommunications Equipment Centre
- Interlocking Store, Southern Store, Northern Store and Brick Toilet
- Platform 1 to 10 facings
- Platform 4 to 10 Buildings
- Platform 11 and 12 below ground structures.

For further information on these heritage-listed items refer to Figure 14.1 in Chapter 14 of the EIS.

Where vibration intensive works are required within the minimum working distances, mitigation measures to control excessive vibration would be implemented as outlined in Section 7.3.

Specific vibration mitigation measures would be determined during detailed design. This should include as a minimum, building condition surveys and vibration monitoring during construction and would be documented within the CNVMP. If the construction methodology changes during detailed design then a reassessment of the minimum working distances would be required.

Table 22 Minimum working distances of vibration intensive equipment to be used during the Project

Plant	Rating/ Description	Cosmetic damage		Human response
		Heritage	Residential/ commercial	
Jackhammer	Handheld	1 metre (nominal)	1 metre (nominal)	Avoid contact with structure
Plate compactor[1]	Handheld	8 metres	5 metres	15 to 20 metres
Pile boring	<= 800 mm	4 metres	2 metres (nominal)	4 metres

Notes:

1. *No recommendations provided in the Construction Noise and Vibration Strategy for a plate compactor (assumed to be the same as a small roller)*

6. Operational noise and vibration assessment

The Project comprises the installation of lifts, new station entrances, a new services building, and a car park. It does not include any changes to rail movements. It is also noted that additional commuters would access the upgraded station from streets close to the new station entrances.

As noted in Section 4, noise from the car park activities, mechanical services and Opal card readers are assessed in this section using the *Noise Policy for Industry*. The receivers mostly likely to be affected by car park activities would not be affected by the mechanical services and Opal card readers, therefore these sources have been considered separately. Receivers affected by noise from Opal card readers could also be affected by noise from mechanical services, however in this case the mechanical services would be designed so that cumulative noise impacts would comply with the relevant criteria. Noise from commuters walking through shared zones has been assessed using the *Noise Guide for Local Government's* checklist for 'offensive noise'.

During operation the Project is not anticipated to generate any additional vehicular traffic, and therefore negligible impacts to traffic noise around Redfern Station are expected. The only considerable change the Project would bring is the reduction in the speed limit to 10 kilometres per hour within the new shared zones along Little Eveleigh Street and Marian Street/Cornwallis Street/Rosehill Street. This would generally reduce the noise levels from vehicles, however given that the current traffic flow in these roads is already characterised by slow operating speeds of vehicles, this impact is expected to be negligible.

The operation of the Project would not include any sources of vibration likely to exceed the relevant criteria, and therefore no further consideration of operational vibration has been completed.

6.1 Car park noise

An operational noise impact assessment has been completed for the proposed car park to determine the likely impacts. The car park is proposed to have 20 car parking spaces (including 18 resident/restricted parking spaces, one accessible parking space and one car share scheme parking space). The car park would replace the current on-street parking spaces which would be removed as part of the shared zone improvement.

The methodology used to determine car park activity noise is presented in the Bavarian State Office for the Environment's (Bayerishes Landesamt für Umwelt/BayLfU) *Parking Area Noise* (2007). The car park activity noise calculated by this method is then compared to the Project specific noise level criteria as presented in Section 4.1.3.

6.1.1 L_{Aeq} noise levels

It has been assumed that there would be up to four vehicle movements during the daytime and one vehicle movement during the night-time in a 15 minute period. The predicted noise levels for the most affected receivers are shown in Table 23.

Table 23 Predicted noise levels at most affected residential receivers

Most affected receiver	Receiver type	Project specific noise level criteria[1], $L_{Aeq\ 15\ min}$	Predicted noise level, L_{Aeq} dB(A)	Exceedance, dB(A)
157 Little Eveleigh Street (NCA3)	Daytime	58	52	-
	Night-time	44	46	2
160-166 Little Eveleigh Street (NCA2)	Daytime	46	41	-
	Night-time	38	35	-

Notes:

1. *Project specific criteria from Table 15*

Table 23 shows that the operational noise levels comply with the relevant criteria at all receivers during the daytime, however there may be a temporary and negligible exceedance of up to 2 dB(A) during the night-time period at the rear/western side of 157 Little Eveleigh Street which is the closest residential receiver. It is noted that this is a worst case assessment and assumes the car movement is in the closest proximity to 157 Little Eveleigh Street.

It is noted that cars that would use the car park would include those that currently use parking spaces along Little Eveleigh Street. For most receivers along Little Eveleigh Street use of the new car park would reduce current parking noise levels. However L_{Aeq} levels may increase slightly for 157 Little Eveleigh Street compared to the current situation, given its proximity to the proposed car park.

In summary a negligible exceedance of up to 2 dB(A) of the Project specific L_{Aeq} noise level criteria may occur during the night-time period at the rear/western side of nearby sensitive receivers in Little Eveleigh Street.

6.1.2 Sleep disturbance

A sleep disturbance assessment was performed to assess the potential noise impacts from car parking activities on nearby sensitive receivers. The sound power levels used for the activities are shown in Table 24. These levels have been sourced from AECOM's sound power database.

Table 24 Car park activities sound power levels

Activity	L_{Amax} Sound Power Level, dB(A)
Door/boot slam	91
Car starting	94
Car accelerating	98

The predicted noise levels from car parking activities are shown in Table 25. The results show that the predicted noise levels are expected to exceed the sleep disturbance screening criteria at numbers 157, and 160 to 166 Little Eveleigh Street. The exceedances are due to the close proximity of the nearest car parking space to these receivers.

It is noted that between 10:00 pm and 2:00 am at 125 Little Eveleigh Street L_{Amax} levels currently range between 65 and 75 dB(A), and are reduced from 2:00 am and begin to rise again after 4:00 am. These existing elevated noise levels in the area are likely due to noise from railway operations, vehicle movements/parking on Little Eveleigh Street and general urban noise sources. Given the existing high L_{Amax} levels it is unlikely that the car parking activities would affect nearby receivers adversely before 2:00 am. The car park would be used infrequently between 2:00 am and 5:00 am, therefore it is unlikely that the acoustic environment would change significantly from the current frequency of cars parking along Little Eveleigh Street (i.e. in the existing street parking spaces that are being replaced by the proposed car park).

At other locations, the car park noise level (L_{Amax}) would be reduced from the noise levels presented in Table 25 below due to shielding provided by the building at 157 Little Eveleigh Street and distance loss.

Table 25 Car park worst case predicted noise levels

Most affected receiver	Sleep disturbance screening levels		Predicted noise level		Exceedance, dB(A)	
	$L_{Aeq,15min}$	L_{AFmax}	$L_{Aeq,15min}$	L_{AFmax} dB(A)	$L_{Aeq,15min}$	L_{AFmax}
157 Little Eveleigh Street (NCA3)	44	54	46	74	2	20
160-166 Little Eveleigh Street (NCA2)	40	52	35	64	-	12

Notes:

1. Project specific criteria from Table 16.

It is understood that a new solid fence would be constructed between the boundary of the car park and 157 Little Eveleigh Street as part of the Project (and also the boundary with 155 Little Eveleigh Street), which would reduce noise levels by around 5 dB(A). Depending on the acoustic performance of the proposed fence, consideration would be given to at-receiver treatments such as the provision of mechanical ventilation to allow windows to be closed and/or upgraded glazing at 157 and 155 Little Eveleigh Street. The installation of at-receiver treatments would address any residual exceedances.

6.2 Mechanical services noise

Noise sources from mechanical services associated with the operation of the Project are expected to include the following:

- lift motors
- lift air conditioning plant
- building air conditioning plant
- toilet exhaust fans.

Final equipment has not yet been selected, therefore operational noise levels cannot be predicted definitively at this stage. However, based on the nature of the mechanical services to be installed, standard noise controls such as appropriate selection and placement of mechanical plant and the inclusion of attenuation measures such as duct lining/attenuators would reduce noise levels so that they meet the *Noise Policy for Industry* criteria. Noise levels would not be intrusive for nearby residential receivers.

6.3 Public address system noise

New public address system speakers would be installed at the southern ends of the platforms for regular announcements. Speakers would also be installed in the concourse and within the new station entrances. These speakers would be used for train delay or special event announcements only.

A public address system has not yet been selected, therefore operational noise levels cannot be predicted definitively at this stage of the design. However given the nature of these systems and mitigation measures successfully applied to other projects, it is expected that potential impacts can be readily mitigated during the detailed design stage, and noise levels would not be intrusive for nearby residential receivers.

6.4 Opal card reader noise

It is understood that Opal card readers are to be installed at the new station entrances. Table 26 presents the potential forecast station patronage for 2024, based on investigations undertaken to inform the design of the Project.

Table 26 Redfern Station patronage forecasts for 2024

Period	Entries[1]	Transfers[1]	Exits[1]	Total
AM peak hour	2,570	4,630	10,160	17,360
PM peak hour	8,000	3,360	2,760	14,120

Notes:

1 – Transport for NSW and extrapolated data

It is estimated that around 19% of total commuters would use the Little Eveleigh Street entrance and 39% would use the Marian Street entrance. Therefore it is likely that around 825 passengers would be 'tapping on/off' in a 15 minute period in the AM peak commuter hour at the Little Eveleigh Street entrance and 1,695 passengers at the Marian Street entrance.

Assuming a sound power level of 73 dB(A) (based on measurements completed at St James Station on 14 January 2020,) the highest 15 minute L_{Aeq} level from the Opal card readers would be as presented in Table 27.

Conservatively, assuming during the night-time period (i.e. 10:00 pm until trains finish running for the night) that around 82 and 170 passengers (10% of PM peak commuter period) would be 'tapping on/off' in a 15 minute period at the Little Eveleigh Street and Marian Street entrances respectively, the highest 15 minute L_{Aeq} levels at the closest receivers would be as presented in Table 27.

Table 27 Predicted noise levels at most affected residential receivers

Most affected receiver	Receiver type	Criteria, $L_{Aeq\ 15\ min}$	Predicted noise level, L_{Aeq} dB(A)	Exceedance, dB(A)
124 Little Eveleigh Street (NCA2) (approximately 10 metres from the Opal card readers)	Daytime	46	44	-
	Night-time[1]	35	33	-
1 Marian Street (NCA4) (approximately 20 metres from the Opal card readers)	Daytime	58	41	-
	Night-time[1]	45	31	-

Notes:

2. *Excludes the hours after trains finish running for the night*
3. *Noise from Opal card readers would not be tonal over a 15 minute period at receiver locations, therefore a correction to account for annoying characteristics under the NPfI is not required*

Table 27 shows that the predicted noise levels comply with the criteria during both the daytime and night-time periods.

6.5 Commuter noise

The investigations undertaken to inform the design of the Project estimated that approximately 3,300 and 6,770 people would be walking down Little Eveleigh Street and Marian Street respectively during a typical AM peak hour, however there are no specific noise criteria or limits that would apply to this activity. The 'offensive noise' checklist from the *Noise Guide for Local Government* is therefore considered below to determine if nearby noise sensitive receivers are likely to consider the noise the Project as 'offensive'.

Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?

The noise generated by commuters walking through the shared zones to and from the new station entrances would not be loud in an absolute sense (e.g. in the context of the overall existing noise environment) at nearby residential receivers. From Appendix A it can be seen that the ambient L_{Aeq}

noise levels at the nearby residential receivers on Little Eveleigh Street are around 61 to 67 dB(A) during the daytime, 60 to 63 dB(A) during the evening, and 58 to 60 dB(A) during the night-time period when Sydney Trains are in operation. It can also be seen that the ambient L_{Aeq} noise levels at the nearby residential receivers on Marian Street are around 59 to 63 dB(A) during the daytime, 55 to 60 dB(A) during the evening, and 50 to 60 dB(A) during the night-time period when Sydney Trains are in operation. Noise from commuters walking along these roads would not be considered loud relative to these existing ambient noise levels.

Does the noise include characteristics that make it particularly irritating? Is the noise atypical for the area?

The noise generated by commuters would likely comprise footfall noise and conversations and would not be considered atypical for an urban area. It would not include any characteristics that typically irritate such as low frequency or tonal components.

Does the noise occur at times when people expect to enjoy peace and quiet? Does the noise occur often?

It is considered that local residential receivers would notice a difference in ambient noise levels due to the large number of commuters utilising the new station entrances and concourse. The noise levels from commuters would be highest during commuter peak periods which would coincide with the noisier parts of the day, and therefore have less of an effect on the overall noise level. The noise is likely to occur on most days.

Based on the above considerations, noise associated with the commuter use of the new station entrances and surrounding shared zones is unlikely to be considered 'offensive' as defined in Section 4, whilst acknowledging it would be noticeable to the closest residential receivers. The Project would investigate further opportunities to minimise noise impacts to residents through the ongoing design development of the Little Eveleigh Street and Marian Street shared zones.

Noise from commuters and other pedestrians, including anti-social behaviour, is addressed further in the Technical report 2: Social of the EIS.

7. Mitigation and management measures

7.1 Overview

This chapter describes the environmental management approach for noise and vibration during the construction and operation of the Project. Further details on the environmental management approach for the Project are provided in Chapter 24 of the EIS (Environmental management approach and framework).

A Construction Environmental Management Framework (CEMF) (Appendix D of the EIS) describes the approach to environmental management, monitoring and reporting during construction. Specifically, it lists the requirements to be addressed by the construction contractor in developing the Construction Environmental Management Plan (CEMP), sub-plans, and other supporting documentation for each specific environmental aspect.

A Noise and Vibration Management Sub-Plan would be developed for the Project as identified by Section 6.2 (Noise and Vibration) of the CEMF, and well as the *Construction Noise and Vibration Strategy* (CNVS) (refer **Appendix E** of the EIS).

The chapter includes a compilation of the performance outcomes as well as mitigation measures, including those that would be included in this plan.

7.2 Performance outcomes

The following performance outcomes have been established for this Project:

- construction airborne and ground-borne noise and vibration is effectively managed to minimise adverse impacts on acoustic amenity
- construction vibration is effectively managed to minimise adverse impacts on the structural integrity of buildings and items
- increases in noise emissions and vibration during operation of the Project affecting nearby properties and other sensitive receivers are effectively managed to protect the amenity and well-being of the community
- appropriate mitigation measures outlined in the TfNSW CNVS are identified and implemented to minimise noise and vibration impacts
- specific notifications to the community are issued no later than seven days prior to construction works.

7.3 Mitigation measures

The mitigation measures that would be implemented to address potential construction noise and vibration impacts are listed in Table 28.

Table 28 Mitigation measures

ID	Mitigation measure	Applicable location (s)
Construction		
N1	A Construction Noise and Vibration Management Sub-Plan (CNVMP) would be prepared as part of the Construction Environmental Management Plan. The CNVMP would include all feasible and reasonable safeguards to manage noise emissions from the Project. The CNVMP would include, as a minimum, the following: • identification of nearby residences and other sensitive land uses • description of approved hours of work and an Out of Hours Protocol • description and identification of all construction activities, including work areas, equipment and duration (and provision for re-assessment of noise and vibration impacts if required due to changes) • description of the work practices (generic and specific) that would be applied to minimise noise and vibration • works scheduling to minimise the noise impact on sensitive receivers, with consideration given to cumulative noise impacts (and provision for re-assessment of noise and vibration impacts if required due to changes to work stages or other surrounding projects) • a complaints handling process • noise and vibration monitoring procedures, including for heritage-listed items/structures • overview of community consultation required for identified noise intensive works • the CNVMP and CEMP must be updated as required to account for changes in noise and vibration management issues and strategies, to ensure these documents remain adequate for their purposes.	All
N2	All employees, contractors and subcontractors shall receive an environmental induction. As a minimum the induction must include: • all relevant Project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on noise generating activities with special audible characteristics (noise with characteristics that can cause annoyance and disturbance, containing noticeable factors such as tonality, low frequency noise, impulsive or intermittent noise events) • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures and complaint handling procedures.	All

ID	Mitigation measure	Applicable location (s)
N3	All nearby residents and sensitive receivers impacted by noise levels from the Project which are expected to exceed the NML shall be consulted prior to the commencement of the particular activity, with the highest consideration given to those that are predicted to be most affected as a result of the works. The information provided to the receivers will include: • programmed times and locations of construction work • the hours of proposed works • construction noise and vibration impact predictions • construction noise and vibration mitigation measures being implemented on site. • Community consultation regarding construction noise and vibration would be detailed in a Community Liaison Plan for the construction of the Project and would include a 24 hour hotline and complaints management process.	All
N4	If vibration intensive equipment is to be used within the minimum working distances for cosmetic damage, as presented in Table 22, then attended vibration measurements shall be undertaken when work commences, to determine “site specific minimum working distances” and confirm appropriate vibration limits for that structure. The Construction Contractor would be informed of the minimum working distances.	All
N5	For heritage items where the screening criteria are predicted to be exceeded, the more detailed assessment would include condition assessment and specifically consider the heritage values of the structure in consultation with a heritage specialist to ensure sensitive heritage fabric is adequately monitored and managed.	Heritage items

ID	Mitigation measure	Applicable location (s)
N6	The CNVMP would be implemented with the aim of meeting the construction noise management levels where feasible and reasonable. The following noise and vibration mitigation measures are recommended: • use of at-source noise attenuation around equipment where feasible and reasonable • where feasible and reasonable structures, such as site sheds, earth bunds and fencing shall be used to shield residential receivers from noise (e.g. including along appropriate sections of the rail corridor fence line of Little Eveleigh Street and Marian Street, and through the use of 1.8m high fencing around ancillary facility 3). Site topography shall be considered when situating plant • traffic flow (i.e. vehicle movements, including deliveries), parking and loading/unloading areas shall be planned to minimise reversing movements within construction sites • loading and unloading of materials/deliveries shall occur as far as possible from sensitive receivers • if site access points and roads are altered during detailed design, they would be selected to be as far as possible away from sensitive receivers within rail corridor access constraints • dedicated loading/unloading areas shall be shielded if close to sensitive receivers wherever feasible and reasonable • delivery vehicles shall be fitted with straps rather than chains for unloading, wherever possible. • non-tonal reversing beepers shall be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out-of-hours work, including delivery vehicles • on-site storage capacity shall be maximised to reduce the need for truck movements during sensitive times • the offset distance between noisy plant and adjacent sensitive receivers shall be maximised • plant used intermittently shall be throttled down or shut down • noise-emitting plant shall be directed away from sensitive receivers where feasible and reasonable • the noise levels of plant and equipment must have operating sound power or sound pressure levels as presented in Table 18 that would meet the predicted noise levels • quieter and less vibration emitting construction methods shall be used where feasible and reasonable (e.g. rubber wheeled instead of steel tracked plant) • where practicable, materials shall be pre-fabricated and/or prepared off-site to reduce noise with special audible characteristics occurring on site. Materials can then be delivered to site for installation.	All

ID	Mitigation measure	Applicable location (s)
N7	Work generating noise with special audible characteristics (such as jack hammers, rock breakers, piling rigs and diamond saws) and/or vibration levels shall be scheduled during less sensitive time periods for receivers (for example, before 10 pm or as determined during community consultation) where feasible and reasonable.	All
N8	Vehicle movements shall be routed away from sensitive receivers and scheduled during less sensitive times where feasible and reasonable. The speed of vehicles shall be limited and the use of engine compression brakes avoided.	
N9	A noise and vibration monitoring program shall be carried out for the duration of works in accordance with the CNVS, CNVMP and any approval and licence conditions. Monitoring of noise shall be undertaken at appropriate intervals and in response to complaints during construction. In addition, vibration intensive work shall not proceed within the site specific minimum working distances unless a permanent vibration monitoring system is installed approximately one metre from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective.	All
N10	In accordance with the CNVS, additional mitigation measures should be implemented according to Table 29, Table 30 and Appendix B of this Noise and Vibration Impact Assessment for sensitive receivers where noise levels are predicted to exceed applicable criteria.	As per Table 29, Table 30 and Appendix B
Operation		
N11	Mechanical plant selections should be reviewed during the detailed design phase to ensure compliance with the operational noise criteria detailed in Section 4 of this Noise and Vibration Impact Assessment is achieved. Standard noise controls such as appropriate selection and placement of mechanical plant and the inclusion of attenuation measures such as duct lining/attenuators are recommended to achieve operational noise criteria.	Redfern Station
N12	Public address system selection should be reviewed during the detailed design phase to ensure compliance is achieved with the operational noise criteria detailed in Section 4 of this Noise and Vibration Impact Assessment.	Redfern Station
N13	The type and design of the new solid fence proposed to be constructed at the boundary of the proposed car park should be developed to optimise the level of acoustic shielding provided. Depending on the acoustic performance of the proposed fence, consideration would be given to at-receiver treatments for 157 Little Eveleigh Street such as the provision of mechanical ventilation to allow windows to be closed and/or upgraded glazing.	Car park boundary and 157 Little Eveleigh Street
N14	The Project would investigate further opportunities to minimise noise impacts to residents through the ongoing design development of the shared zones at Little Eveleigh Street and Marian Street.	Little Eveleigh Street and Marian Street shared zones

7.3.1 Community consultation and complaints handling

Feedback received from the community during the public exhibition of the EIS and also from other consultation activities proposed would also be considered in the detailed design of the Project (refer to Chapter 6 of the EIS for a summary of the consultation undertaken to date, and the proposed future consultation proposed). This may result in additional or other specific noise mitigation measures being introduced.

7.3.2 Control of residual construction noise impacts

TfNSW's *Construction Noise and Vibration Strategy* provides practical guidance on how to minimise, to the fullest extent practicable, the impacts on the community from airborne noise, ground-borne noise and vibration generated during construction of TfNSW projects. This is managed through the application of all feasible and reasonable mitigation measures.

However, even after application of all standard noise-reducing mitigation measures some exceedances may still occur; predicted exceedances after the application of standard noise-reducing mitigation measures are presented in Table 19 and Table 20. These exceedances represent residual noise impacts.

In addition to these predicted exceedances there may also be cumulative noise impacts from concurrent construction stages as well as from other projects in the surrounding area, as presented in Section 5.6. Cumulative noise impacts may result in an increase in the overall noise level by up to 3 dB(A).

The *Construction Noise and Vibration Strategy* recommends the implementation of additional mitigation measures where there are predicted exceedances resulting in residual noise impacts. These additional mitigation measures are presented in Table 29.

The provision of additional mitigation measure/s is based on the degree of a predicted exceedance above the RBL, and when the exceedance is predicted to occur, which is related to a receiver's perception of the noise. From Table 29 it can be seen that the consideration of a receiver's perception of construction noise ranges from 'noticeable' to 'highly intrusive'. The RBLs can be found in Table 4, and Appendix B shows the location of impacted receivers and degree of noise exceedance predicted (to determine which mitigation measure/s should be applied to which receiver).

Table 29 Additional mitigation measures matrix

Construction hours		Action level[1] (mitigation measures)[2]			
		0 – 10 dB(A) Noticeable	>10 – 20 dB(A) Clearly audible	>20 – 30 dB(A) Moderately intrusive	>30 dB(A) Highly intrusive
Standard	Weekday (7:00 am–6:00 pm) Saturday (8:00 am–1:00 pm) Sunday/Public Holiday (Nil)	-	-	PN, V	PN, V
Out-of-Hours Work Period 1	Weekday (6:00 pm–10:00 pm)	-	PN, RP[3], DR[3]	PN, V, SN, RO, RP[3], DR[3]	PN, V, SN, RO, RP[3], DR[3]
	Saturday (7:00 am–8:00 am) and (1:00 pm–10:00 pm)				
	Sunday/Public Holiday (8:00 am–6:00 pm)				
Out-of-Hours Work Period 2	Weekday (10:00 pm–7:00 am)	PN	PN, V, SN, RO[4], RP[3], DR[3]	PN, V, SN, RO[4], RP[3], DR[3]	PN, V, SN,RO[4], RP[3], DR[3], AA
	Saturday (10:00 pm–8:00 am)				
	Sunday/Public Holiday (6:00 pm–7:00 am)				

Notes:

1. Action level is) the noise level ($L_{Aeq(15\ minute)}$) above background (RBL) - qualitative assessment of noise levels. RBLs are presented in Table 4

2. The following abbreviations have been used (refer to Table 30 for further details):

PN: Project notification
V: Verification monitoring
SN: Specific notification
RP: Respite period
DR: Duration reduction
RO: Project specific respite offer
AA: Alternative accommodation.

3. Respite periods and duration reduction are not applicable when works are carried out during OOHW Period 1 Day only (i.e. Saturday 6:00 am-7:00 am and 1:00 pm-6:00 pm, Sundays/Public Holidays 8:00 am-6:00 pm)

4. Respite offers during OOHW Period 2 are only applicable for evening periods (i.e. Sundays / Public Holidays 6pm-10pm), and may not be required if a respite offer has already been made for the immediately preceding OOHW Period 1.

Table 30 provides an explanation of each additional mitigation measure, as outlined in the *Construction Noise and Vibration Strategy*.

Table 30 Description of additional mitigation measures

Abbreviation	Mitigation measure	Explanation
PN	Periodic notification	A notification entitled 'Project Update', 'Construction Update' or 'Community Update' or similar is produced and distributed to stakeholders via letterbox drop and distributed to the project postal and/or email mailing lists. The same information will be published on the TfNSW website. Periodic notifications provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions can assist in reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where works may impact on them. Content and length is determined on a project-by-project basis and must be approved by TfNSW prior to distribution. Most projects distribute notifications on a monthly basis.
V	Verification	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver or a nominated representative location. Monitoring can be in the form of either unattended logging or operator attended surveys. The purpose of monitoring is to confirm that: Attended noise monitoring is to be undertaken as follows: • Construction noise and vibration from the project are consistent with the predictions in the noise assessment • Mitigation and management of construction noise and vibration is appropriate for receivers affected by the works. Where noise monitoring finds that the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required.

Abbreviation	Mitigation measure	Explanation
SN	Specific notifications	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. Alternatively (or in addition to), communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities and provide an individual briefing. • Letters may be letterbox dropped or hand distributed • Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and their specific needs • Individual briefings are used to inform stakeholders about the impacts of noisy activities and mitigation measures that would be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. Specific notifications are used to support periodic notifications, or to advertise unscheduled works and must be approved by TfNSW prior to implementation/distribution.
RO	Respite offers	The purpose of a respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre-purchased tickets for activities, restaurants or similar.
AA	Alternative accommodation	Alternative accommodation options may be provided for residents living in close proximity to construction works that are likely to incur unreasonably high impacts. Alternative accommodation would be determined on a case-by-case basis and should provide a like-for-life replacement for permanent residents, including provisions for pets, where reasonable and feasible.
RP	Respite period	OOHW during evening and night periods would be restricted so that receivers are impacted for no more than three consecutive evenings and no more than two consecutive nights in the same NCA in any one week, except where this is a Duration Reduction. A minimum respite period of four evenings/five nights shall be implemented between periods of evening and/or night works. Strong justification must be provided where it is not feasible and reasonable to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by TfNSW through the OOHW Approval Protocol.

Abbreviation	Mitigation measure	Explanation
DR	Duration reduction	Where Respite Periods are considered to be counterproductive to reducing noise and vibration impacts to the community it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and implemented in consultation with Project Community Engagement Representatives.

8. Conclusion

A construction and operational Noise and Vibration Impact Assessment has been completed for the Redfern Station Upgrade – New Southern Concourse ('the Project'). Nearby noise and vibration sensitive receivers were identified. Attended and unattended noise measurements were completed to characterise the existing noise environment. The measured noise levels were used to establish construction and operational noise criteria and management levels.

The Project is expected to commence in late 2020/early 2021 and take up to 18 months to construct, with construction undertaken within standard hours and out-of-hours periods. Works outside standard hours would be required to minimise disruptions to traffic, pedestrians, nearby residents and businesses, and also for constructability, safety, continuity of rail services reasons or to meet approval requirements (e.g. Road Occupancy Licence).

Construction stages have been developed in consultation with TfNSW and the proposed equipment has been detailed within this report. Five distinct construction stages were used in a computer-based noise model to determine the predicted noise levels generated from the Project. Construction noise impacts were assessed at all residential receivers surrounding the Project. Impacts were also assessed at non-residential receivers. Operational noise impacts were also assessed.

8.1 Construction noise

The predicted construction noise levels exceed the construction NMLs during all construction stages with varying levels of exceedances. Notwithstanding the implementation of feasible and reasonable noise mitigation measures, noise exceedances are generally unavoidable given the proposed works and proximity to receivers. The greatest overall impacts during most work packages would be experienced by residents in NCA 2 as predicted exceedances would occur during several stages of work (due to the proximity and duration of the works). 100 residents are predicted to be 'highly affected' during the Stage 5 (Roadworks) construction works. Measures to mitigate noise during construction have been identified.

Implementation of mitigation measures outlined in Section 7.3 would minimise and manage noise impacts on noise sensitive receivers where possible. Mitigation measures have been recommended in accordance with TfNSW's *Construction Noise and Vibration Strategy*.

8.2 Construction vibration

Minimum working distances to nearby structures have been recommended for nominated plant. If the minimum working distances are maintained, then no adverse impact from the vibration intensive works are likely in terms of human response or cosmetic damage. Should works be required within the minimum working distances, the recommended additional mitigation measures would be implemented as outlined in Section 7.3. It is noted that there would be some heritage-listed items which may be affected which are within the Project footprint.

Specific vibration mitigation measures would need to be determined in collaboration with the construction contractor during the detailed design stage when a more concise construction program is developed.

8.3 Operational noise

Operational noise from car park activities, mechanical plant, public address systems and Opal card readers was modelled and assessed. The assessment demonstrated that predicted noise levels from the car park were expected to be generally compliant with the *Noise Policy for Industry* criteria however some exceedances may occur at the closest receivers, and some mitigation (such as construction of a boundary fence to mitigate noise would be required). If required, operational noise emissions from mechanical plant and the public address system shall be addressed during the detailed design phase in order to comply with operational noise criteria as per the *Noise Policy for Industry.*

Noise from commuters using the new station entrances and surrounding shared zones is unlikely to be considered 'offensive' however it would be noticeable to the closest residential receivers. The Project

would investigate further opportunities to minimise noise impacts to residents through the ongoing design development of the Little Eveleigh Street and Marian Street shared zones.

9. References

Australian Standard AS 1055:2018 *Acoustics - Description and measurement of environmental noise*

Australian Standard AS 2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*

Australia Standard AS IEC 61672.1:2019 *Electroacoustics – Sound level meters Specifications*

Bavarian State Office for the Environment, 2007, *Parking Area Noise*.

British Standard 5228-Part 1:2009 including amendment 2014 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise*

British Standard 6472:1992 *Evaluation of human exposure to vibration in buildings (1-80 Hz)*

British Standard 7385-Part 2:1993 *Evaluation and Measurement of Vibration in Buildings*

Department of Environment and Climate Change (DECC), 2009, *Interim Construction Noise Guideline*

Department of Environment and Conservation, 2006, *Assessing Vibration: A Technical Guideline*

Department of Environment, Climate Change and Water (DECCW), 2011, *NSW Road Noise Policy*

Department of Planning, Industry, and Environment, 2008, *Development Near Rail Corridors and Busy Roads*

DIN Standard 4150-Part 3:2016 *Vibration in Buildings - Effects on Structures*

Environment Protection Authority (EPA), 2013a, *Noise Guide for Local Government*

Environment Protection Authority (EPA), 2013b, *Rail Infrastructure Noise Guideline*

Environment Protection Authority (EPA), 2017, *Noise Policy for Industry*

International Standard ISO 9613-2:1996 *Acoustics -- Attenuation of sound during propagation outdoors - Part 2: General method of calculation*

Transport for NSW (TfNSW), 2019 *Construction Noise and Vibration Strategy*

Appendix A

Noise Logging

Noise Logger Report

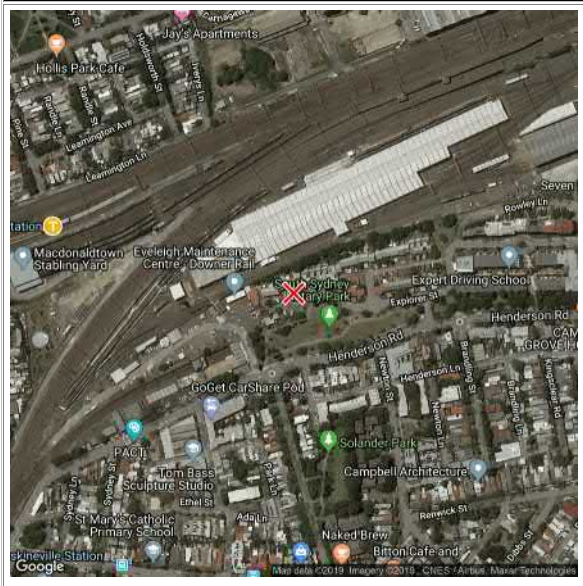
8 Explorer Street, Eveleigh

Item	Information
Logger Type	NL-52
Serial number	876010
Address	8 Explorer Street, Eveleigh
Location	8 Explorer Street, Eveleigh
Facade / Free Field	Free field
Environment	Noise environment controlled by trees rustling. Regular Light vehicle pass by along Henderson road generally inaudible especially in presence of a slight breeze. Plane pass by dominant noise source when passing over. Sunny with very slight breeze at times with minimal clouds. Bird calls in the distance heard intermittently throughout measurement. Train horns audible.

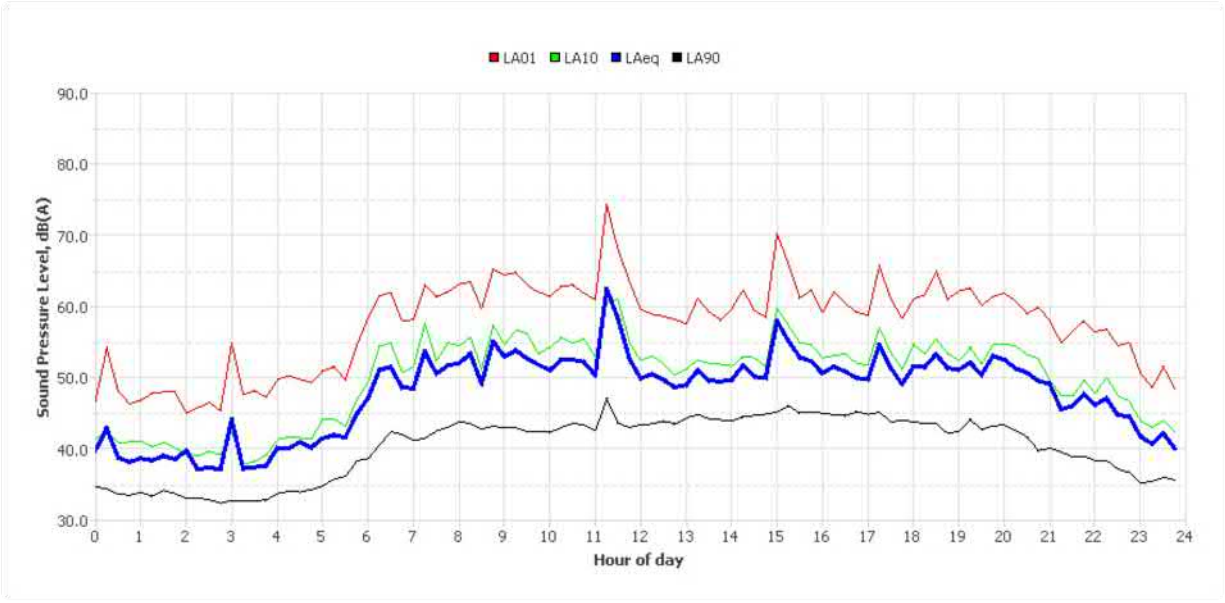
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Mon Nov 11 2019	58	50	47	-	-	-	55	47
Tue Nov 12 2019	52	-	48	-	-	-	52	48
Wed Nov 13 2019	54	52	47	-	39	37	53	47
Thu Nov 14 2019	52	52	47	-	40	38	52	47
Fri Nov 15 2019	54	55	47	40	-	-	54	47
Sat Nov 16 2019	53	52	44	-	34	-	53	44
Sun Nov 17 2019	47	48	42	-	-	28	48	42
Mon Nov 18 2019	54	50	45	-	-	30	53	45
Tue Nov 19 2019	53	57	47	-	-	-	54	47
Wed Nov 20 2019	51	50	44	43	35	32	50	44
Thu Nov 21 2019	57	-	44	-	-	-	57	44
Summary	**54**	**53**	**46**	**42**	**37**	**32**	**53**	**46**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

Typical Day



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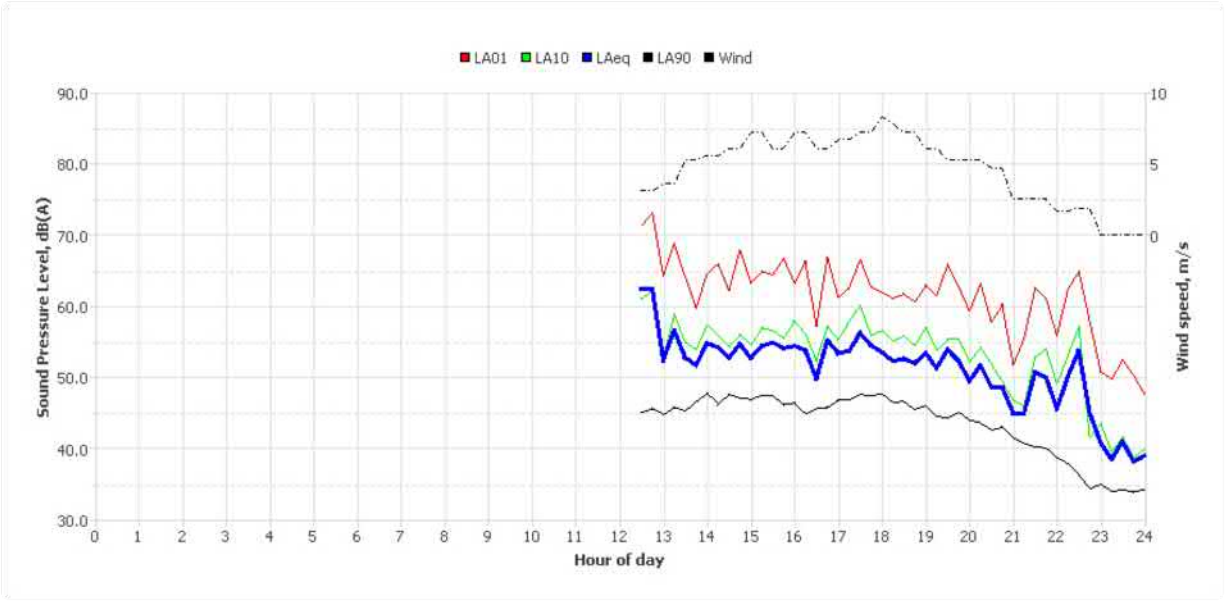

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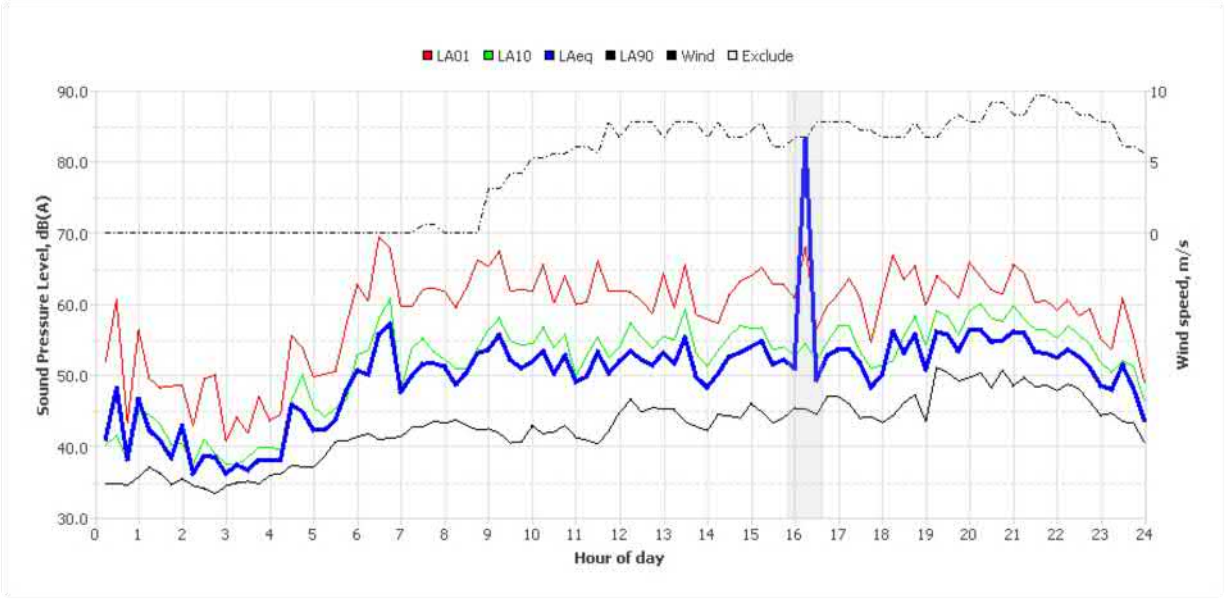

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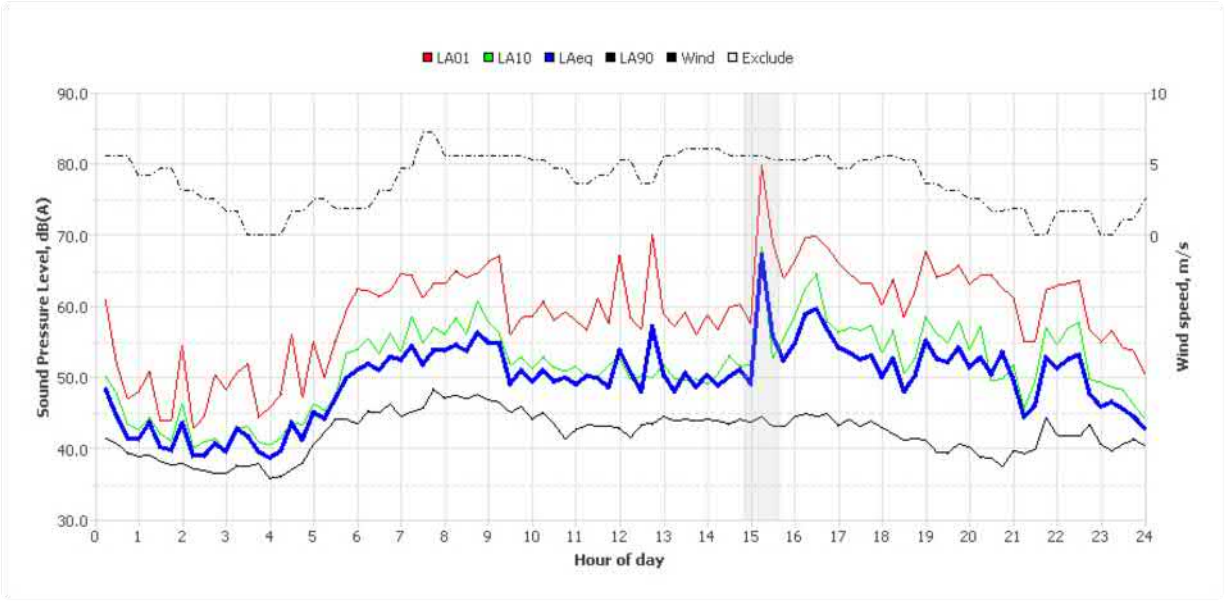

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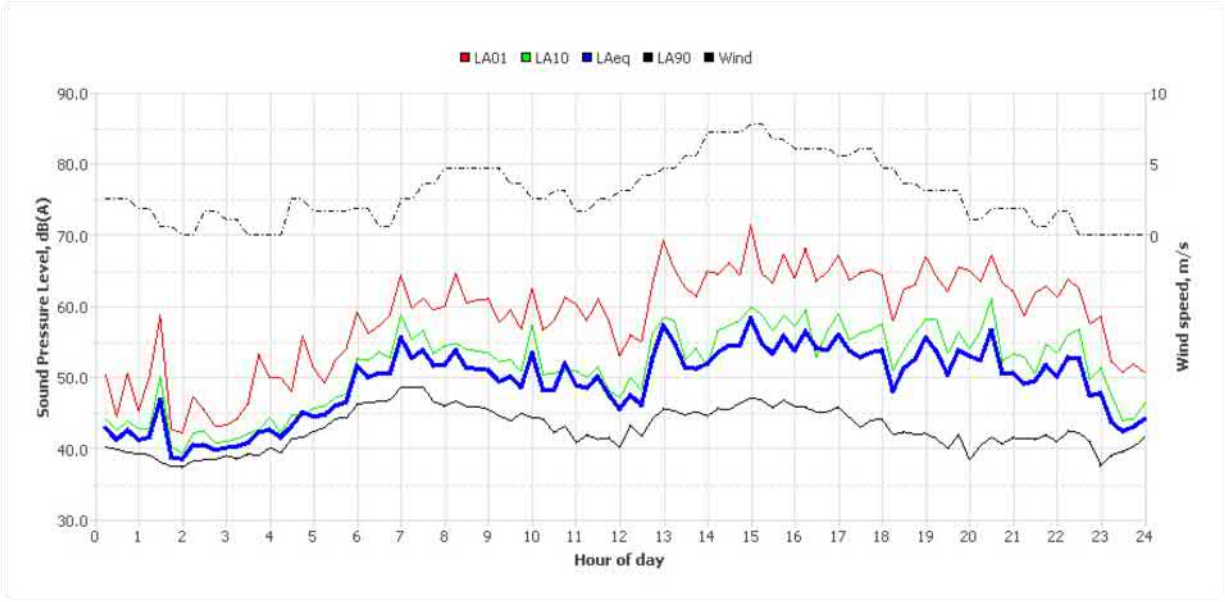

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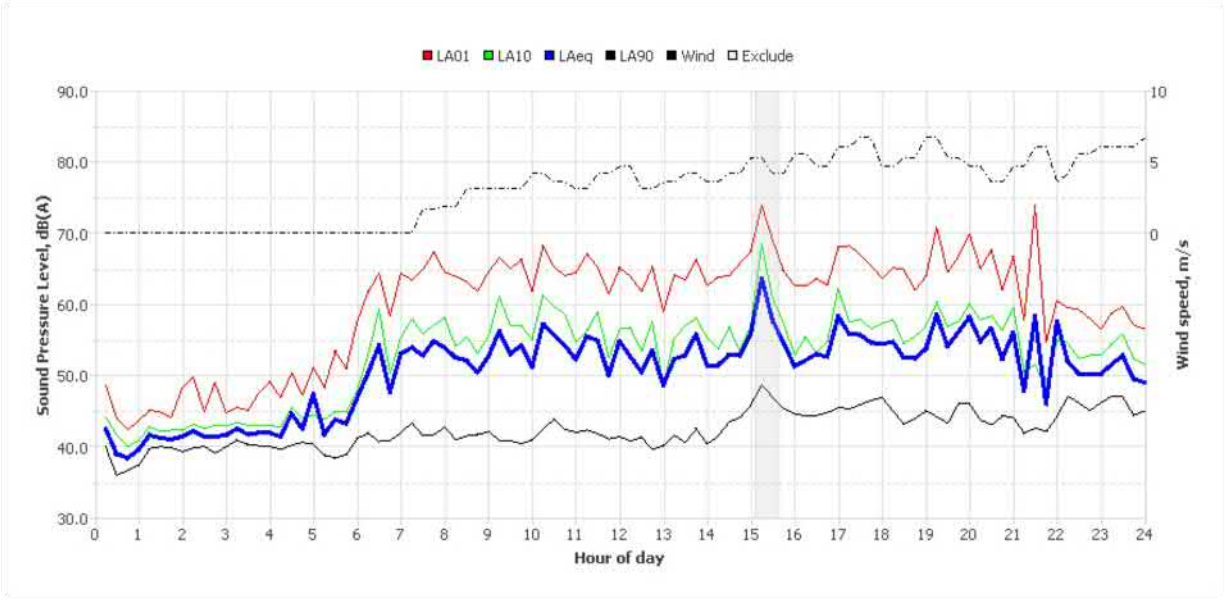

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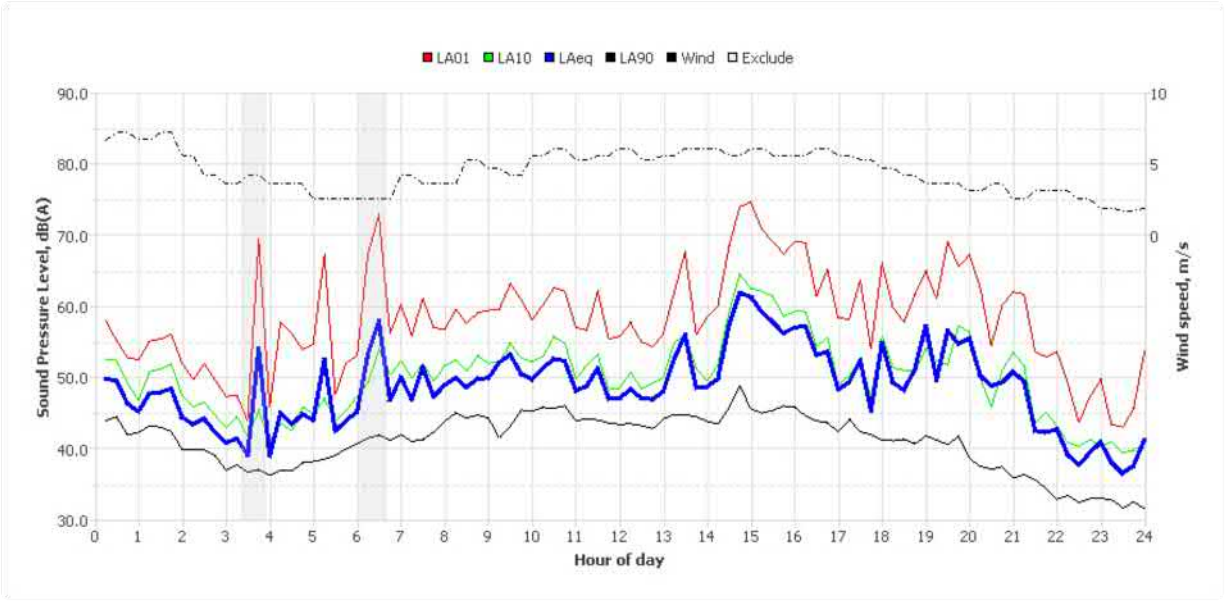

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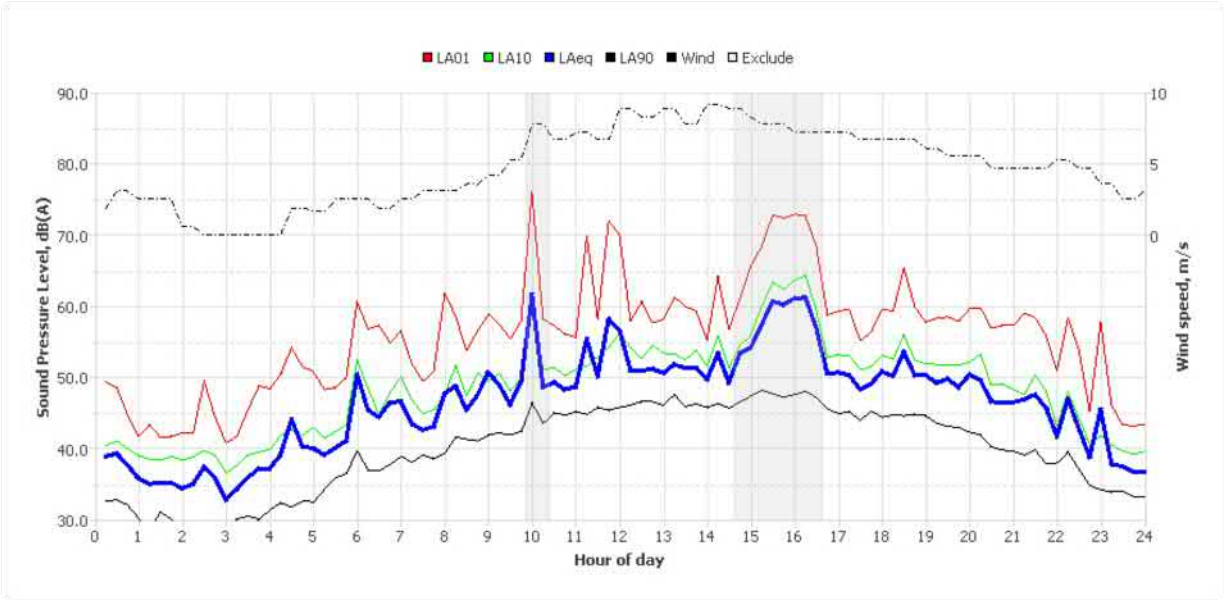

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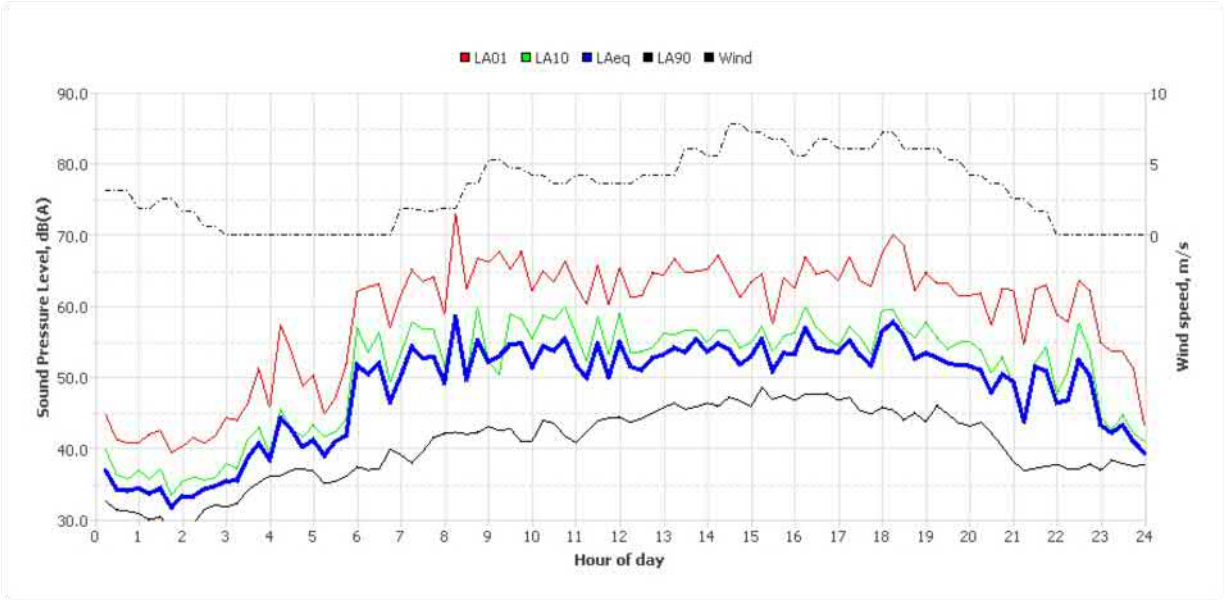

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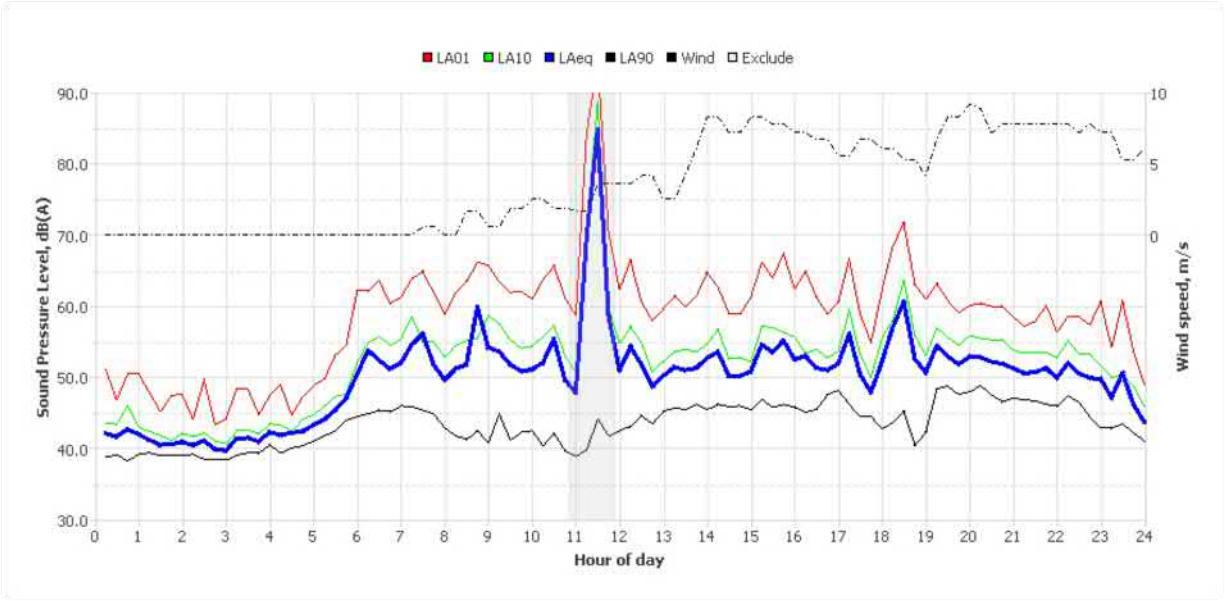

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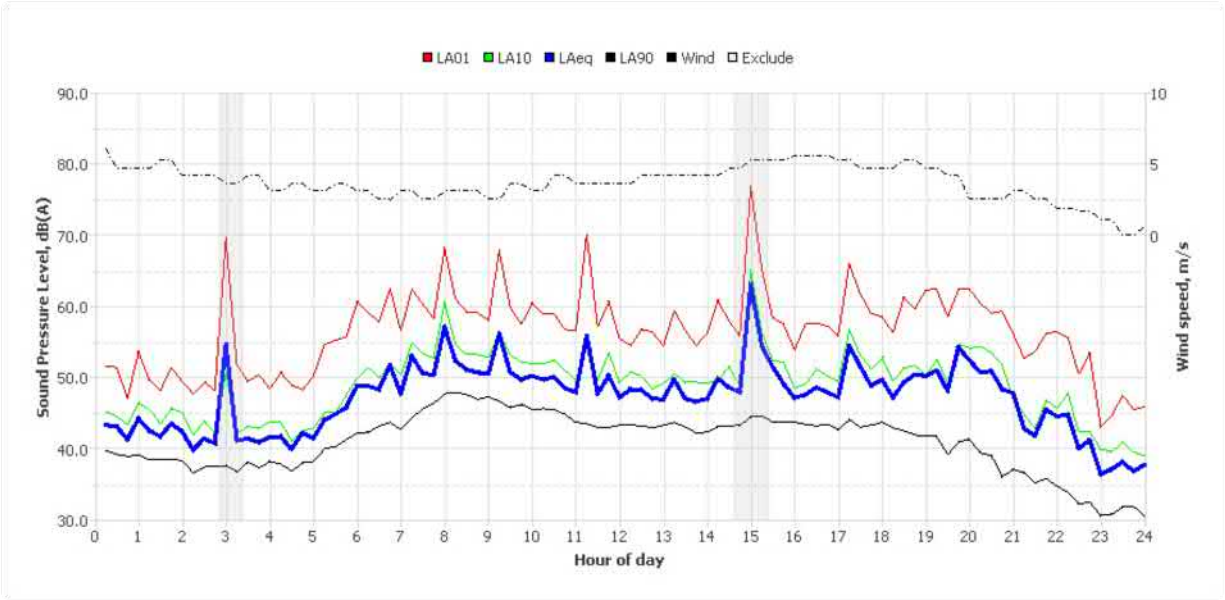

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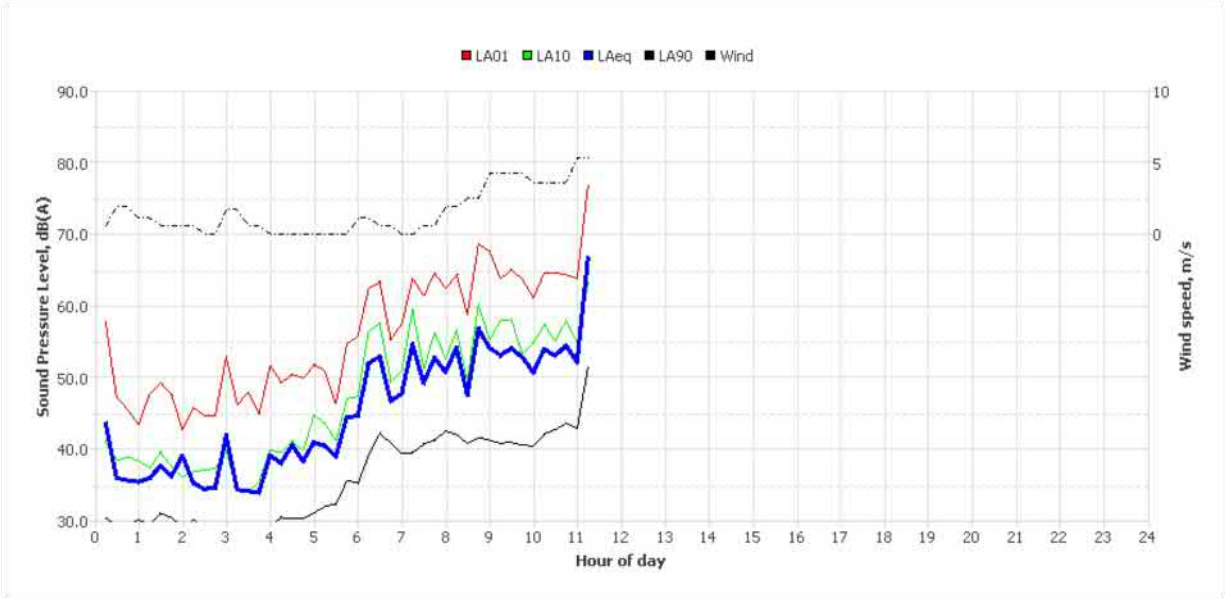


Noise Logger Report

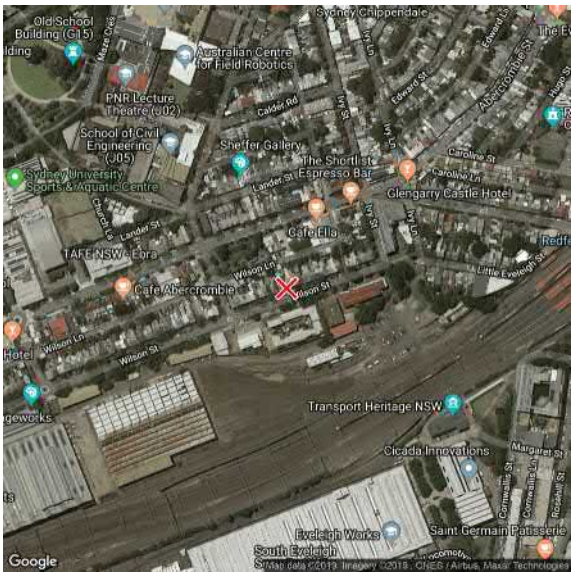
488 Wilson Street, Darlington

Item	Information
Logger Type	NL-52
Serial number	553967
Address	488 Wilson Street, Darlington
Location	488 Wilson Street, Darlington
Facade / Free Field	Facade
Environment	Noise environment dominated by industrial hum to the south. Sunny with very slight breeze at times, minimal clouds. Bird and insect calls heard intermittently throughout measurement. Pedestrians and cyclist pass bys fairly frequent.

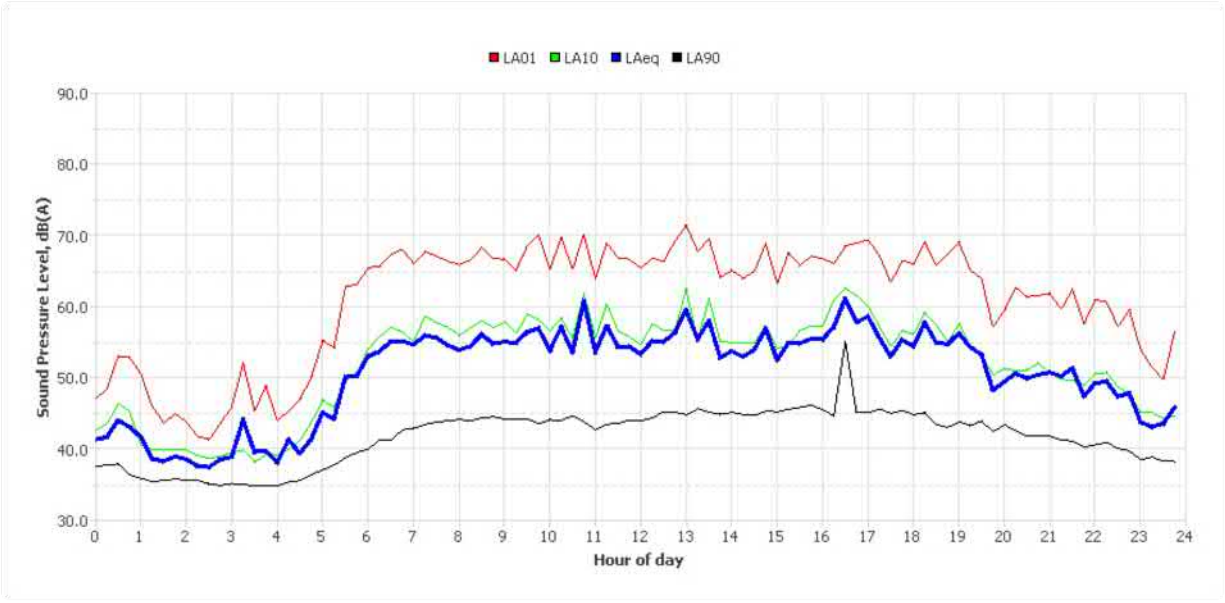
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Mon Nov 11 2019	62	53	47	-	-	-	60	47
Tue Nov 12 2019	55	-	48	-	-	-	55	48
Wed Nov 13 2019	55	52	48	41	41	35	55	48
Thu Nov 14 2019	55	55	47	-	42	36	55	47
Fri Nov 15 2019	56	53	49	41	-	-	55	49
Sat Nov 16 2019	54	54	50	-	38	-	54	50
Sun Nov 17 2019	51	48	45	-	-	32	50	45
Mon Nov 18 2019	56	50	48	-	-	30	55	48
Tue Nov 19 2019	56	56	49	-	-	-	56	49
Wed Nov 20 2019	56	52	48	43	38	35	55	48
Thu Nov 21 2019	57	-	49	-	-	-	57	49
Summary	**57**	**53**	**48**	**41**	**39**	**35**	**56**	**48**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

Typical Day



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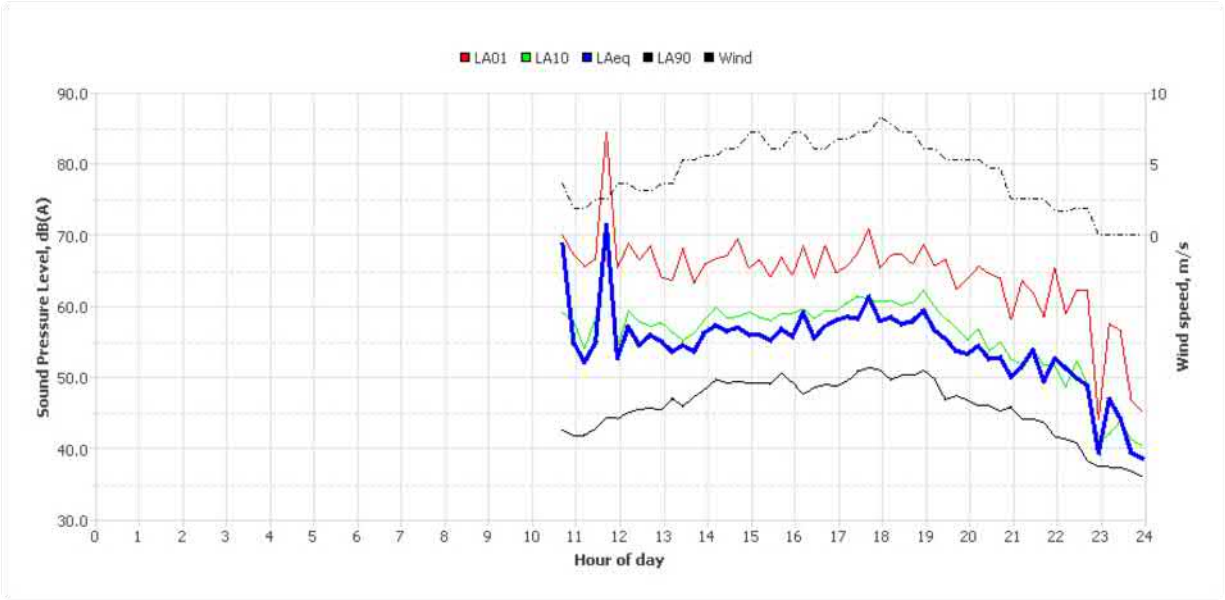

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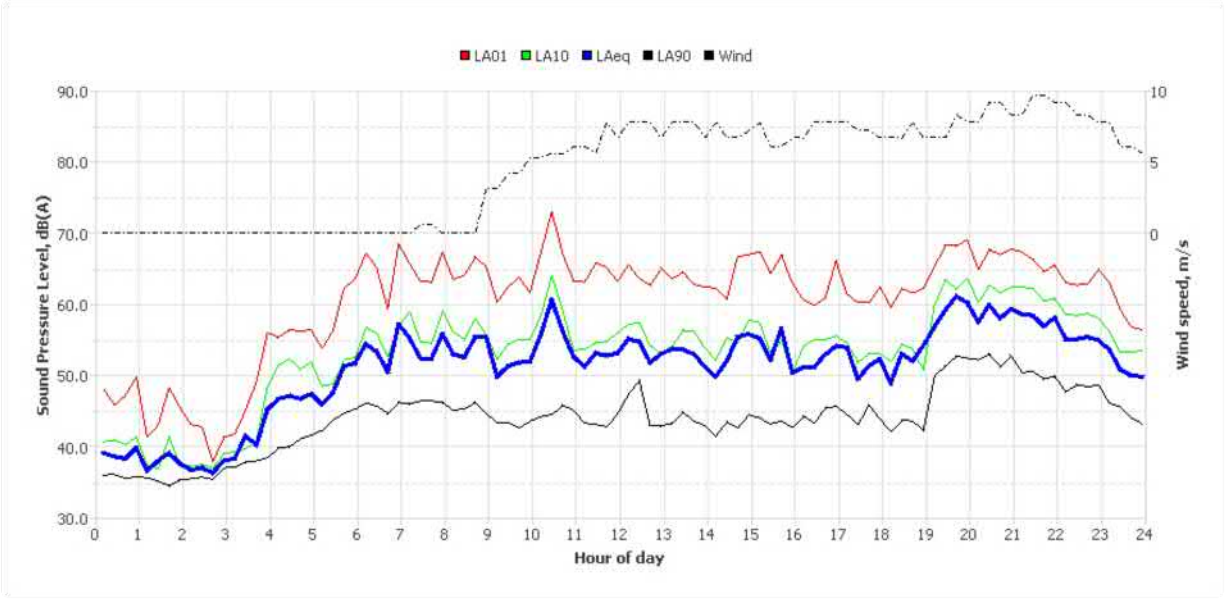

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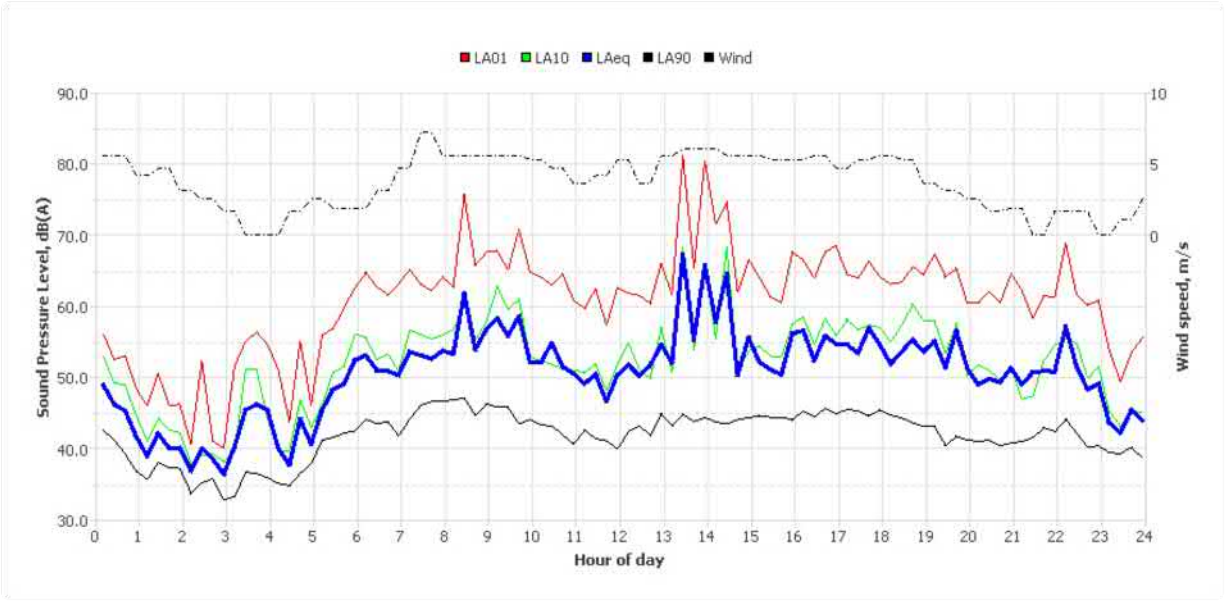

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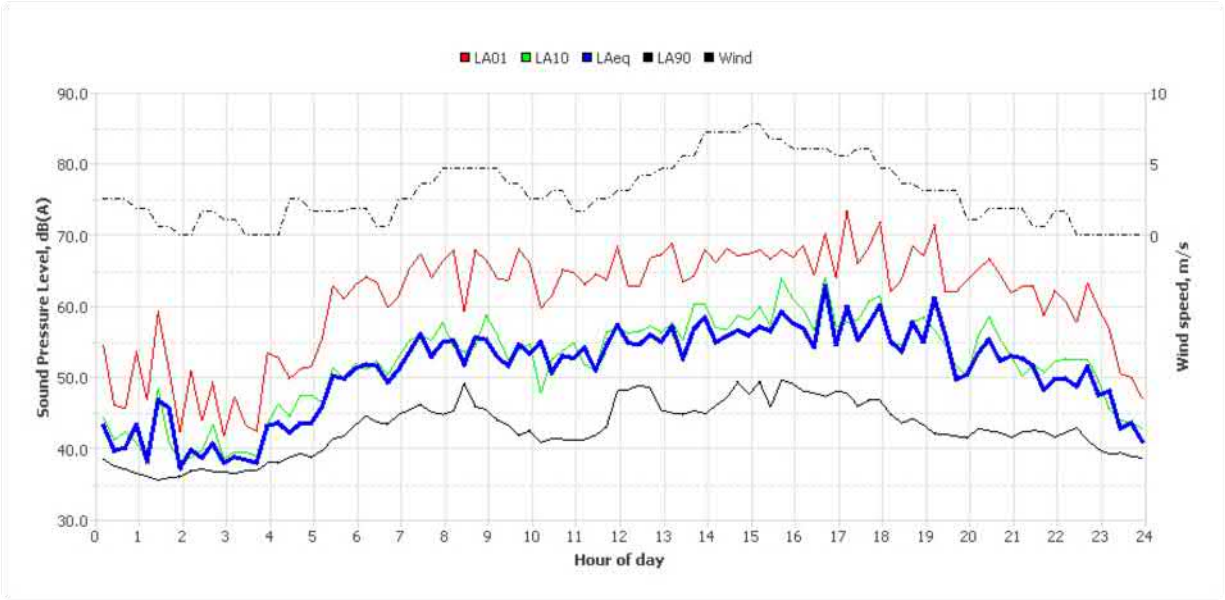

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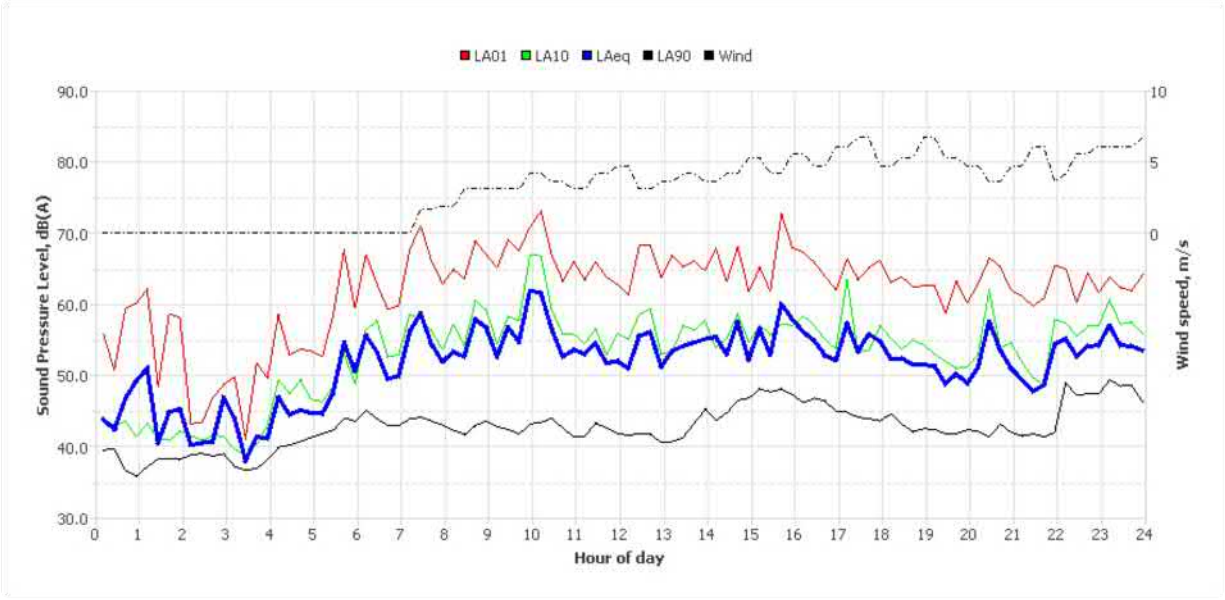

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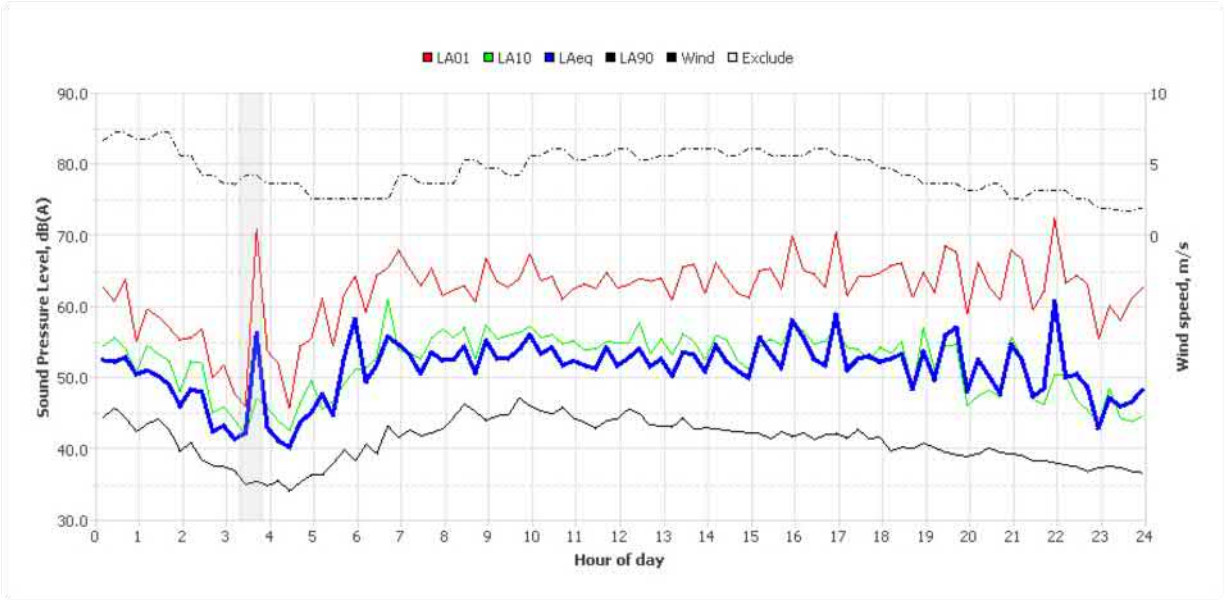

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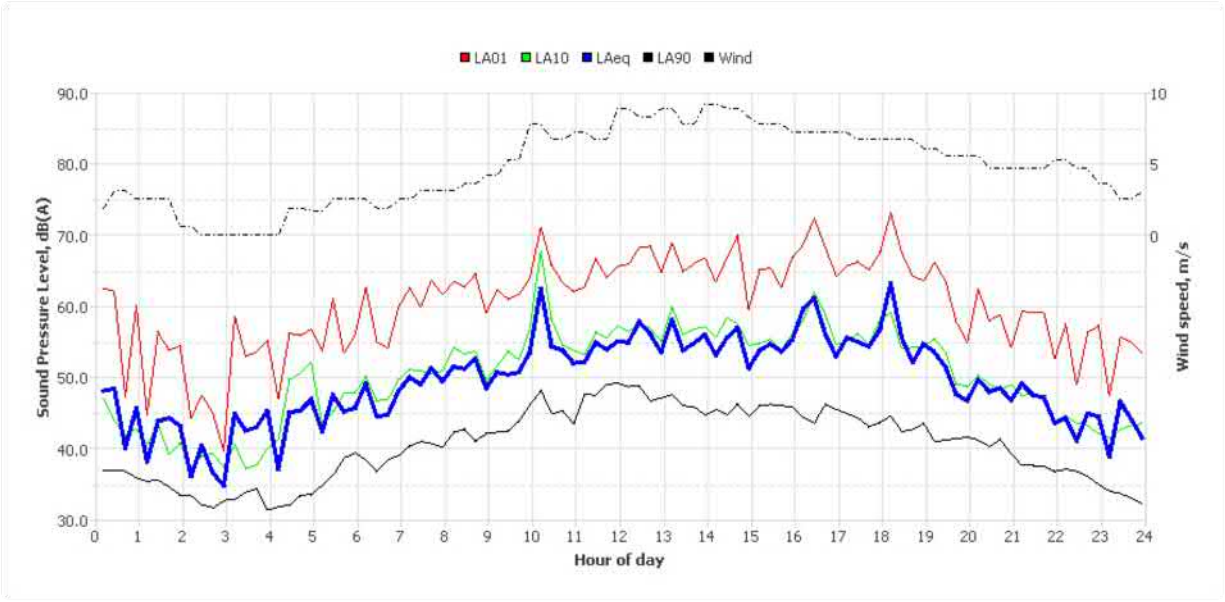

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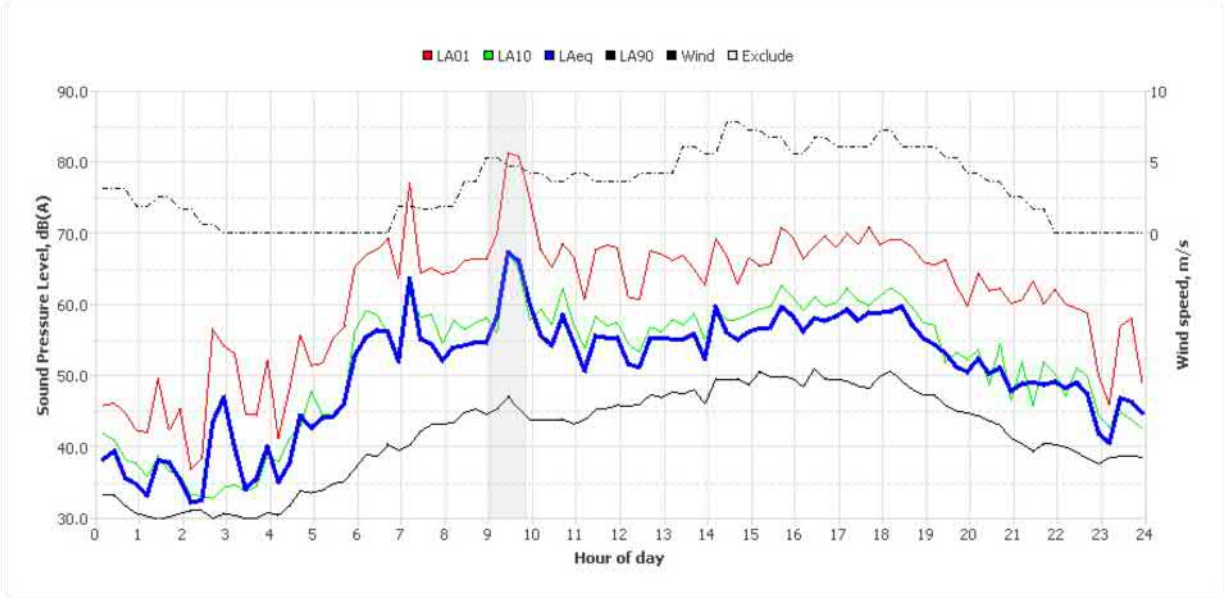

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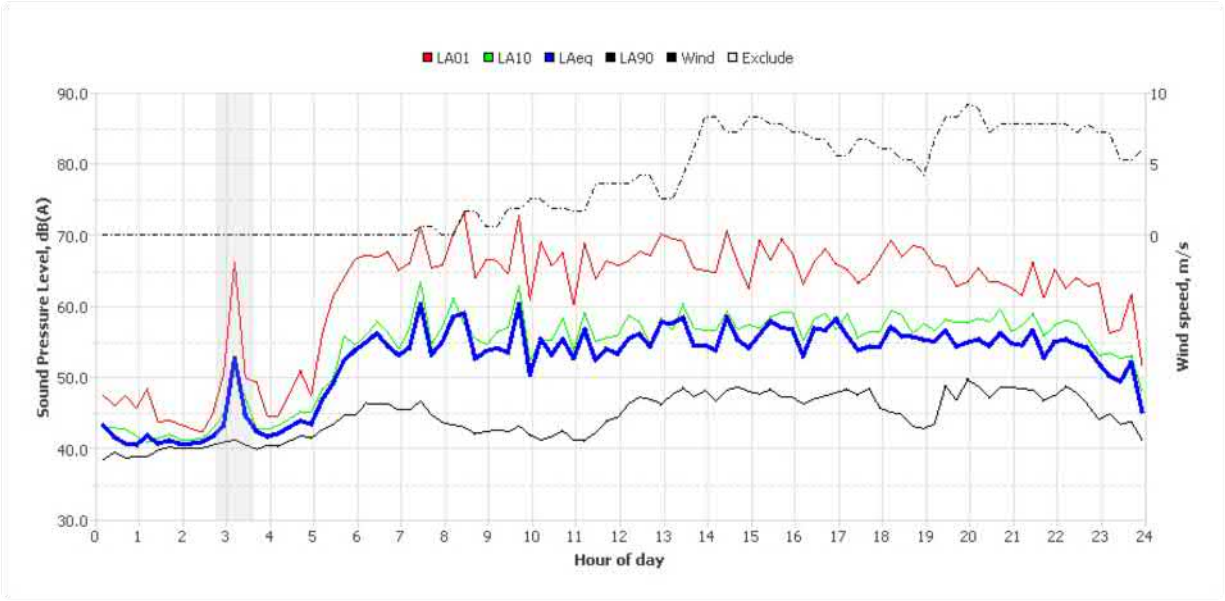

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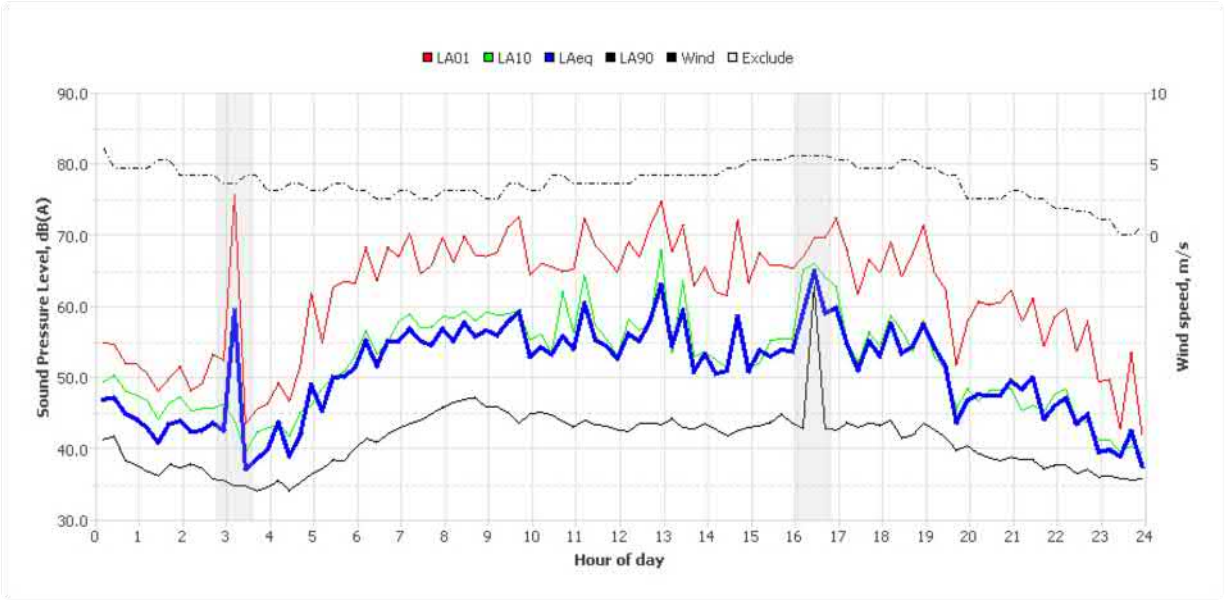

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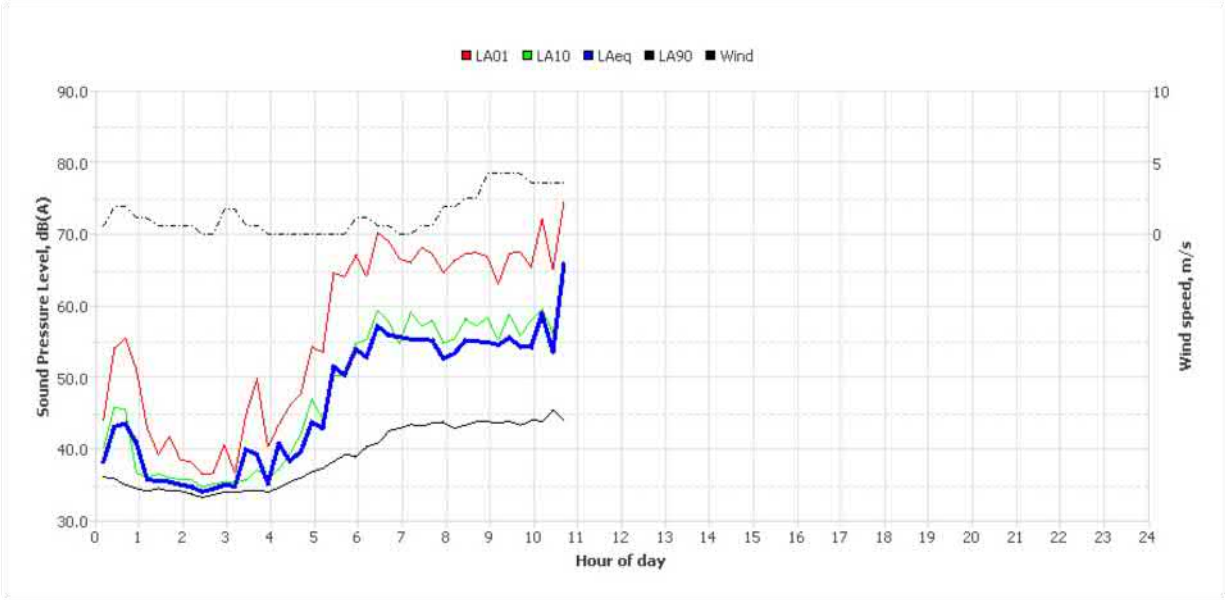


Noise Logger Report

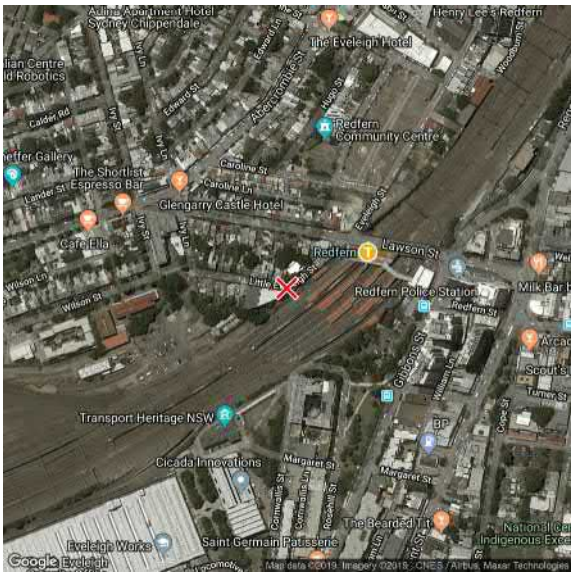
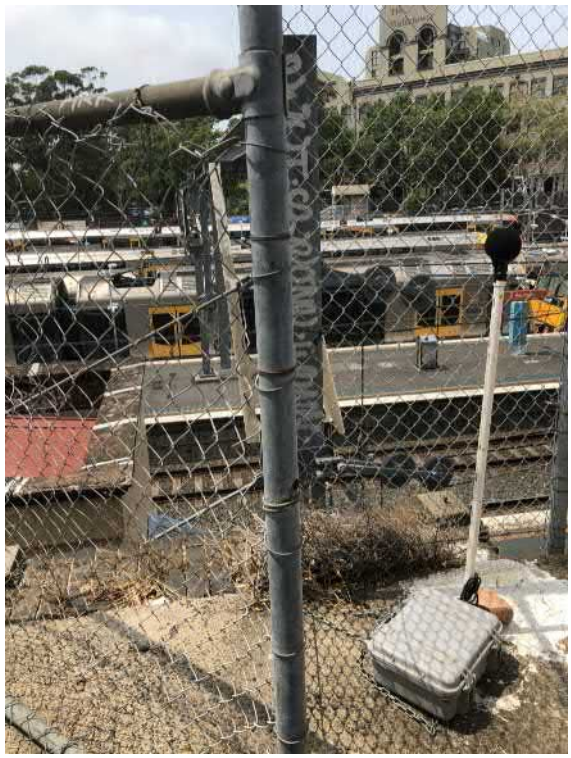
125 Little Eveleigh Street, Redfern

Item	Information
Logger Type	Rion NL21
Serial number	00265112
Address	125 Little Eveleigh Street, Redfern
Location	Front Yard
Facade / Free Field	Facade
Environment	Noise environment dominated by urban hum, predominantly from Redfern station and trains. Construction noise from other side of station also audible. Pedestrians and cyclist pass bys fairly frequent. Trucks accelerating up Gibbon street clearly audible.

Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Fri Nov 22 2019	65	62	60	-	49	-	63	60
Sat Nov 23 2019	62	61	59	50	48	39	62	59
Sun Nov 24 2019	61	61	59	48	45	44	61	59
Mon Nov 25 2019	63	63	60	54	50	41	63	60
Tue Nov 26 2019	65	60	58	-	-	41	64	58
Wed Nov 27 2019	63	62	58	54	52	39	63	58
Thu Nov 28 2019	64	62	59	-	-	39	64	59
Fri Nov 29 2019	64	62	58	55	52	44	64	58
Sat Nov 30 2019	67	62	60	-	49	-	65	60
Sun Dec 1 2019	63	61	60	-	45	-	63	60
Mon Dec 2 2019	63	-	59	-	-	-	63	59
Summary	**64**	**62**	**59**	**54**	**49**	**41**	**63**	**59**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

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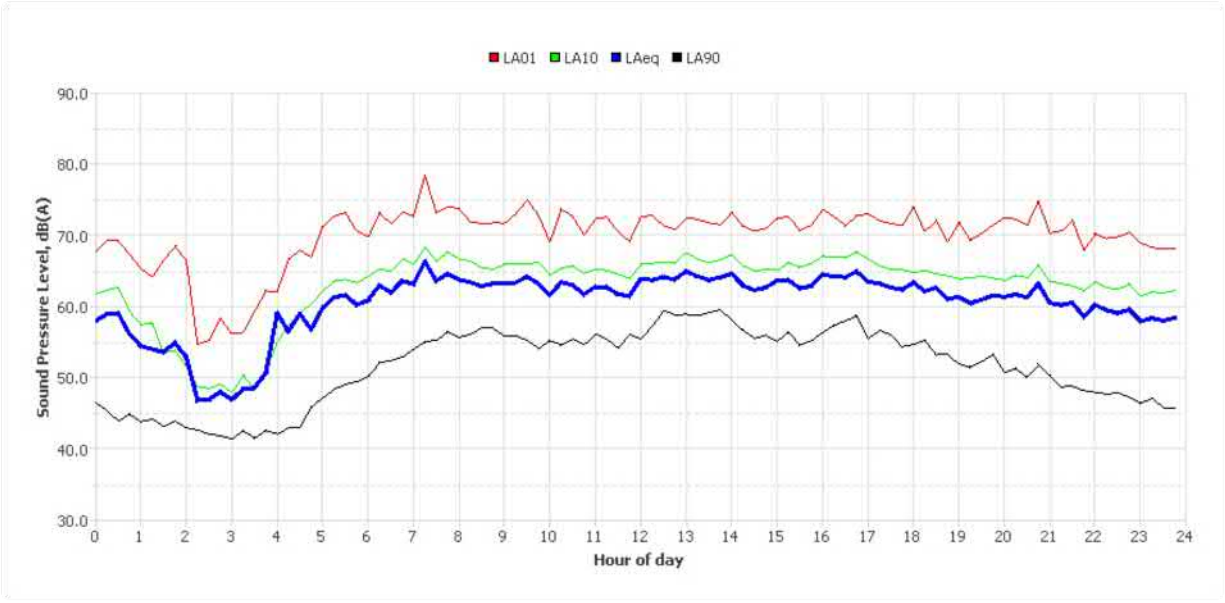

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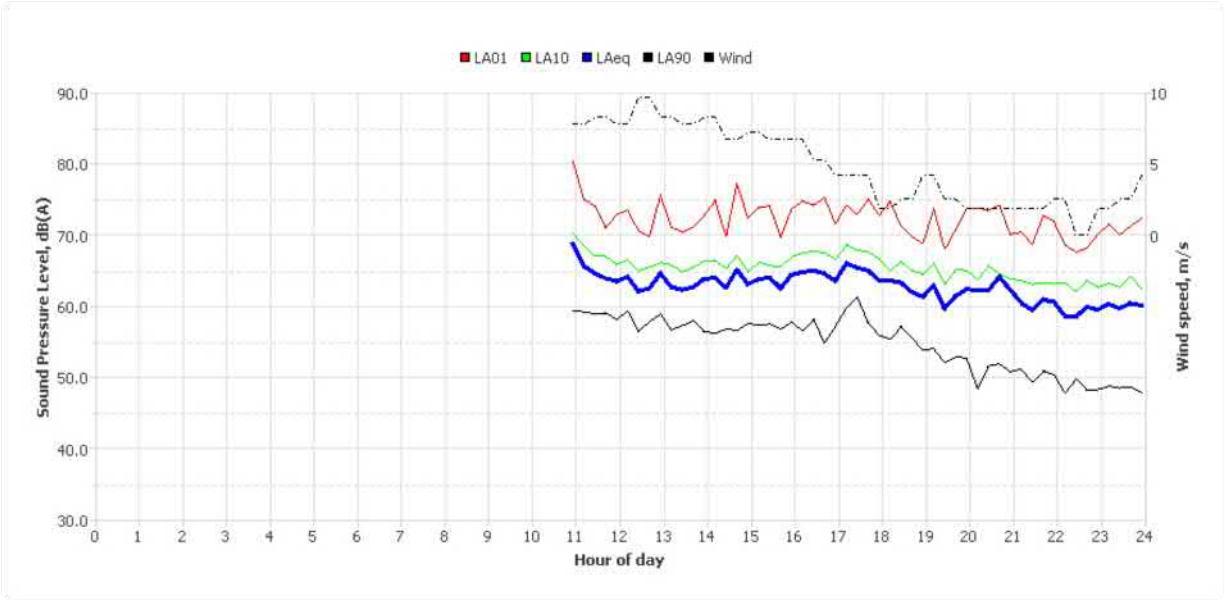

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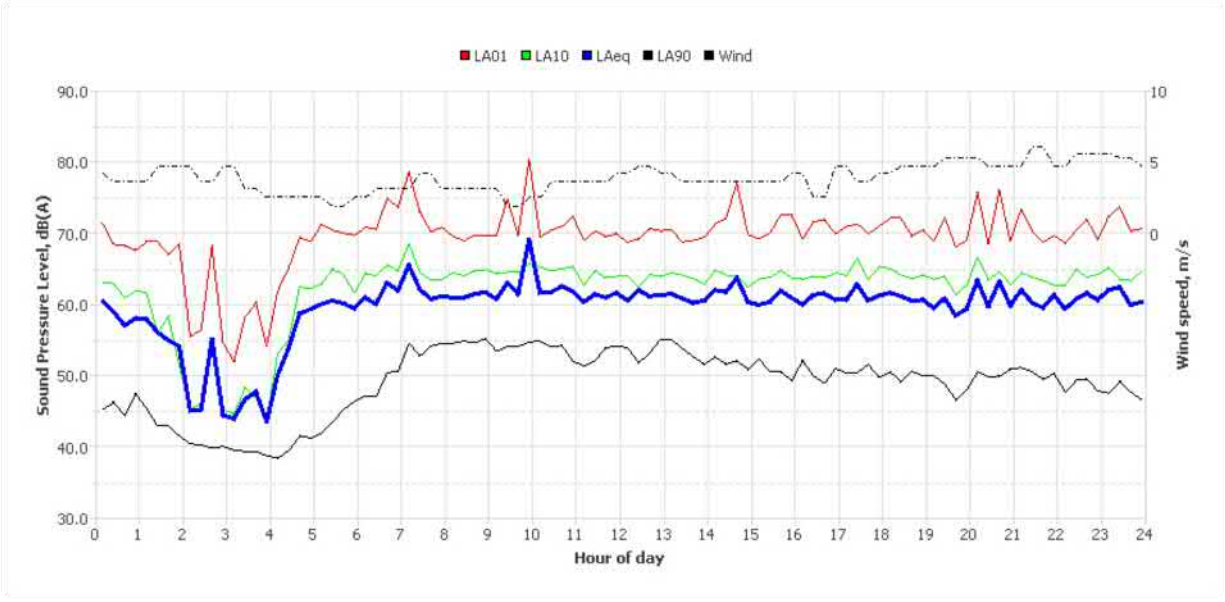
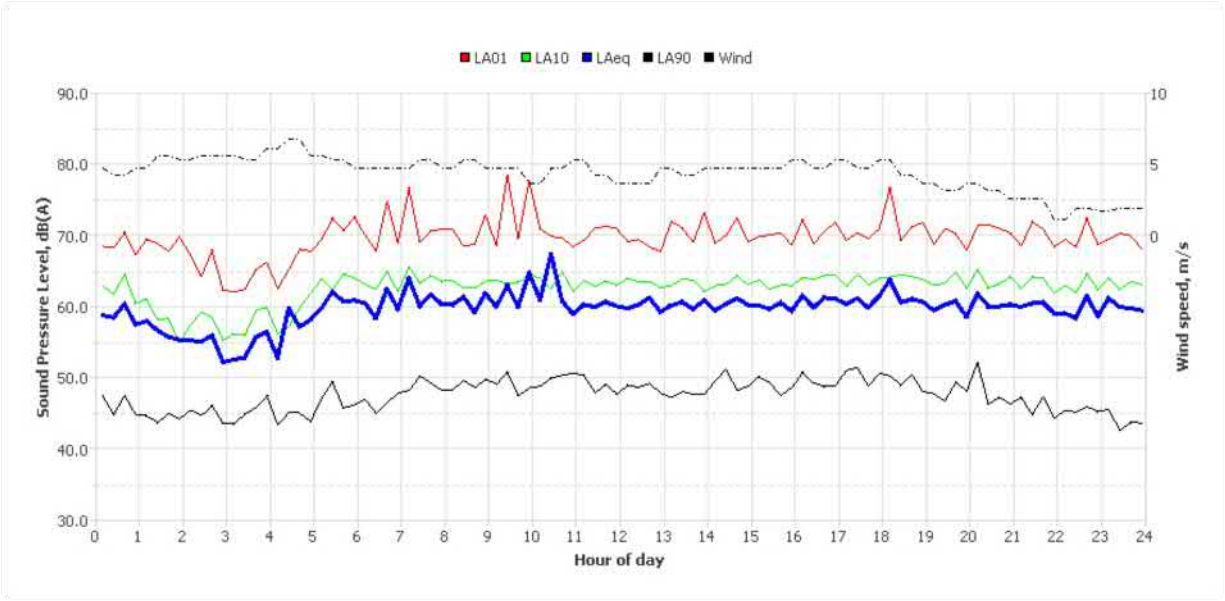


Sunday, 24 Nov 2019



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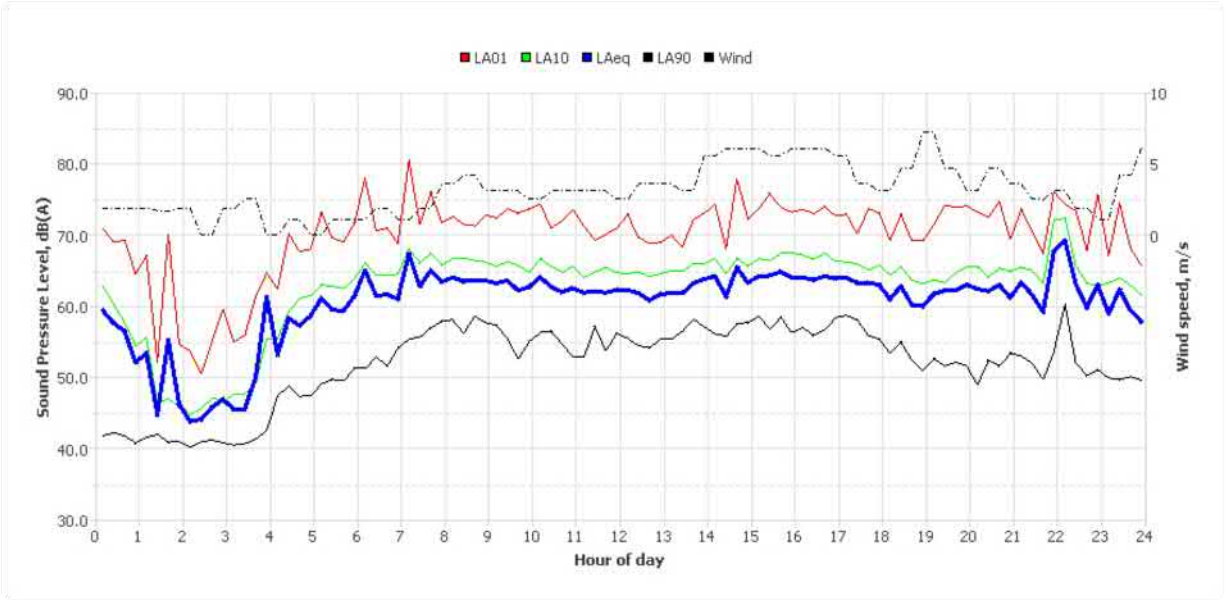

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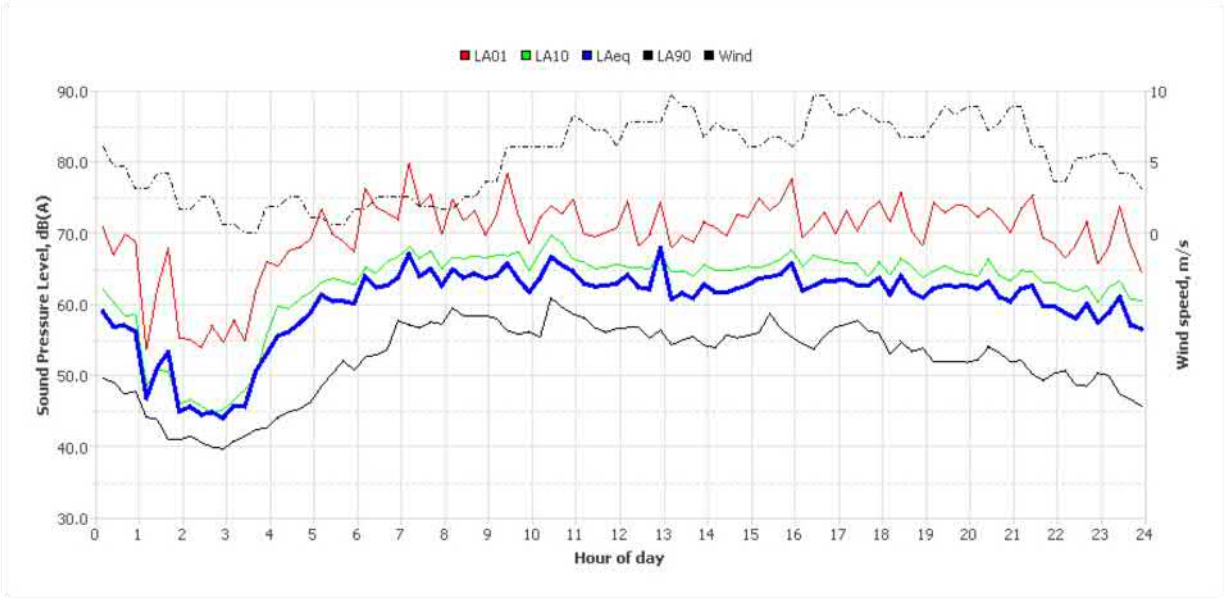

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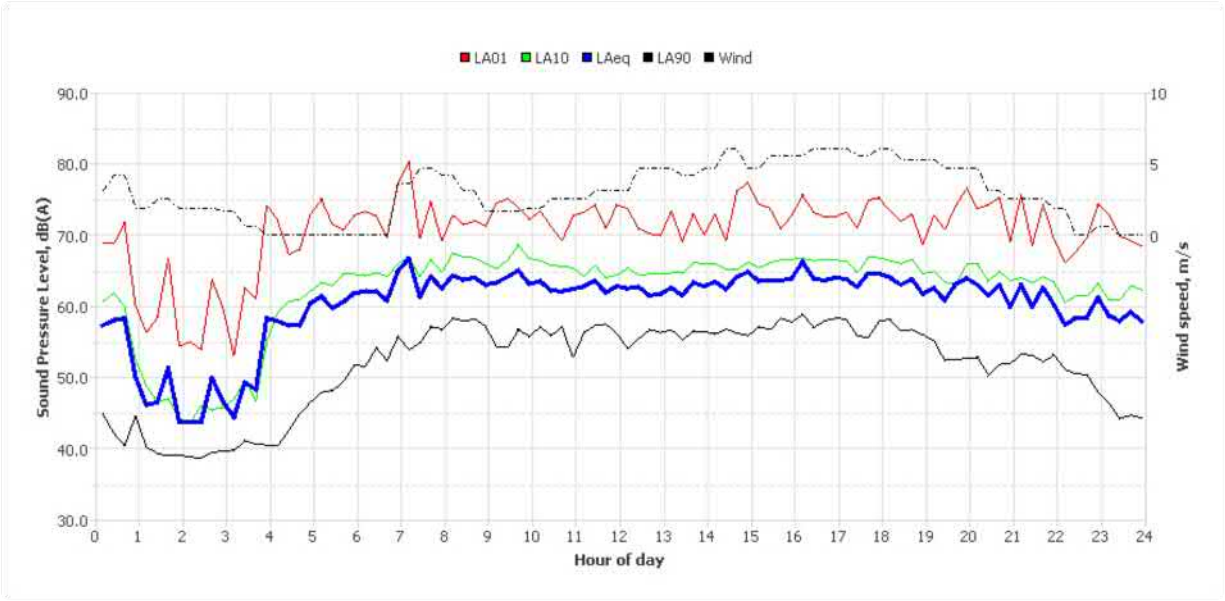

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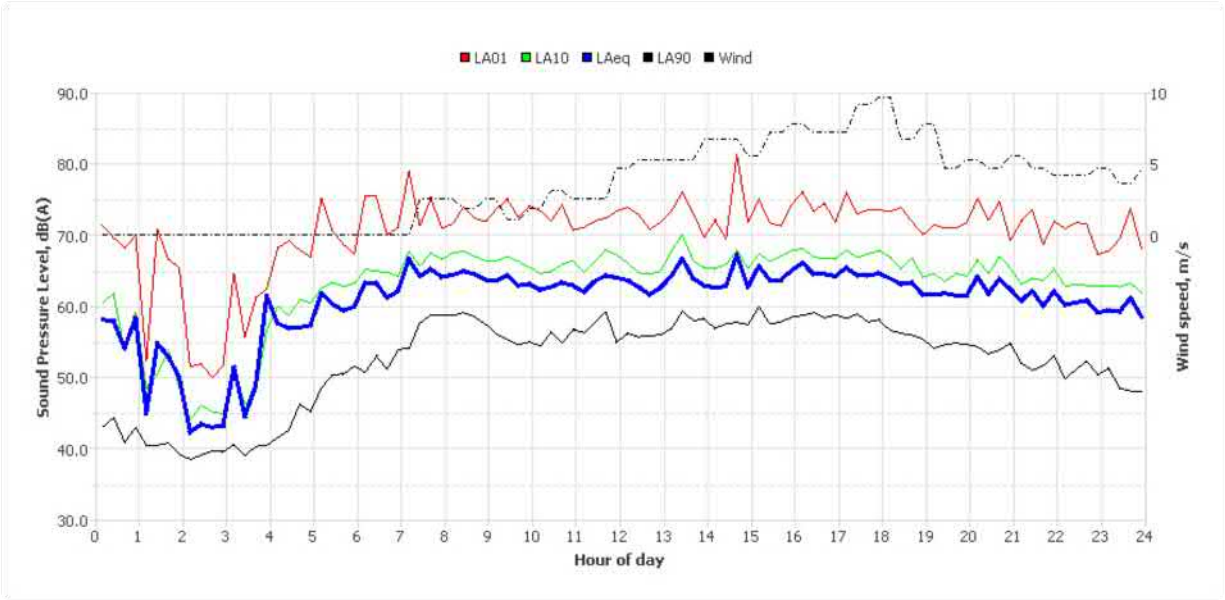

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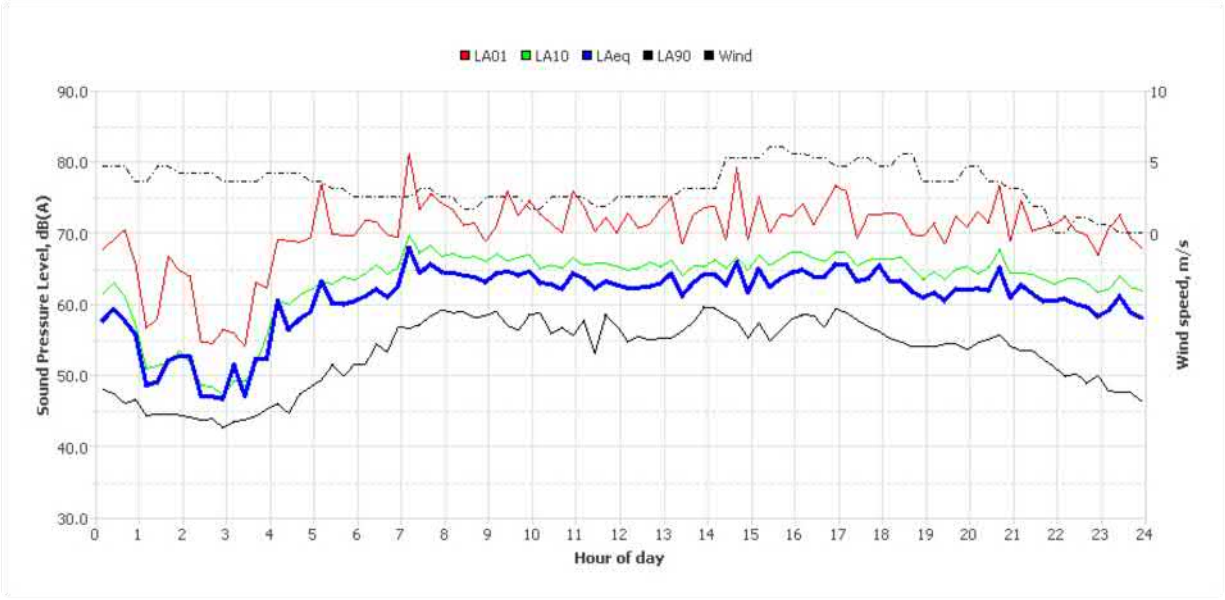

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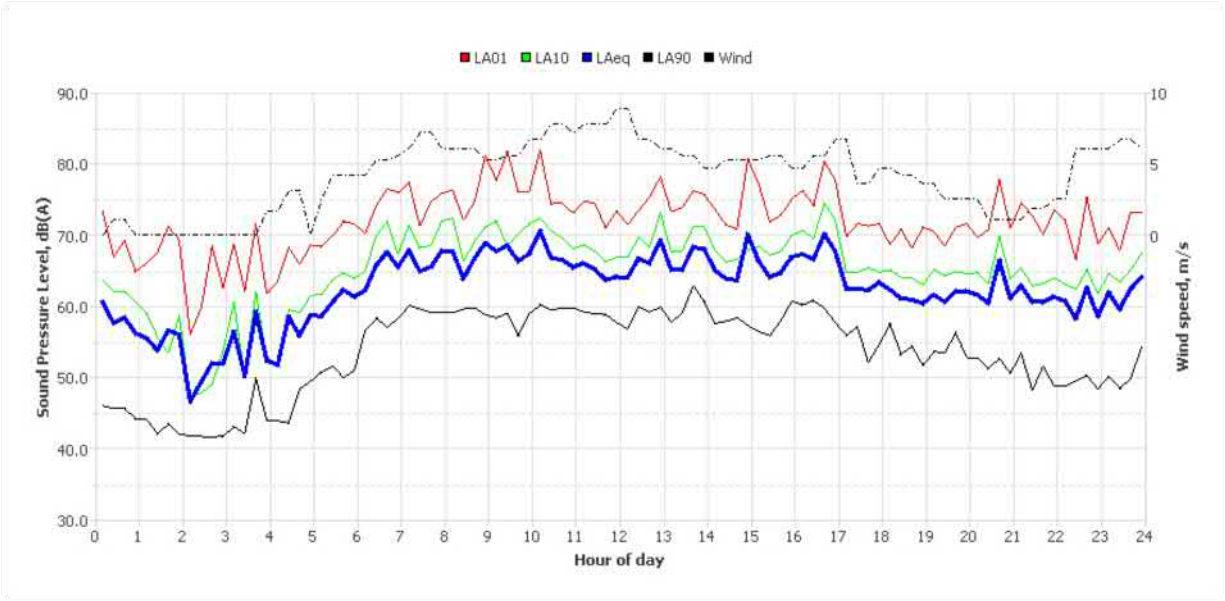
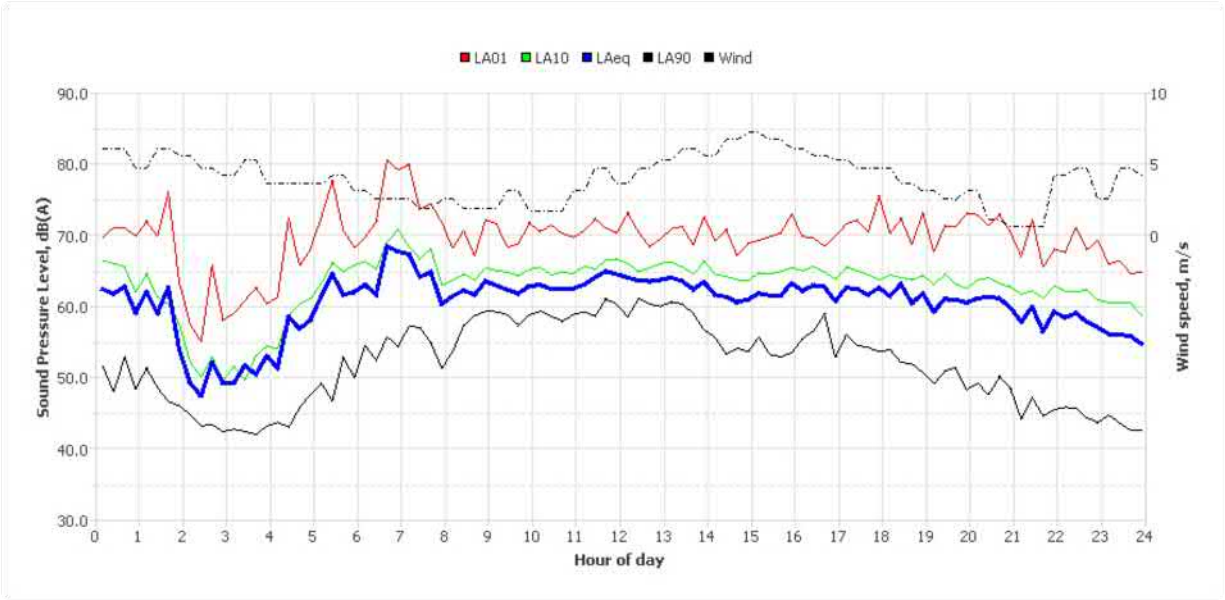
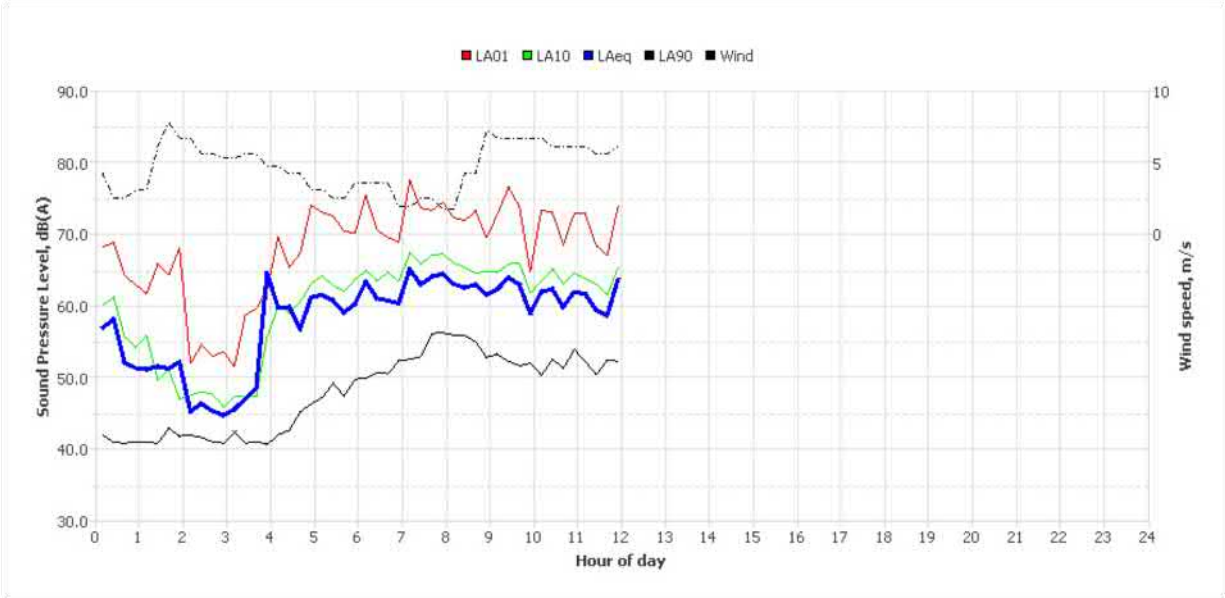


Sunday, 01 Dec 2019



Monday, 02 Dec 2019



Noise Logger Report

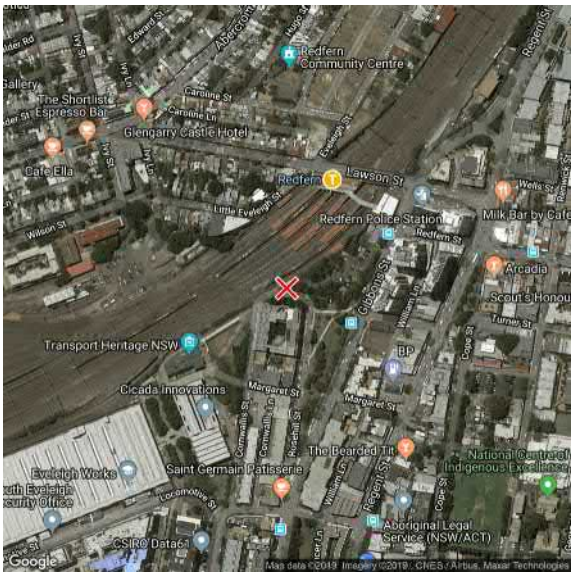
Marian Street, Eveleigh

Item	Information
Logger Type	ARL-315
Serial number	15-299-444
Address	Marian Street, Eveleigh
Location	Marian Street, Eveleigh
Facade / Free Field	Free field
Environment	Noise environment dominated by station activities and road traffic noise from Gibbon Street. Banging from construction site to the north on other side of station audible also from construction site to east (corner Gibbon and Marian Street)

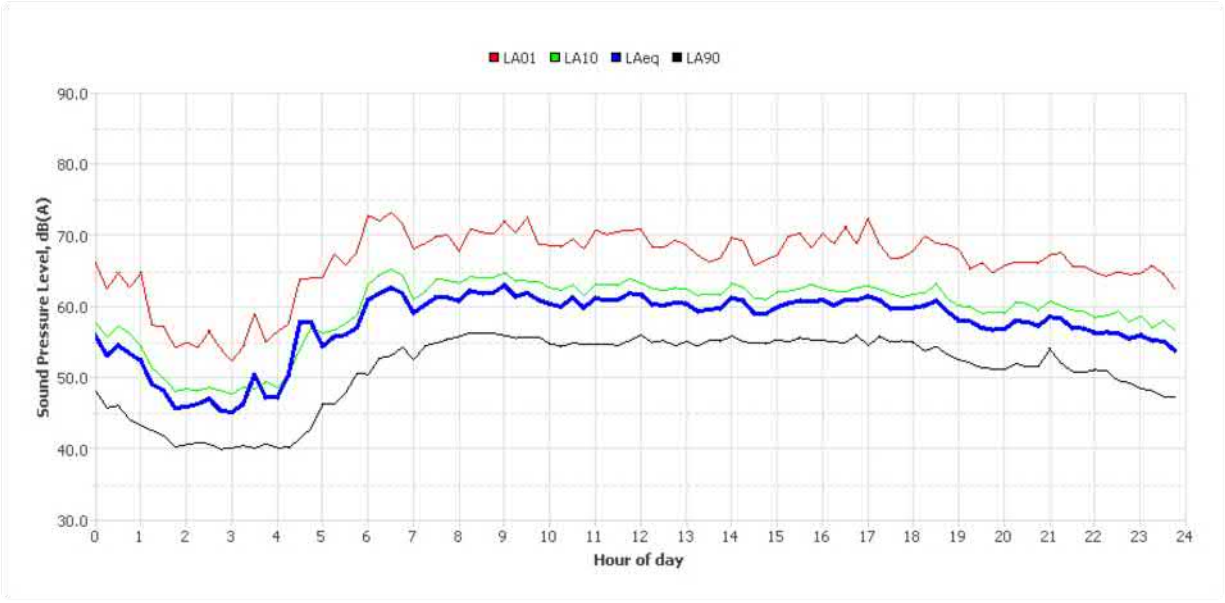
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Mon Nov 11 2019	62	59	56	-	-	-	61	56
Tue Nov 12 2019	61	-	57	-	-	-	61	57
Wed Nov 13 2019	60	60	56	51	51	39	60	56
Thu Nov 14 2019	61	60	57	-	52	40	61	57
Fri Nov 15 2019	60	55	57	53	-	-	59	57
Sat Nov 16 2019	61	58	56	-	49	-	60	56
Sun Nov 17 2019	63	56	56	-	-	39	61	56
Mon Nov 18 2019	63	59	56	-	-	38	62	56
Tue Nov 19 2019	60	57	58	-	-	-	60	58
Wed Nov 20 2019	62	59	57	54	51	38	62	57
Thu Nov 21 2019	60	-	56	-	-	-	60	56
Summary	**61**	**58**	**57**	**53**	**51**	**39**	**61**	**57**

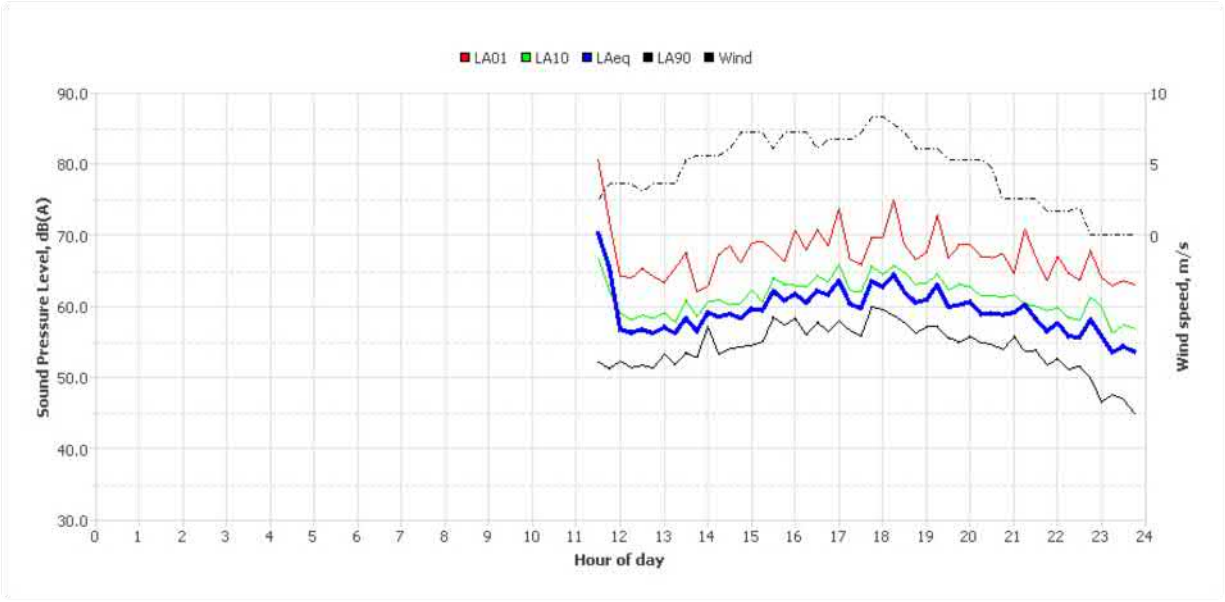
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

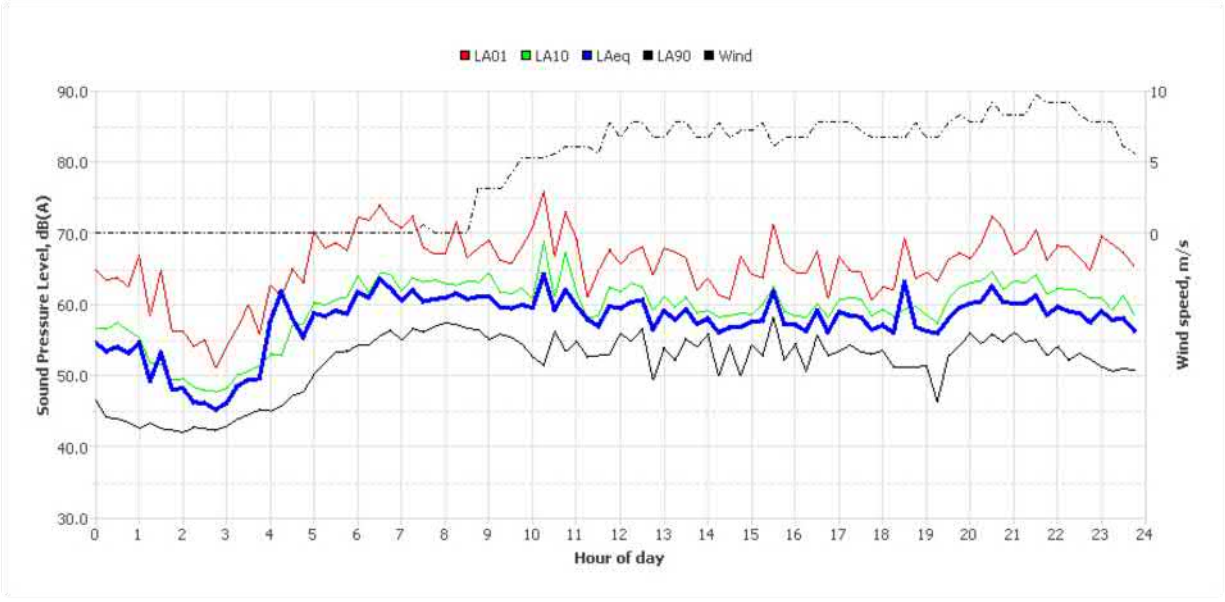
Typical Day



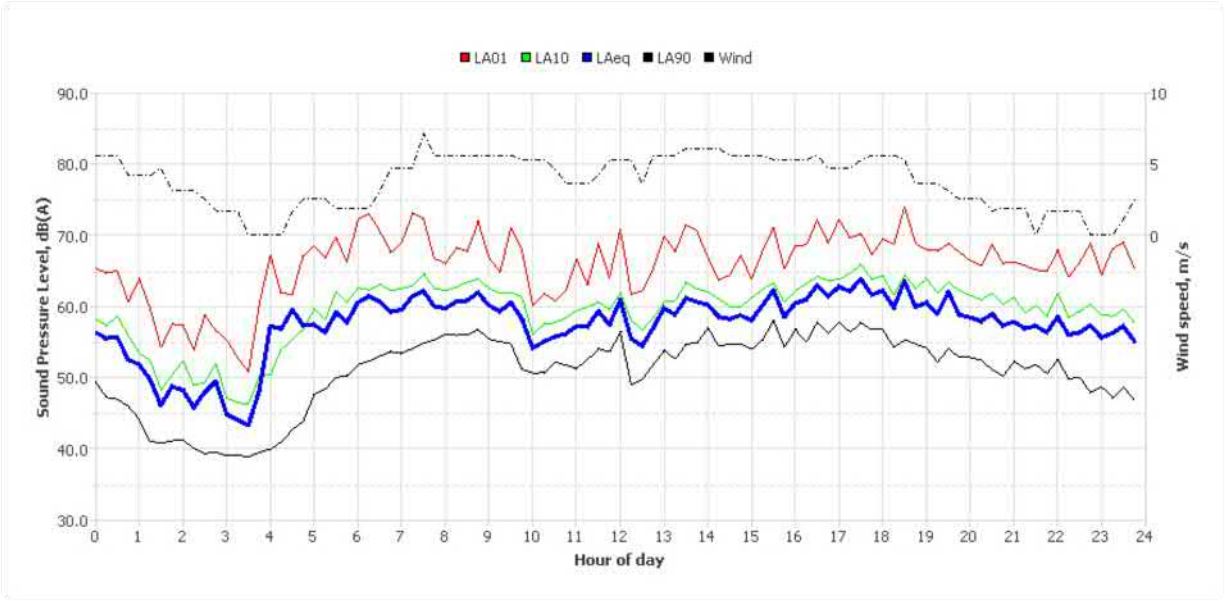
Monday, 11 Nov 2019



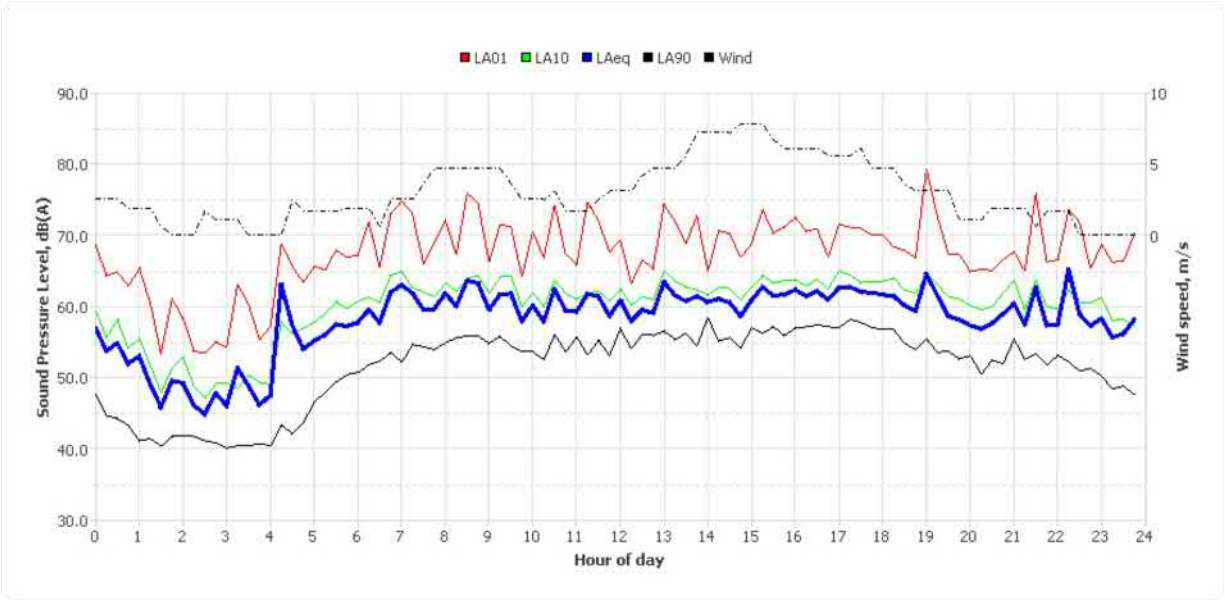
Tuesday, 12 Nov 2019



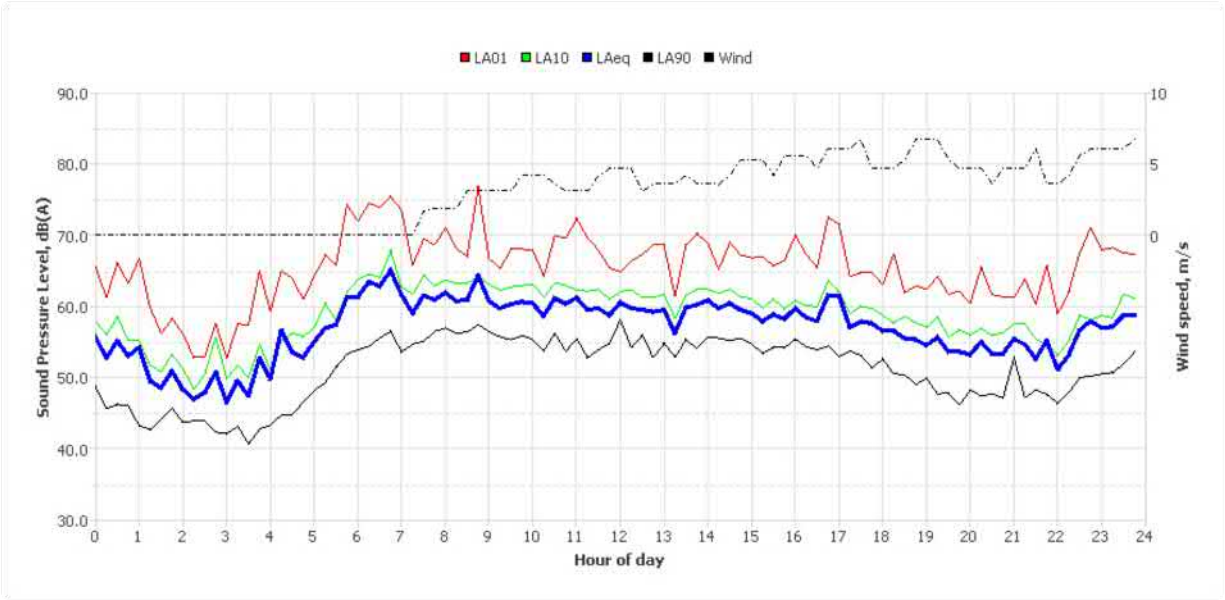
Wednesday, 13 Nov 2019



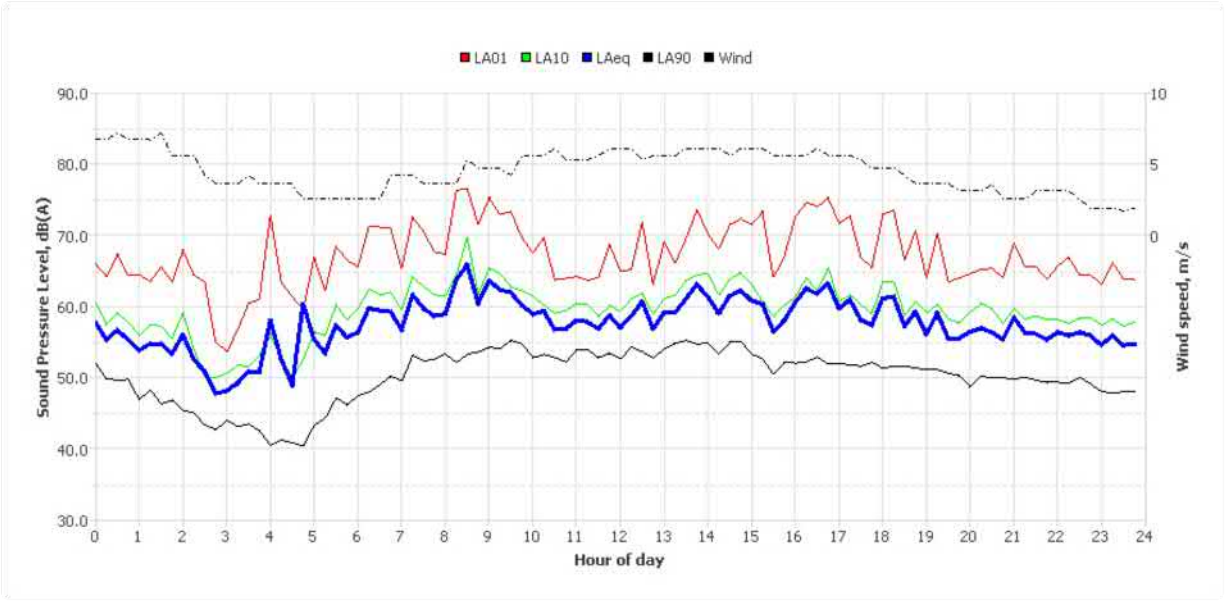
Thursday, 14 Nov 2019



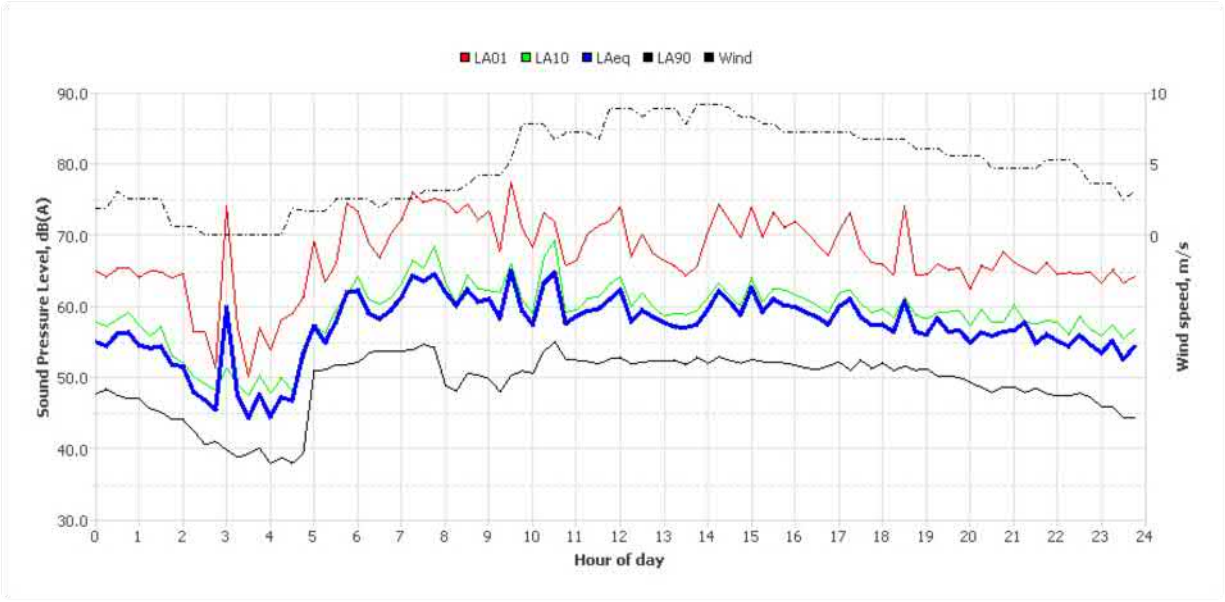
Friday, 15 Nov 2019



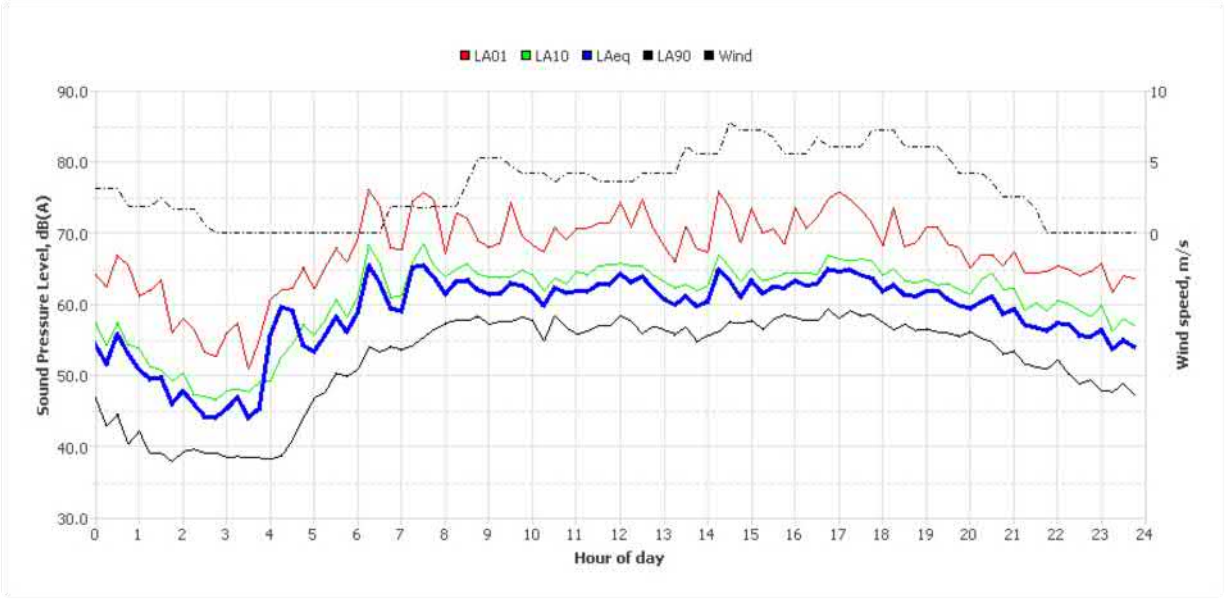
Saturday, 16 Nov 2019



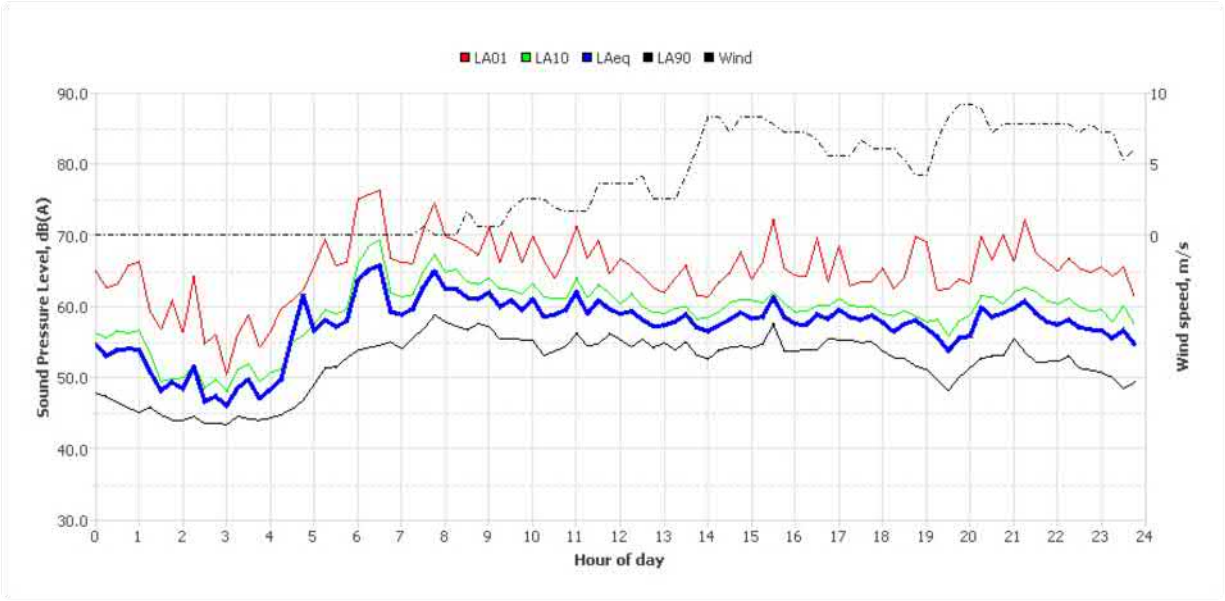
Sunday, 17 Nov 2019



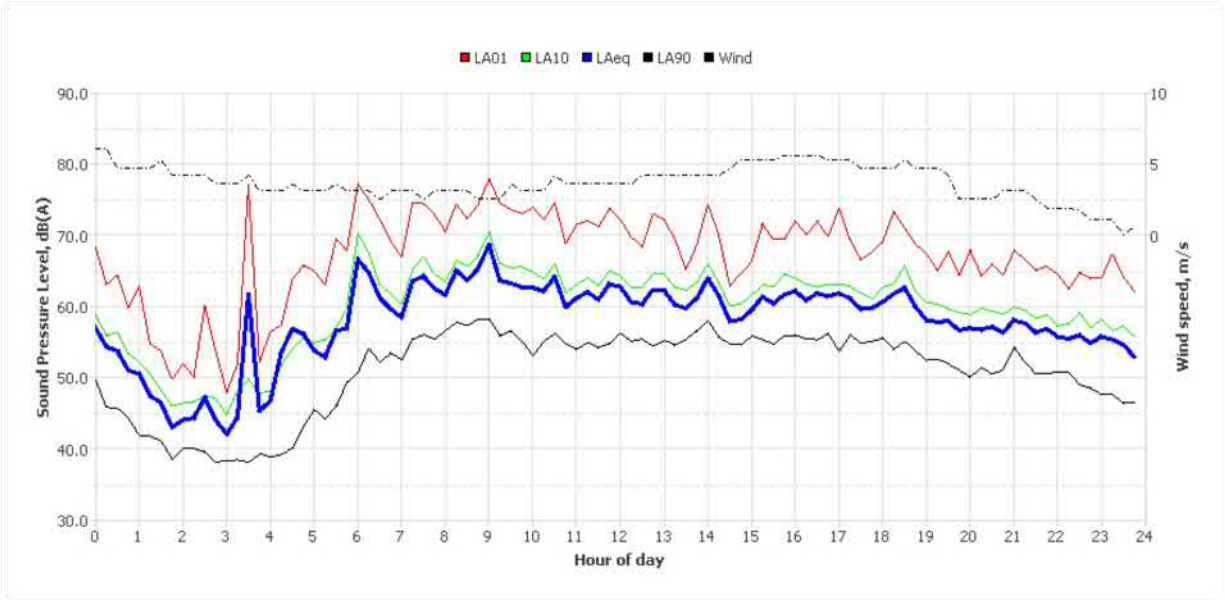
Monday, 18 Nov 2019



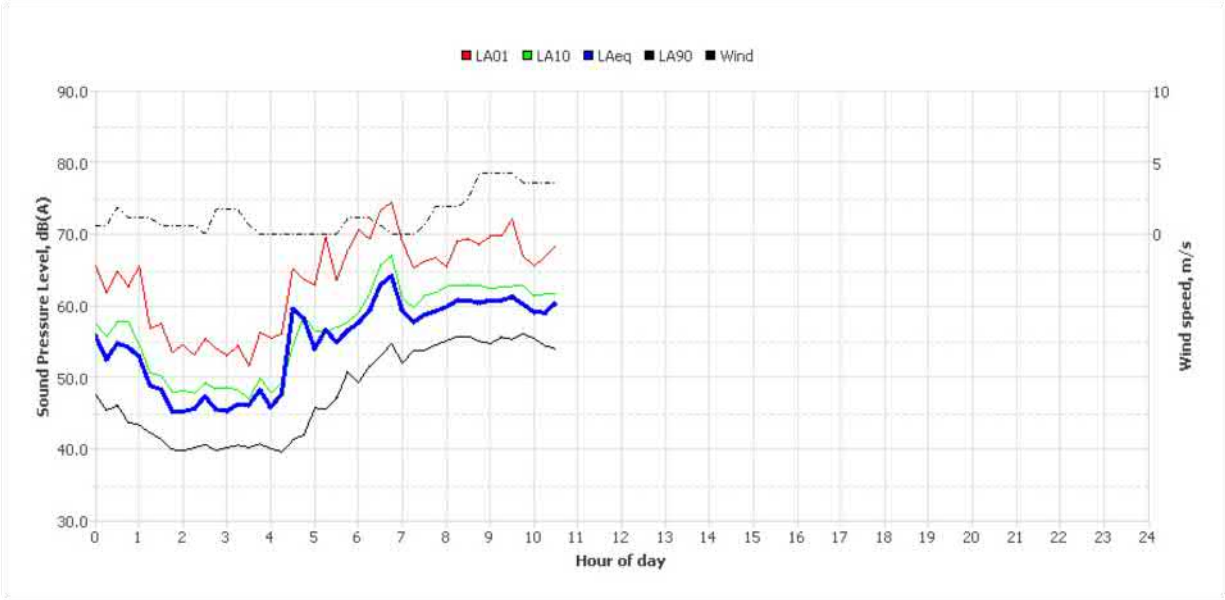
Tuesday, 19 Nov 2019



Wednesday, 20 Nov 2019



Thursday, 21 Nov 2019



Noise Logger Report

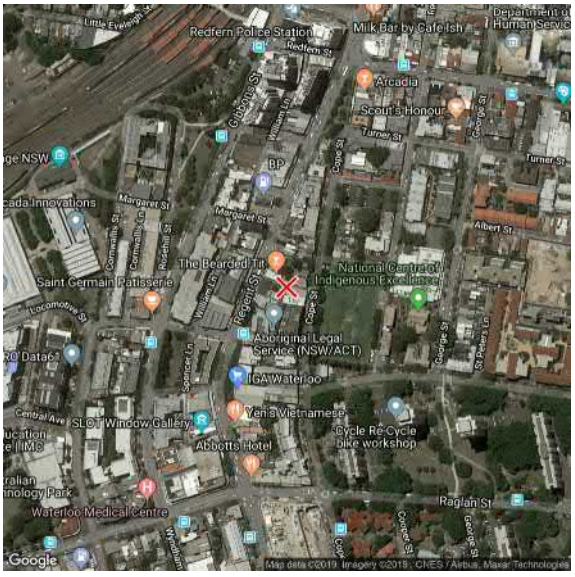
52 Cope Street, Redfern

Item	Information
Logger Type	Svan 957
Serial number	23855
Address	52 Cope Street, Redfern
Location	Back yard
Facade / Free Field	Free Field
Environment	Noise environment dominated by light urban hum, mostly road traffic from Regent street. Train horn barely audible. Aircraft noise clearly audible

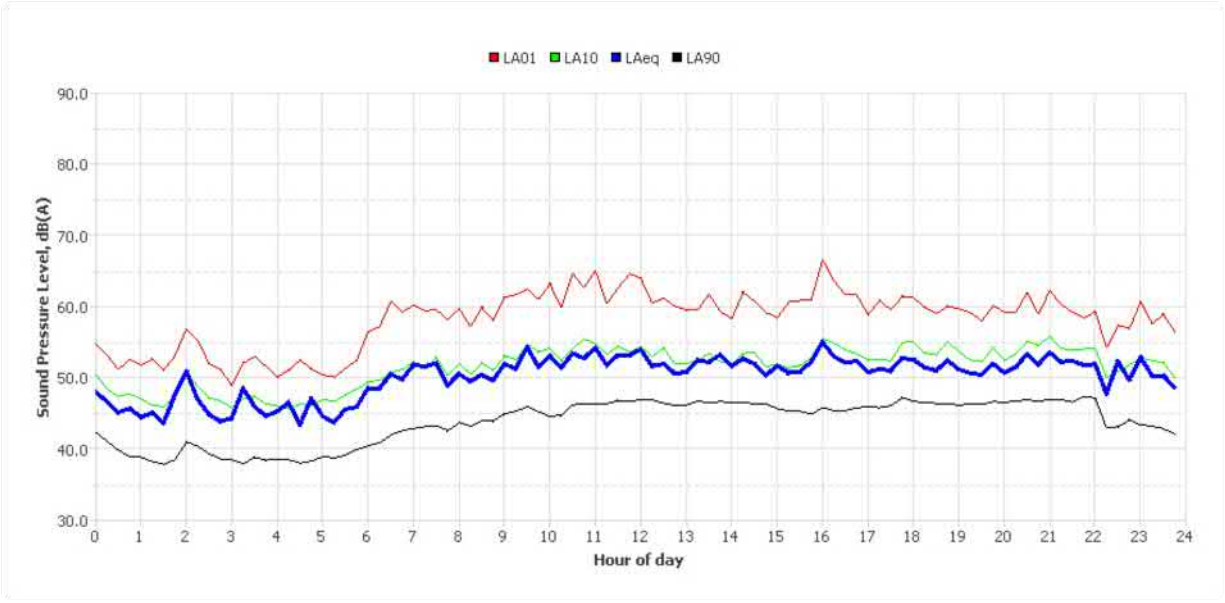
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Nov 20 2019	52	54	50	-	47	-	53	50
Thu Nov 21 2019	51	53	49	-	-	36	52	49
Fri Nov 22 2019	59	56	49	-	46	38	58	49
Sat Nov 23 2019	52	51	46	43	-	36	51	46
Sun Nov 24 2019	50	51	47	41	-	38	50	47
Mon Nov 25 2019	53	56	48	44	-	-	54	48
Tue Nov 26 2019	53	49	47	-	-	38	52	47
Wed Nov 27 2019	51	54	47	44	45	36	52	47
Thu Nov 28 2019	53	56	47	-	-	36	54	47
Fri Nov 29 2019	53	57	49	45	50	40	54	49
Sat Nov 30 2019	53	53	49	-	45	-	53	49
Sun Dec 1 2019	52	50	47	-	44	-	51	47
Mon Dec 2 2019	51	-	48	-	-	-	51	48
Summary	**53**	**54**	**48**	**44**	**46**	**37**	**53**	**48**

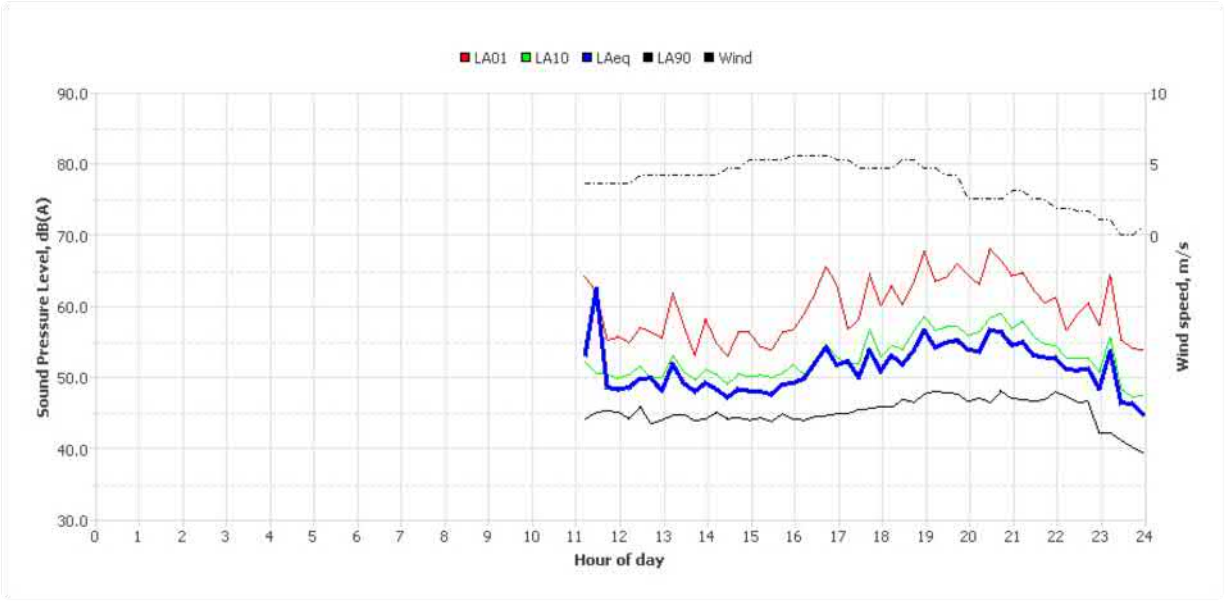
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

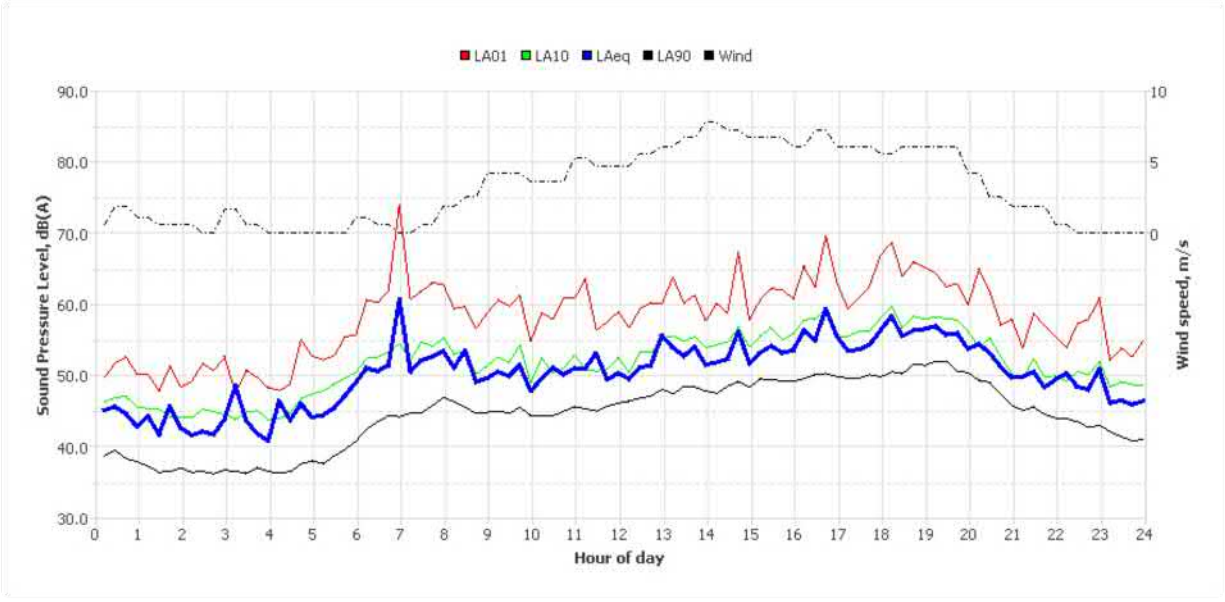
Typical Day



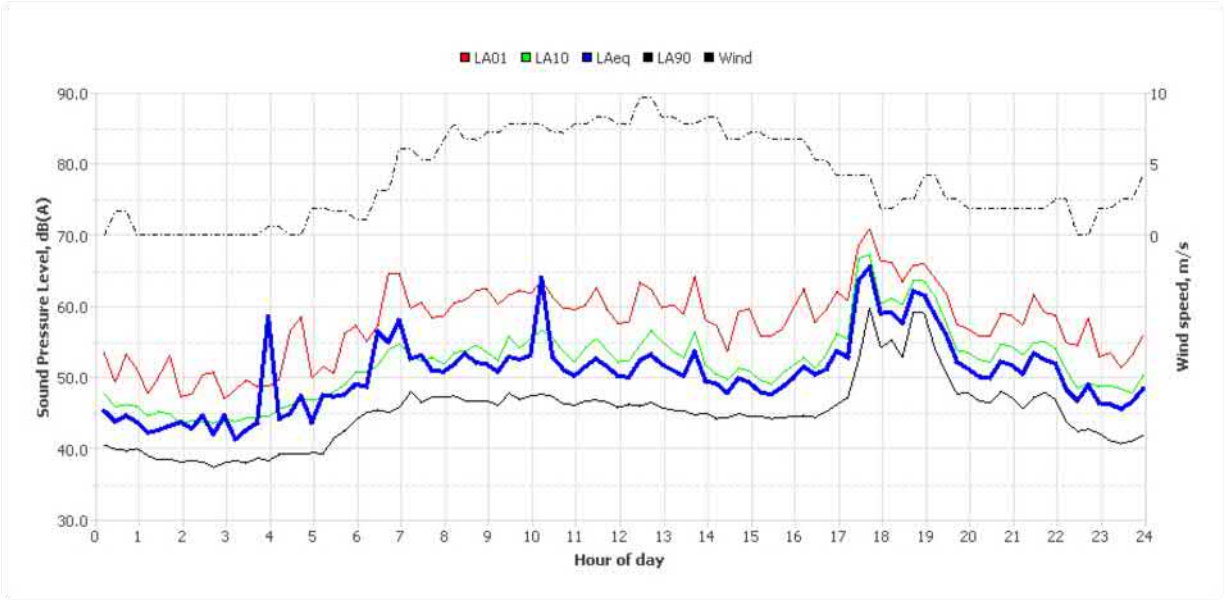
Wednesday, 20 Nov 2019



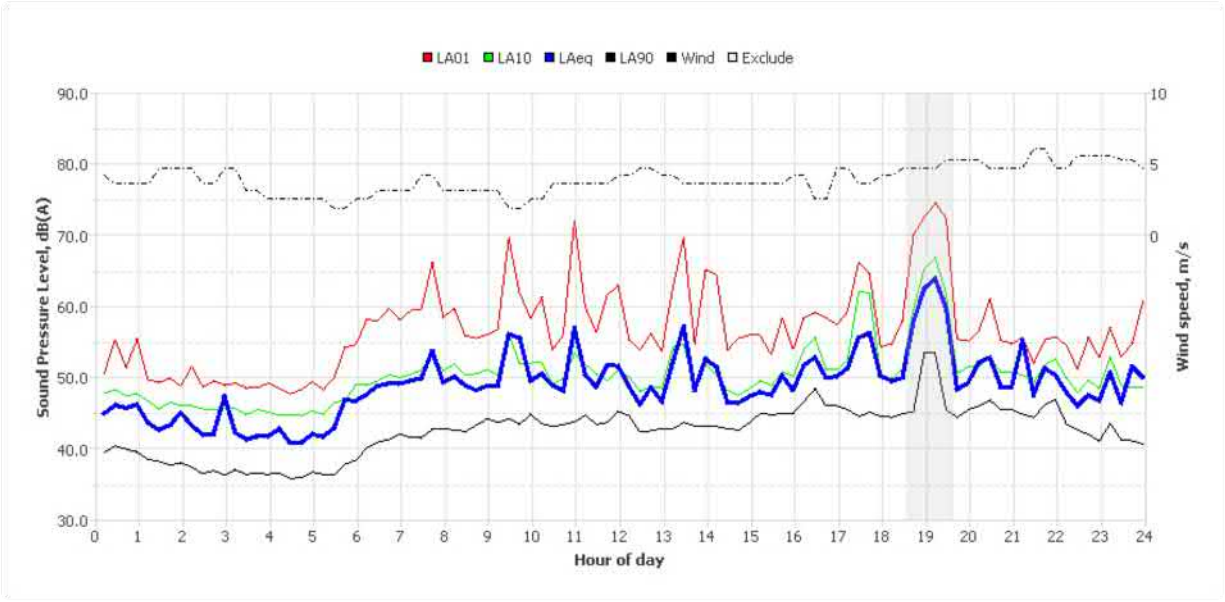
Thursday, 21 Nov 2019



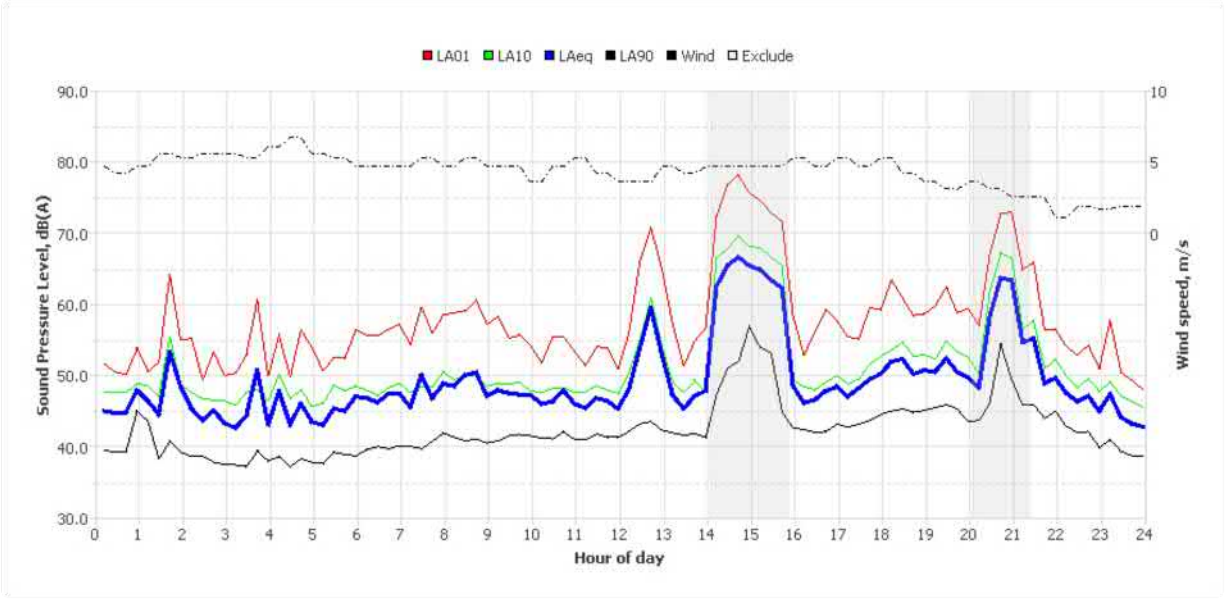
Friday, 22 Nov 2019



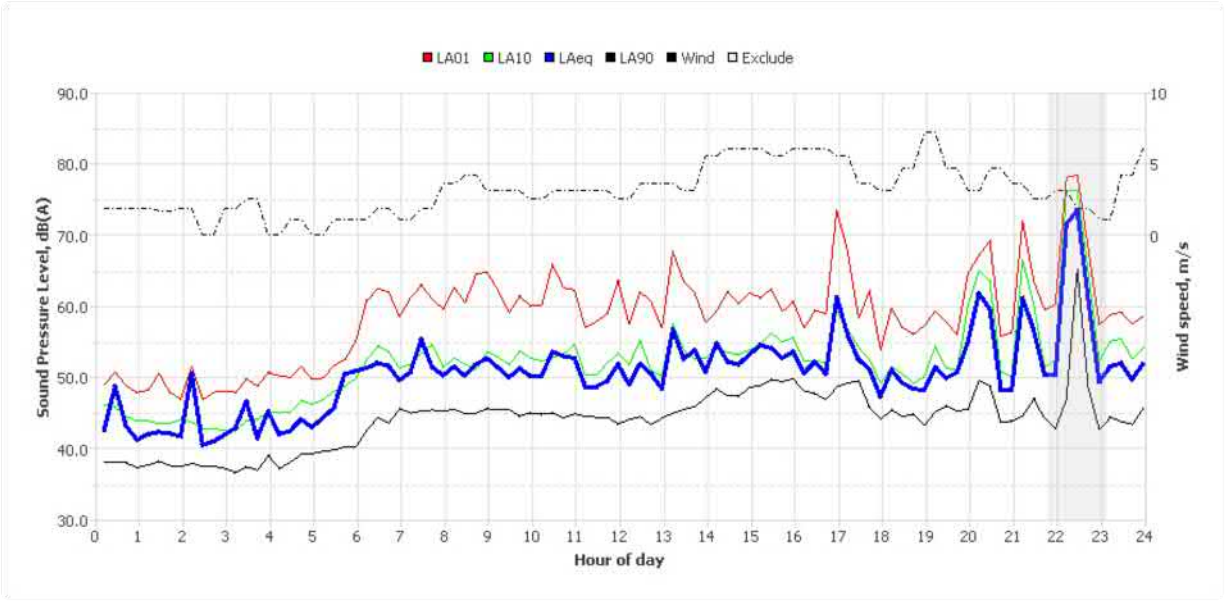
Saturday, 23 Nov 2019



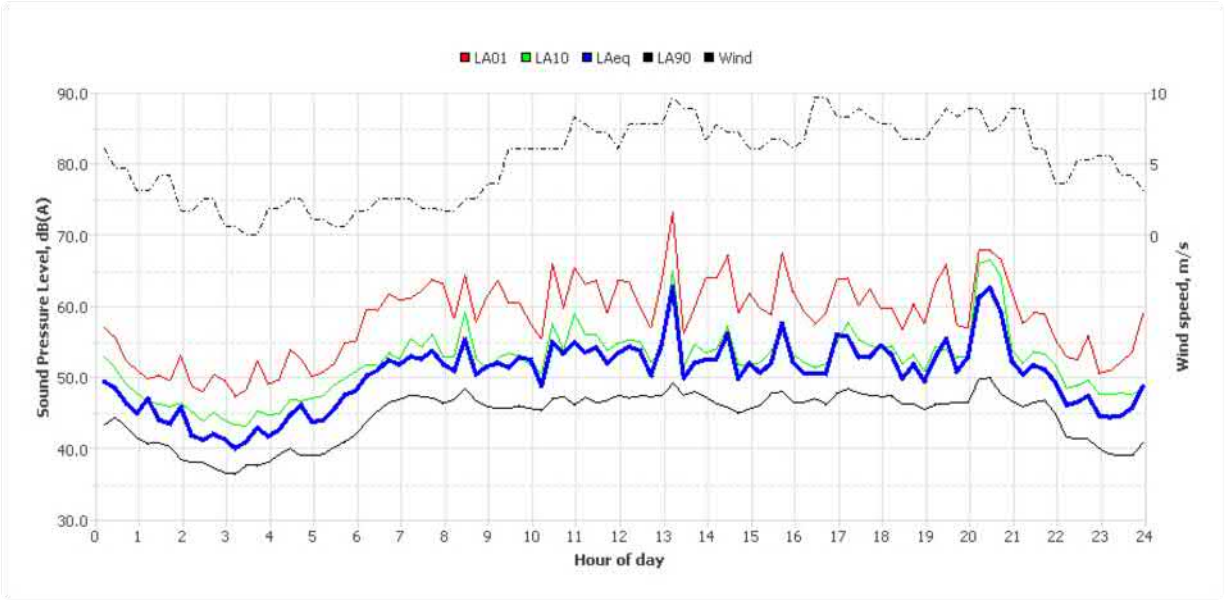
Sunday, 24 Nov 2019



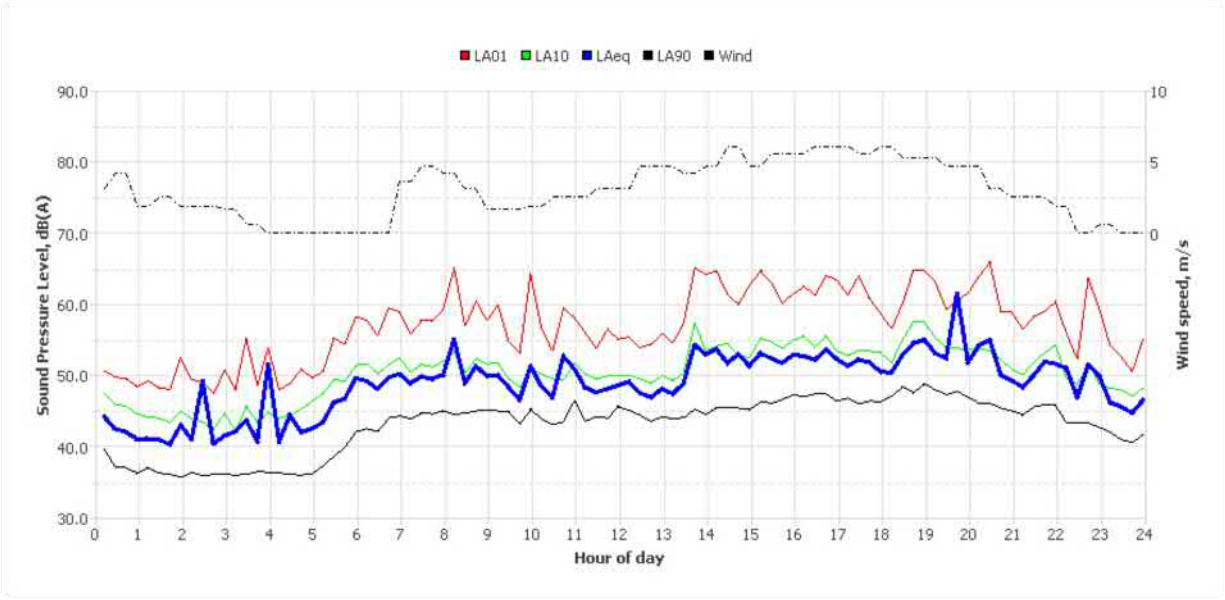
Monday, 25 Nov 2019



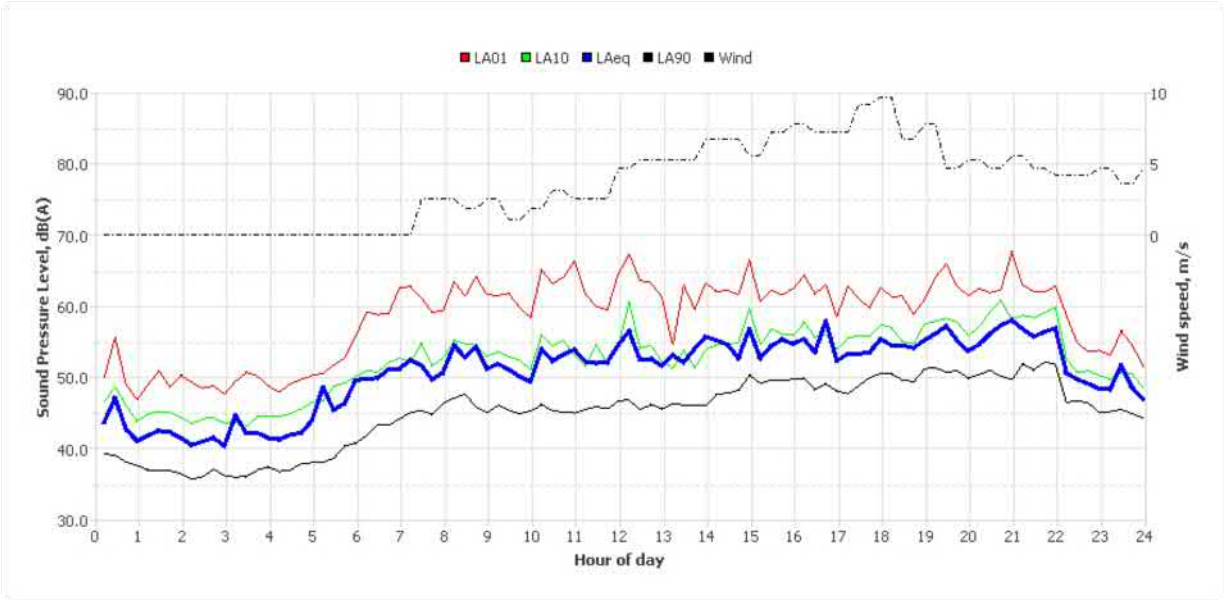
Tuesday, 26 Nov 2019



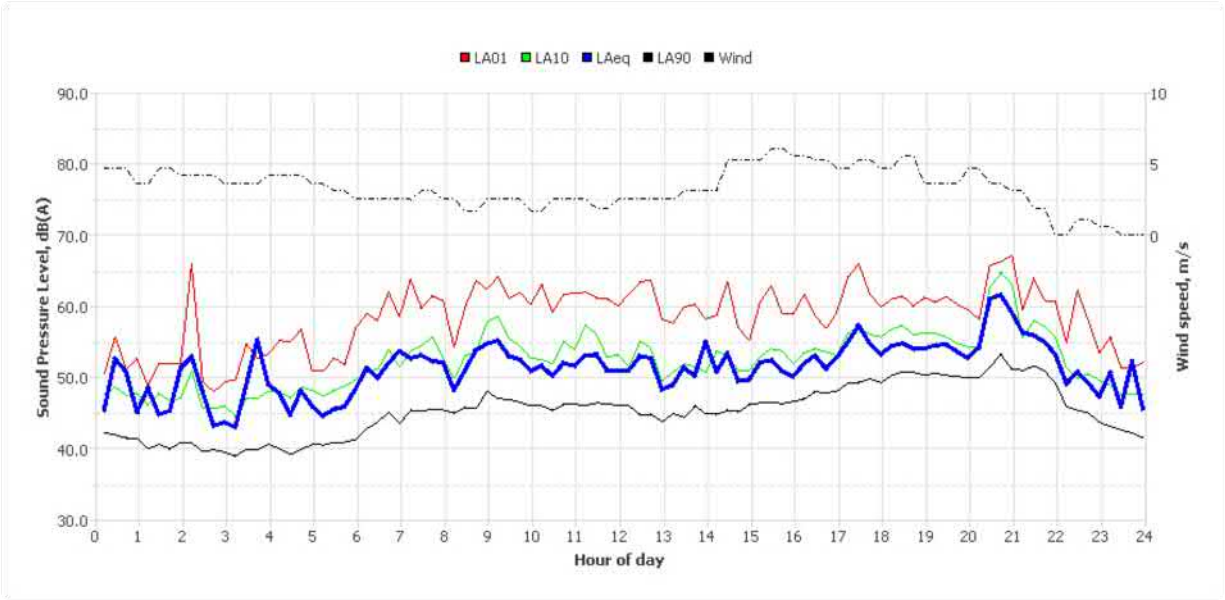
Wednesday, 27 Nov 2019



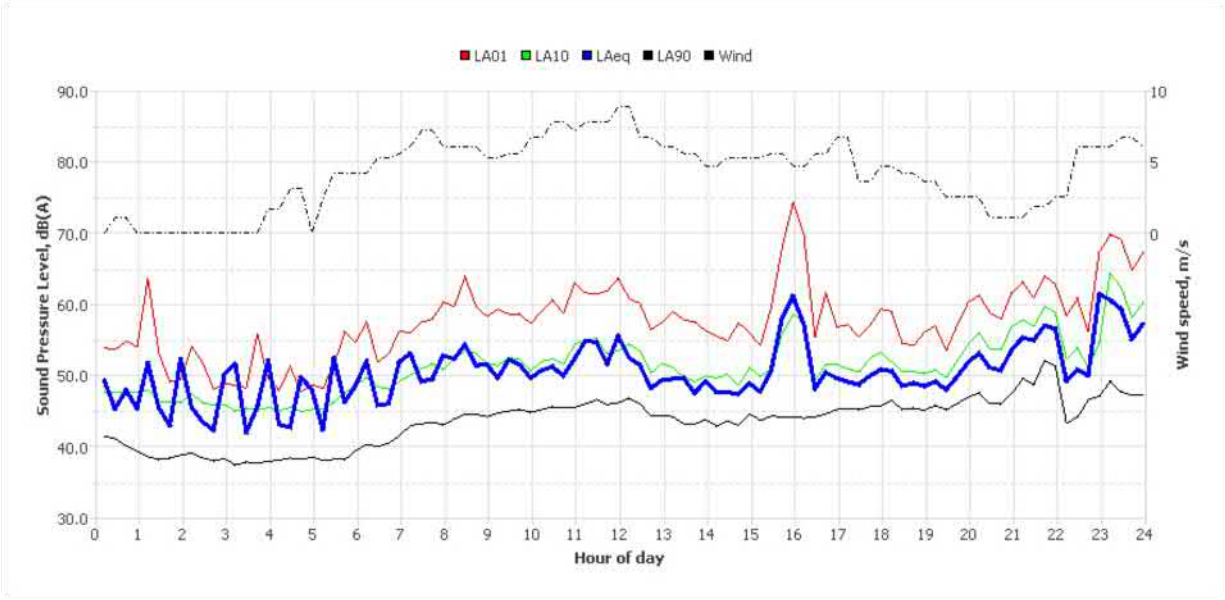
Thursday, 28 Nov 2019



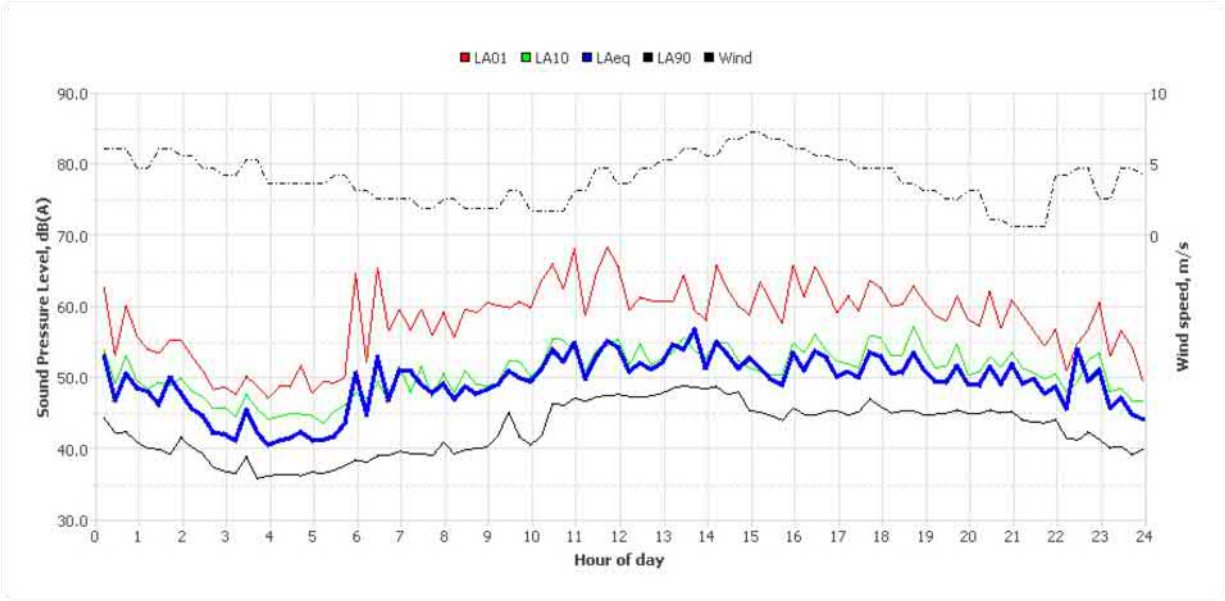
Friday, 29 Nov 2019



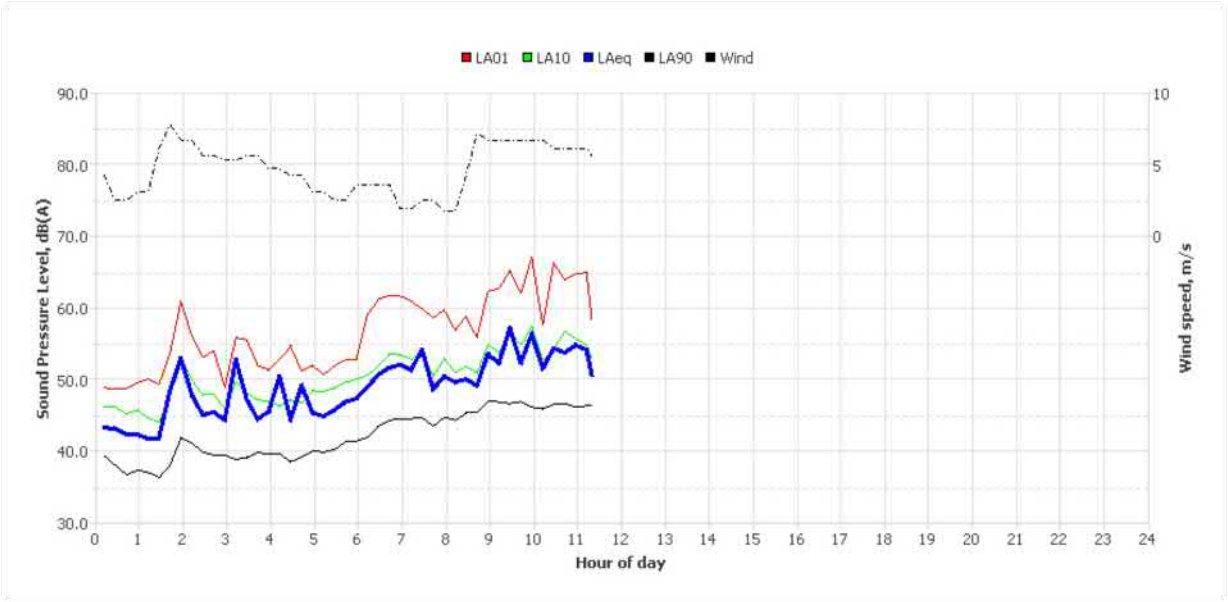
Saturday, 30 Nov 2019



Sunday, 01 Dec 2019

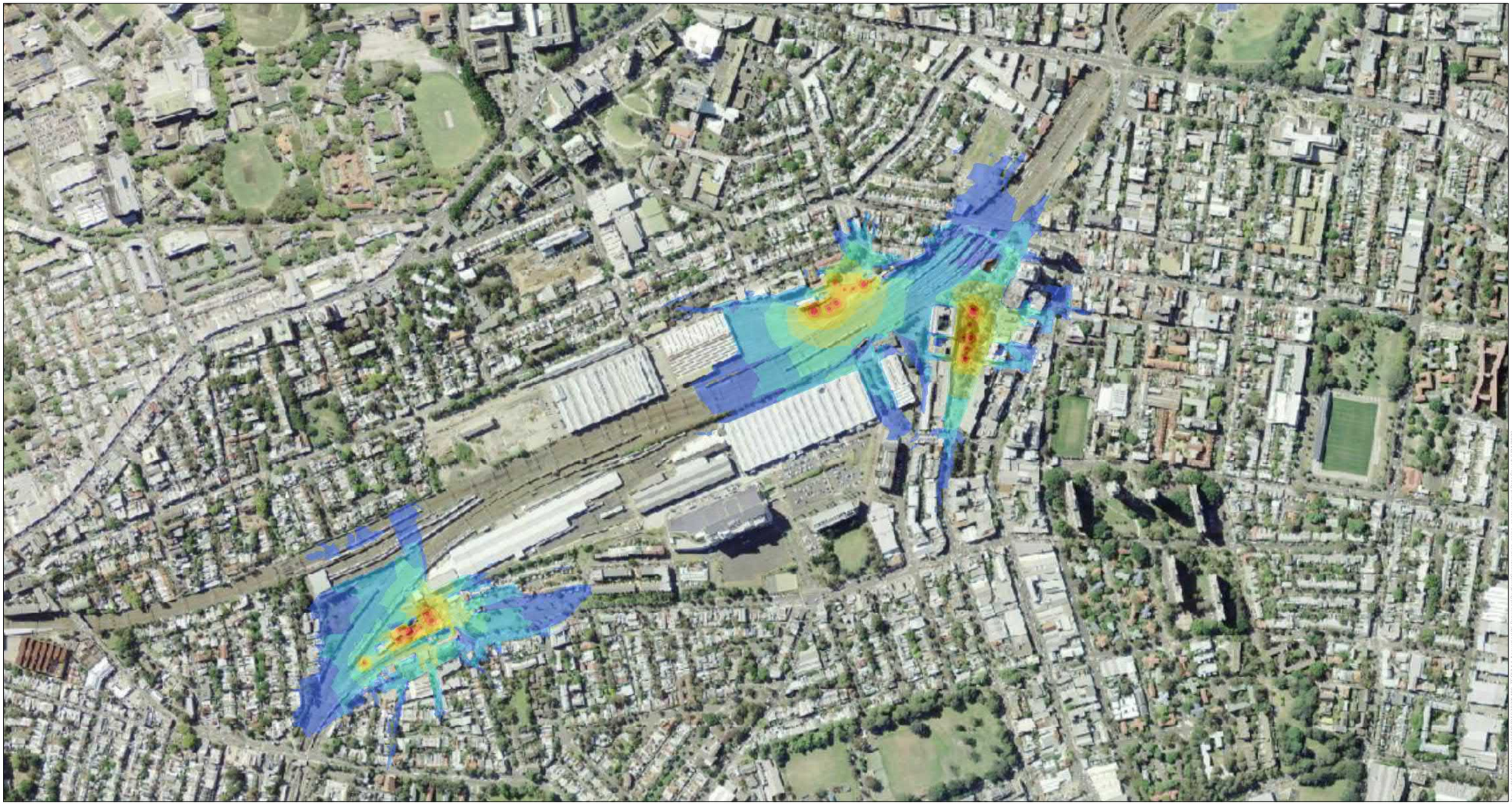


Monday, 02 Dec 2019



Appendix B

Predicted Construction Noise Contours



Predicted Construction Noise Levels - Stage 1 - Site establishment and enabling works

N

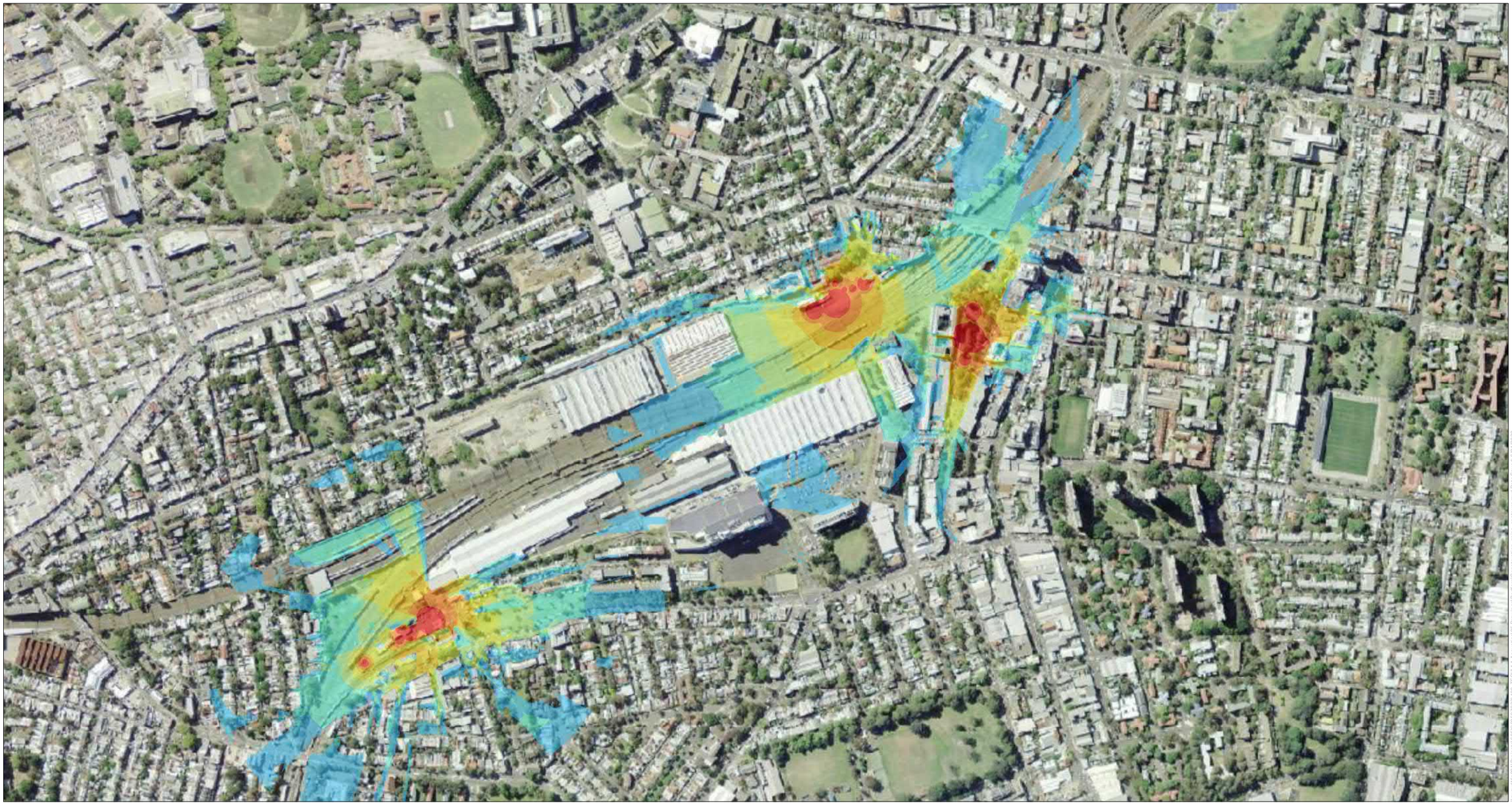
0 0.1 0.2 km

AECOM

Sound Pressure Level, L_{Aeq} dB(A)

< 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | 75 - 80 | > 80

Source:



Predicted Construction Noise Levels - Stage 1 - Site establishment and enabling works (Lmax night)

N

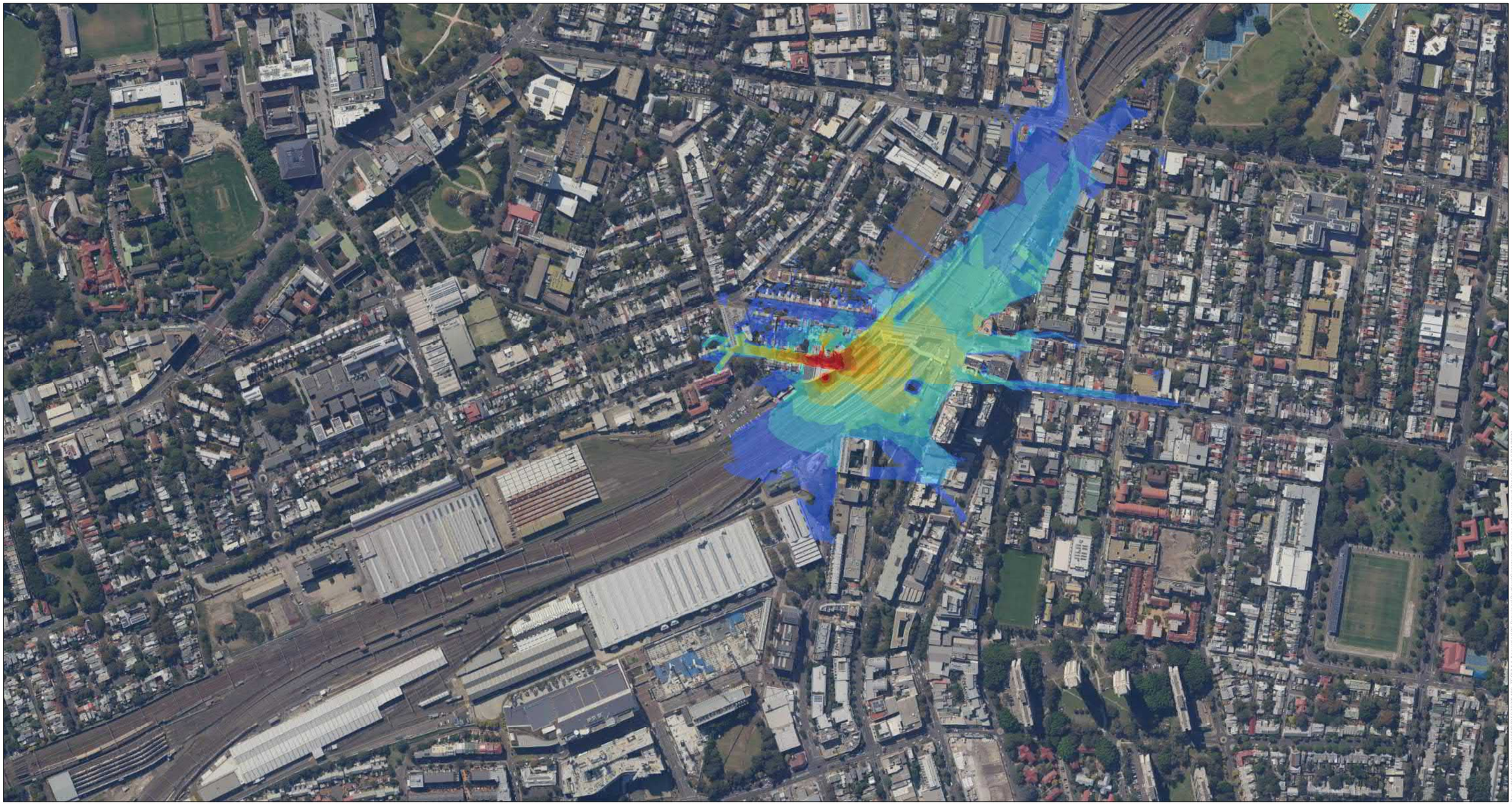
0 0.1 0.2 km

AECOM

Sound Pressure Level, L_{Max} dB(A)

<50 50 - 55 55 - 60 60 - 65 65 - 70 70 - 75 75 - 80 >80

Source:



Predicted Construction Noise Levels - Stage 2 - Building modification works

Sound Pressure Level, L_{Aeq} dB(A)

< 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

N

0 0.085 0.17 km

AECOM

Source:

Predicted Construction Noise Levels - Stage 3 - Utility and overhead wiring relocations

Sound Pressure Level, L_{Aeq} dB(A)

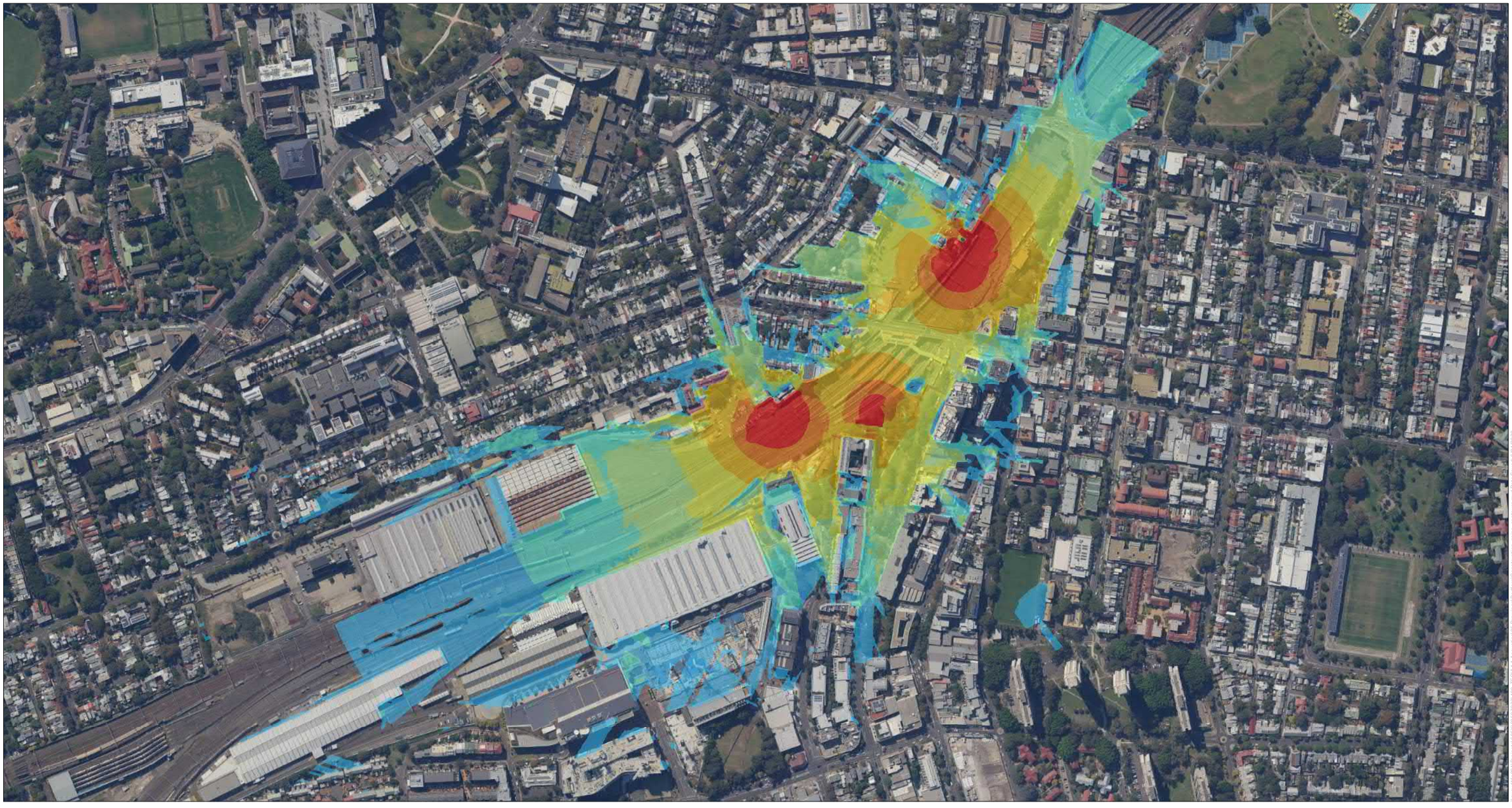
< 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

N

0 0.085 0.17 km

AECOM

Source:



Predicted Construction Noise Levels - Stage 3 - Utility and overhead wiring relocations (Lmax night)

N

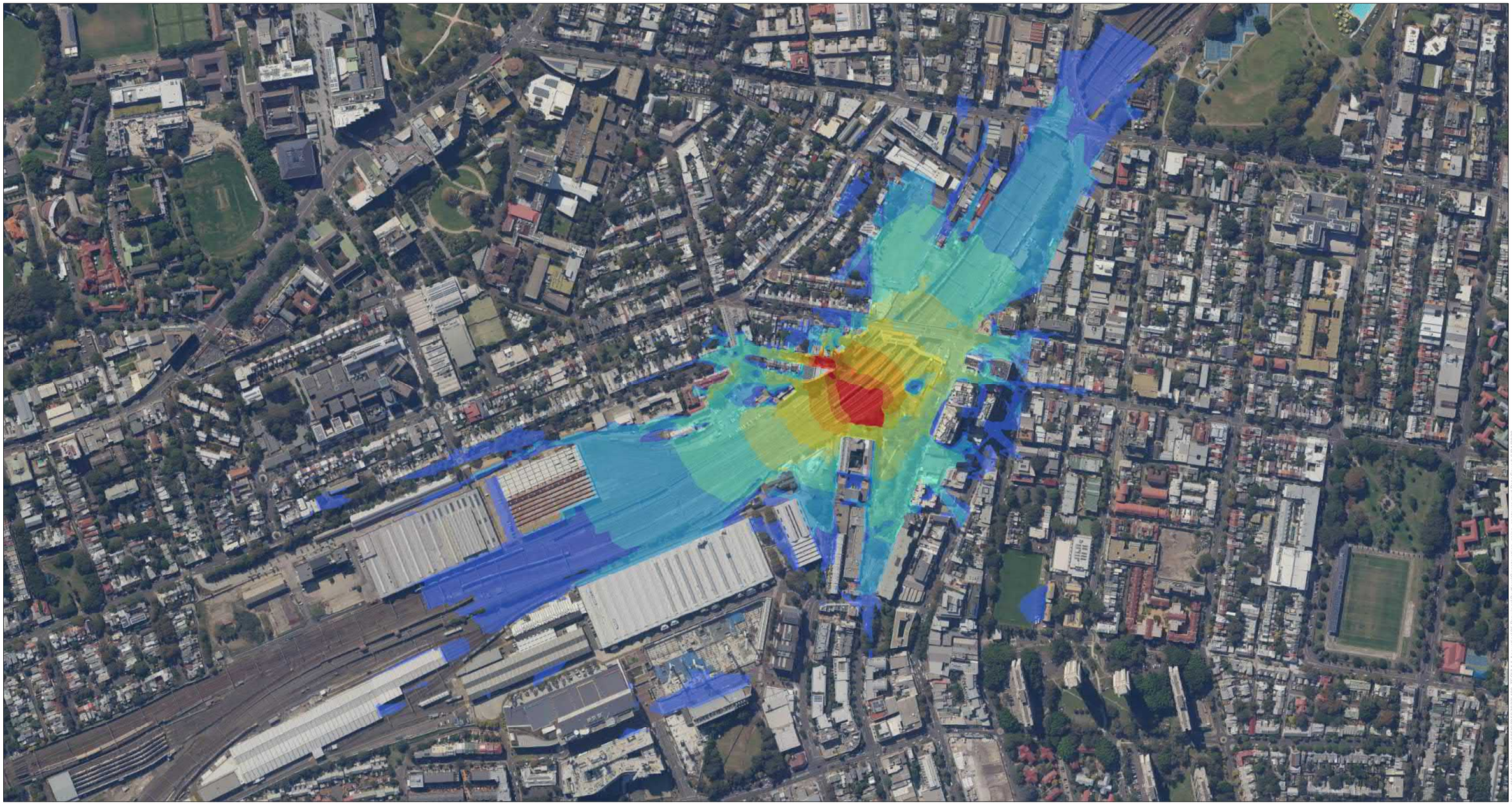
0 0.085 0.17 km

AECOM

Sound Pressure Level, L_{Max} dB(A)

< 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | 75 - 80 | > 80

Source:



Predicted Construction Noise Levels - Stage 4 - Main construction works

N

0 0.085 0.17 km

AECOM

Sound Pressure Level, L_{Aeq} dB(A)

< 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | 75 - 80 | > 80

Source:

Predicted Construction Noise Levels - Stage 4 - Main construction works (Lmax night)

Sound Pressure Level, L_{Max} dB(A)

< 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

N

0 0.085 0.17 km

AECOM

Source:

Predicted Construction Noise Levels - Stage 5 - Roadworks

Sound Pressure Level, L_{Aeq} dB(A)

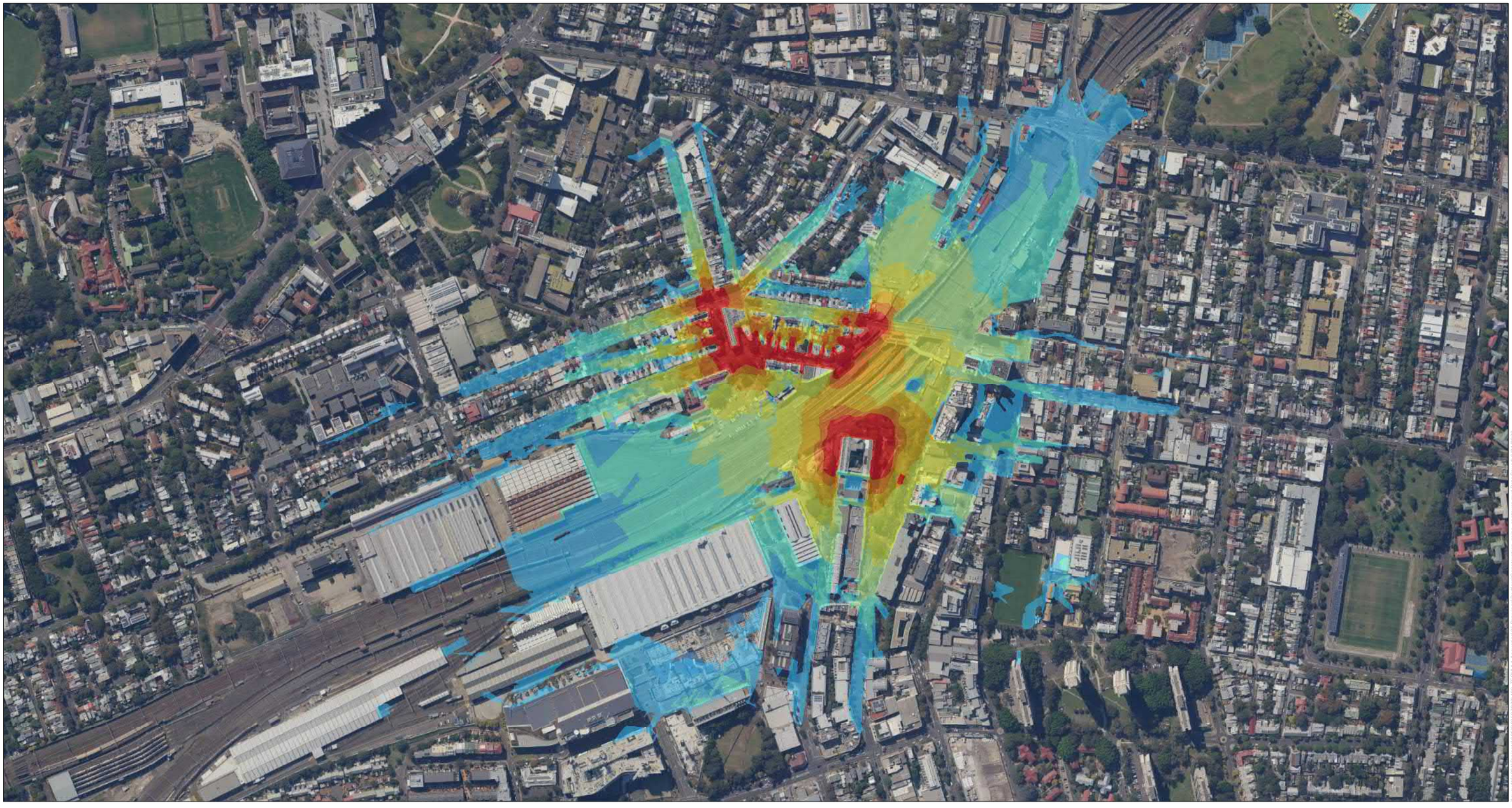
< 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
75 - 80
> 80

N

0 0.085 0.17 km

AECOM

Source:



Predicted Construction Noise Levels - Stage 5 - Roadworks (Lmax night)

N

0 0.085 0.17 km

AECOM

Sound Pressure Level, L_{Max} dB(A)

< 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | 75 - 80 | > 80

Source: