Transport for NSW

ZEB Macquarie Park Bus Depot Noise and Vibration Impact Assessment

April 2024

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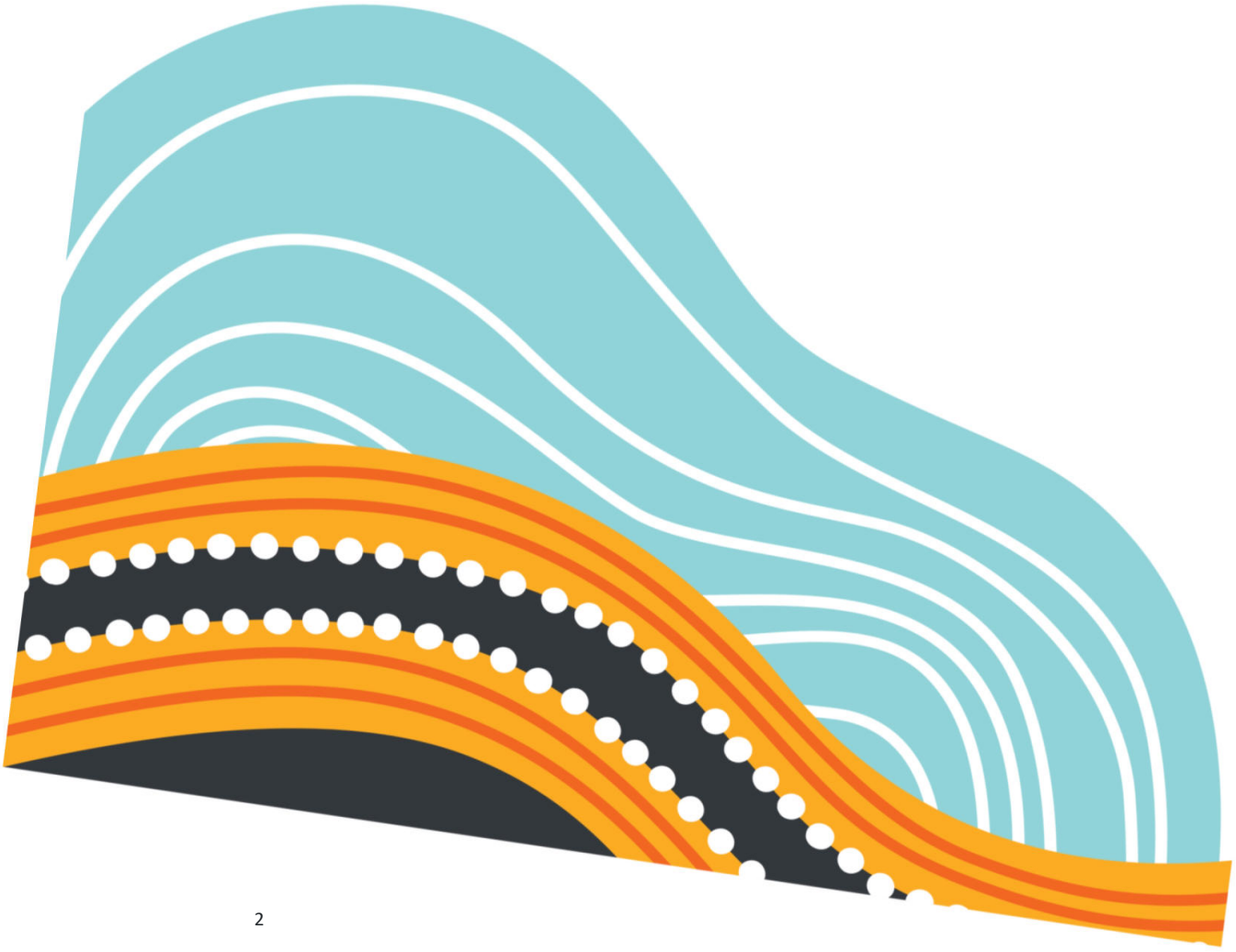
Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the land, waters and seas and their rich contribution to society.



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Report controls

Approval and authorisation

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Draft 1	05/03/2024	Jack Liang	Michael Allan
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1. Introduction

Transport proposes to construct a new ZEB depot at 1A and 1B Talavera Road, Macquarie Park.

Key features of the proposal would include:

- building new facilities to support future bus operations including:
  - a single-level underground staff and visitor car park accommodating up to 163 cars including accessible parking spaces, car share spaces, electric vehicle spaces with charging equipment and bike storage options.
  - a multilevel administration office featuring a wide selection of office spaces and staff facilities including end of trip facilities, a first aid room, social breakout and gaming rooms, and an outdoor rooftop garden.
  - a bus maintenance facility accommodating up to 30 staff and featuring a spray booth, inspection pits and a multilevel staff facility including an outdoor BBQ area, a kitchen and toilet facilities.
  - a designated bus wash bay with washing and water recycling equipment
- removal of the existing one-way bike path connection between the M2 motorway and Talavera Road to make way for the new bus maintenance facility
- delivering up to 165 bus parking spaces including:
  - 129 charging bays for 12.5 metre standard rigid buses
  - 22 charging bays for 19 metre articulated buses
  - 14 maintenance bays
- one breakdown bay
- one bus wash bay
- installation of gantries to facilitate the preferred bus arrangement and charging structure
- installation of standard 75kW and fast 150kW plug-in chargers for buses around the depot
- upgrading Pittwater Road to enable two-way bus access to and from the bus depot
- essential fire services such as hydrant and sprinkler system, a fire control room and pump building, smoke detection and warning systems, hardstand area for one fire truck, portable fire extinguishers and fire blankets
- installation of new pedestrian crossing and footpaths, security booths, fencing and lighting

1.1 Scope of this report

This report provides a Noise and Vibration Impact Assessment (NVIA) for the proposal. This NVIA is required to address noise and vibration impacts that have the potential to be generated by the proposal.

This report:

- Identifies the existing noise sensitive receivers,
- Presents details about existing noise environment,
- Identifies the applicable NSW noise and vibration policies and applicable construction and operational design criteria,
- Assesses the construction and operational noise and vibration impacts in accordance with the applicable NSW policies; and
- Provides construction and operational noise and vibration mitigation and management measures to comply with the applicable design criteria.

2. Location

The Macquarie Park new depot site's address is 1A-B Talavera Road, Macquarie Park NSW 2113.

The site covers lots: Lot 12 / DP883750; Lot 13 / DP 883750; Lot 25 / DP232697; Lot 27 / DP232964 and Lot 105 / DP1001474. The total area of the site is 24,662m^2.

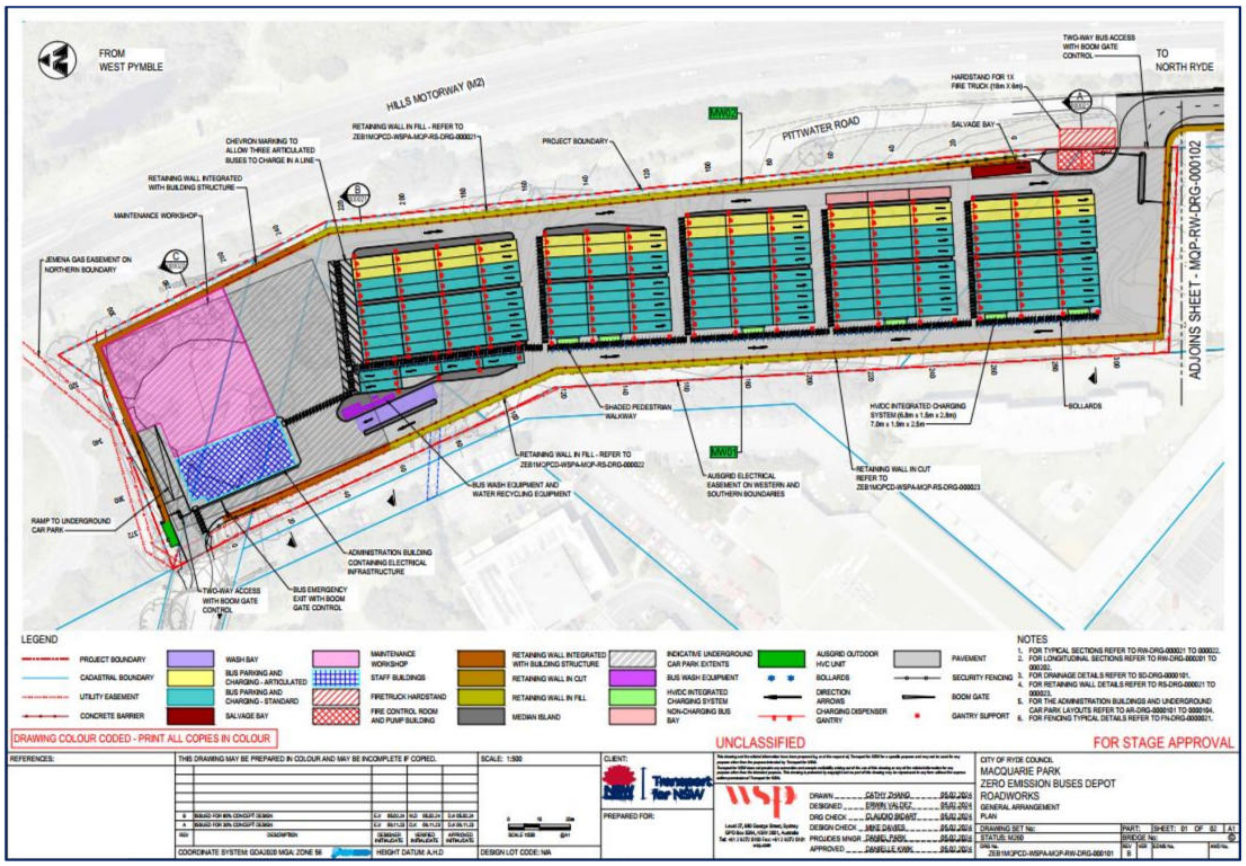


Figure 2-1: Location

The site is located adjacent to the M2 Motorway to the east and the Macquarie Park commercial precinct to the north, south, and west. Presented below in Figure 2-2 is an illustration of the site location in context of the nearest sensitive receivers.

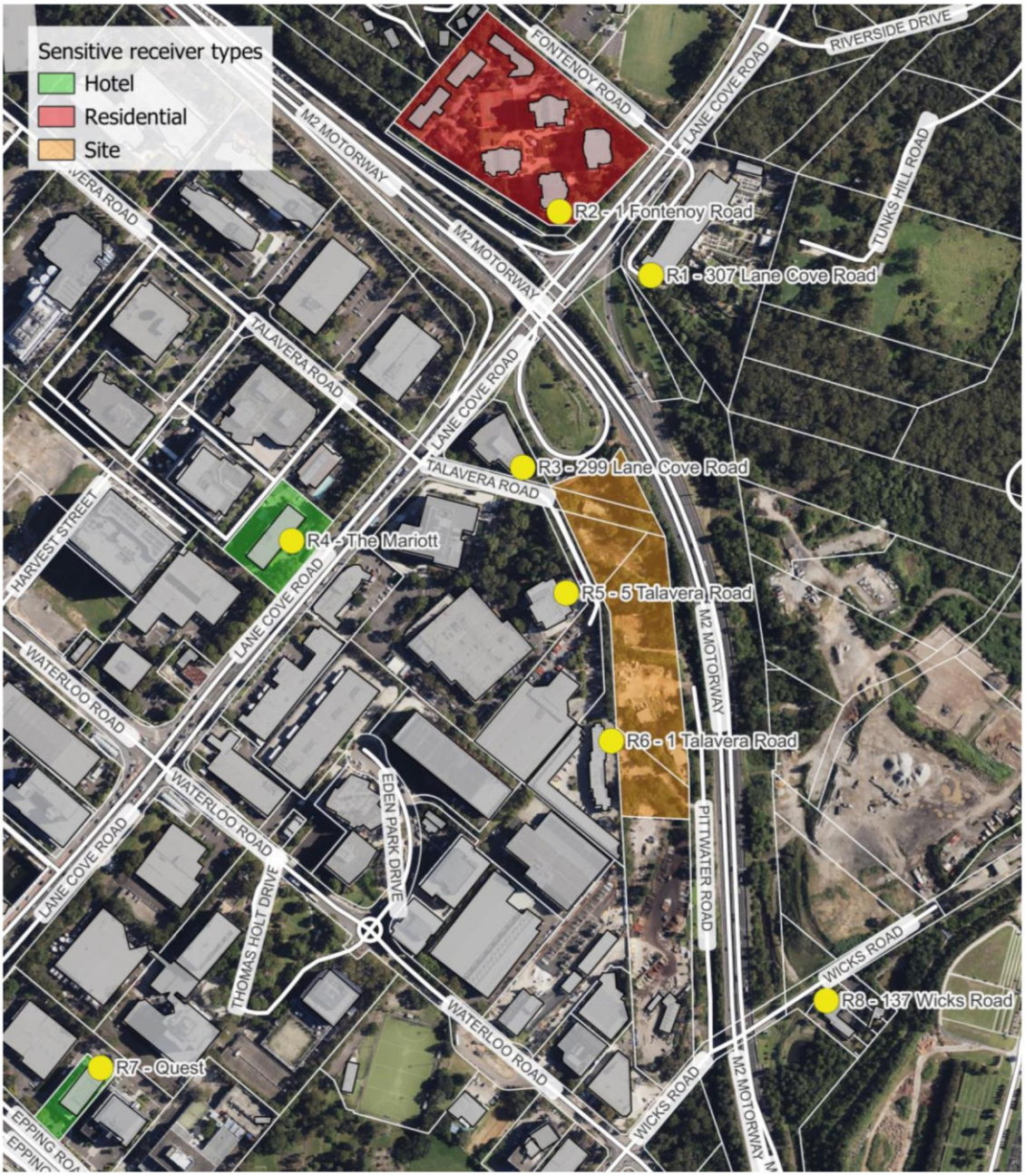


Figure 2-2: Sensitive receiver locations

Located directly to the north is the only group of residential receivers, 1 Fontenoy Road, residential towers which overlook the M2 Hills Motorway and Lane Cove Road. The Marriott Hotel (R4) is located to the west, and Quest apartments are located to the south-west.

The noise environment for all sensitive receivers is controlled by significant amounts of road traffic noise from the M2 Hills Motorway and Lane Cove Road. The noise environment throughout the assessment is considered to be Urban due to the high traffic volumes controlling the road traffic noise levels.

3. Existing ambient noise environment

3.1 Noise monitoring and analysis

Background noise logging was undertaken at one location from 8 to 18 December 2023. The noise logging data has been measured, analysed and reported in accordance with Australian Standard 1055:2018 Acoustics - Description and measurement of environmental noise and the EPAs NPfI.

The noise logger location is illustrated in Appendix A and has been selected to measure the existing noise environment representative of the nearby residential receivers.

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver. It is the 90th percentile of the daily background noise levels during each assessment period, being day, evening and night. The $L_{Aeq,period}$ is the ambient noise level (logarithmically averaged) over the defined period.

The standard measurement periods used in NSW for site noise impacts are:

- Daytime – 7 am to 6 pm
- Evening – 6 pm to 10 pm
- Night-time – 10 pm to 7 am

Presented in Table 3-1 is a summary of the ambient and RBL noise levels measured over the entire measurement period. Noise logging charts are presented in Appendix B. These noise levels are used throughout the assessment to determine the existing noise environment and establish appropriate site-specific noise criteria.

Table 3-1: Measured ambient noise levels, dB(A)

ID	Address	**Rating background level**			Ambient noise level, $L_{Aeq,15min}$		
		Daytime	Evening	Night-time	Daytime	Evening	Night-time
L01	1 Fontenoy Road, Macquarie Park	64	61	57	67	65	63

4. Operational noise assessment

4.1 Noise criteria

4.1.1 Operational facility noise criteria

Noise Policy for Industry

Responsibility for the control of noise emissions in New South Wales is vested in Local Government and the NSW Environment Protection Authority (EPA).

The EPA's NSW Noise Policy for Industry (NPfI) provides guidance on appropriate noise levels for external noise emissions from fixed facilities on surrounding sensitive receivers. The NPfI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity of defined land uses for residents and sensitive receivers in other land uses.

The intrusiveness noise level protects against significant changes in noise, while the amenity noise level seeks to protect against cumulative noise impacts from industry. Together, these levels are used to assess the potential impact of noise and assess reasonable and feasible noise mitigation measures. Project noise trigger levels are developed through this process. They are not used directly as regulatory limits.

The NPfI requires a project to take consideration of other industrial noise sources in setting amenity noise objectives. In cases of a new development where there are no existing industrial sources, the NPfI accepts a default of the amenity noise level minus 5 dB to take account of future industrial sources.

For this project, the default amenity noise level minus 5 dB adjustment will be used to account for cumulative noise sources.

Intrusive noise impacts – residential receivers

The intrusiveness noise level protects against significant changes in noise levels and is applicable to residential receivers only. The criterion is defined by the formula:

$$L_{Aeq,15min} = rating\ background\ noise\ level + 5\ dB$$

The RBL is the average background noise level over a measurement period of at least one week. Using the RBL results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

Presented below in Table 4-1 is a summary of the measured RBL and corresponding intrusiveness level for each time period.

Table 4-1: Intrusive noise criteria, dB(A)

ID	Rating background level			Intrusive noise level, $L_{Aeq,15min}$		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
L01	64	61	57	69	66	62

Protecting noise amenity

The amenity noise level seeks to protect against cumulative noise impacts from industry.

The NPfI uses project noise trigger levels measured over a 15-minute time period, assessed as an $L_{Aeq,15min}$. To account for converting $L_{Aeq,period}$ to $L_{Aeq,15min}$, the NPfI accepts a default conversion factor of $L_{Aeq,15min} = L_{Aeq,period} + 3dB$.

To ensure industrial noise levels do not gradually increase with new developments, a minus 5 dB correction is applied to the amenity noise level. The amenity noise levels have been presented in Table 4-2.

Table 4-2: Noise Policy for Industry Amenity noise levels, dB(A)

Receiver	Noise amenity area	**Time of day**	Recommended amenity noise level
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day		
School classroom	All	Noisiest 1-hour period	35 internal
Hospital ward	All	Noisiest 1-hour period	35 internal
50 external			
Place of worship	All	When in use	40
Passive recreation	All	When in use	50
Active recreation	All	When in use	55
Commercial	All	When in use	65
Industrial	All	When in use	70
Industrial interface	Add 5 dB(A) to recommended noise amenity area		

Presented in Table 2.3 of the NPfI is a more detailed description of receiver categories.

The residential receivers are zoned within a R4 High Density Residential land zoning category. The NPfI considers R4 to be Urban, which is an area with an acoustical environment that:

- is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources,
- has through-traffic with characteristically heavy and continuous traffic flows during peak periods,
- is near commercial districts or industrial districts; and
- has any combination of the above.

Project amenity noise criteria

The applicable amenity noise criteria for each zone are presented below in Table 4-3.

The NPfI uses project noise trigger levels measured over a 15-minute time period, assessed as an $L_{Aeq,15min}$. To account for converting the amenity $L_{Aeq,period}$ to an $L_{Aeq,15min}$, the NPfI accepts a default conversion factor of $L_{Aeq,15min} = L_{Aeq,period} + 3dB$. To ensure industrial noise levels do not gradually increase with new developments, a minus 5 dB correction is applied to the amenity noise level. Both these corrections have been included in the amenity noise levels below.

Table 4-3: Noise Policy for Industry Amenity noise levels, dB(A)

NPfI Category	Daytime	Evening	Night-time
Urban residential	58	48	43
Hotels	63	53	48
Passive recreation	48 (when in use)		
Commercial	63 (when in use)		
Industrial	68 (when in use)		

Corrections for annoying noise characteristics

Table C1 of the NPfI provides corrections for tonality, intermittency, irregularity or dominant low-frequency content. These corrections are to be added to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. NPfI also provides adjustments for duration that can increase the project noise criterion for unusual or one-off high-noise level events.

Low frequency noise correction

A difference of 15 dB or more between the C- and A-weighted noise measurements, identifies the potential for an unbalanced spectrum and an increased likelihood of low frequency noise annoyance.

The difference between C- and A-weighted noise levels is typically used as a screening tool to determine if further investigation is required. Where further investigation confirms significant low frequency content, a low frequency noise correction is applied to the predicted or measured noise levels.

The NPfI identifies that the corrections should “reflect external assessment locations”, or sensitive receiver locations so the existing noise environment should be considered.

Project specific noise trigger levels

The project specific noise trigger levels (PSNTLs) for residential receivers is the more stringent of the intrusiveness and amenity noise criteria. For other receivers the PSNTLs are the amenity noise criteria.

Presented below in Table 4-4 is a summary of this assessments PSNTLs.

Table 4-4: Project specific noise trigger levels, dB(A)

Receiver type	Time period	RBL	Intrusiveness	Amenity[1]	Overall[2]
Residential	Daytime	64	69	53	53
	Evening	61	66	43	43
	Night-time	57	62	38	38
Hotel	Daytime	Not applicable	Not applicable	58	58
	Evening	Not applicable	Not applicable	48	48
	Night-time	Not applicable	Not applicable	43	43

Receiver type	Time period	RBL	Intrusiveness	Amenity[1]	Overall[2]
Commercial	When in use	Not applicable	Not applicable	63	63
Industrial	When in use	Not applicable	Not applicable	68	68

Note 1 The amenity noise level has been reduced by 5 dB(A) to account for other industrial noise sources and increased by 3 dB(A) to convert from $L_{Aeq,period}$ to $L_{Aeq,15minute}$

Note 2 The overall noise level is the more stringent of the intrusiveness and amenity criteria

4.1.2 Road generating development – road traffic noise

Industrial developments have the potential to generate additional road traffic and associated noise impacts from the vehicles accessing the site. The NSW Road Noise Policy provides guidance on appropriate noise criteria which should be considered.

Presented below are the applicable noise criteria for road traffic on arterial roads.

Table 4-5: Road generating development noise criteria, dB(A)

Road category	Type of project / land use	Assessment criteria, dB(A)	
		Daytime (7am to 10pm)	**Night-time (10pm to 7am)**
Freeway /arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq\ (15\ hour)}$ 60 (external)	$L_{Aeq\ (9\ hour)}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq\ (1\ hour)}$ 55 (external)	$L_{Aeq\ (1\ hour)}$ 50 (external)

Where the predicted noise levels with the proposal indicate likelihood to exceed the noise criteria presented in Table 4-5, it is considered not reasonable and feasible to provide noise mitigation measures if the proposal does not increase noise by greater than 2.0 dB. A change of 2 dB to 3 dB in road traffic noise is often considered to be indiscernible.

4.1.3 Maximum noise level assessment

During night-time periods, increased night-time noise levels have the potential to create sleep disturbance noise impacts.

The NPfI identifies the amenity noise level, discussed in Section 4.1.1, '*will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance'*. However further guidance is provided in Section 2.5 of the NPfI, which requires consideration of maximum noise level events. This approach provides a screening criterion. The NPfI identifies that where the screening criterion is exceeded, a detailed maximum noise level event assessment should be undertaken.

The sleep disturbance screening noise criteria are:

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

These screening criteria were developed based on a review of research provided by the EPA's NSW Road Noise Policy. The detailed assessment should consider all feasible and reasonable noise mitigation measures with a goal of achieving the above trigger levels.

4.2 Operational noise assessment

4.2.1 Modelling methodology

Site operational noise emissions have been calculated using the CONCAWE algorithm. The CONCAWE algorithm has been selected to ensure that noise enhancing weather conditions including temperature inversions and downwind conditions have been appropriately considered in the noise assessment. These effects are particularly important for this site. The nearest sensitive receivers will be shielded from most impacts by the adjacent industrial buildings, however with temperature inversions the shielding effects may be reduced for receivers further away from the site.

A worst-case assessment has been completed assessing the adverse weather conditions in all directions. The following weather conditions have been included in the assessment, in accordance with the requirements of the NPfI.

Standard meteorological conditions:

- 0.5 m/s wind speeds; and
- Stability category D.

This is equivalent to CONCAWE Meteorological Category 4

Daytime and evening noise enhancing properties:

- 3 m/s wind speeds; and
- Stability category D.

This is equivalent to CONCAWE Meteorological Category 5

Night-time noise enhancing properties:

- 2 m/s wind speeds; and
- Stability category F.

This is equivalent to CONCAWE Meteorological Category 6 (the highest category)

4.2.2 Operational site noise emissions

Noise generating features of the site would include:

- Space for a total of 165 buses on the depot site, including:
  - 129 standard bus charging bays
  - 22 articulated bus charging bays
  - maintenance workshop would provide space for 14 buses, comprising spaces for spray booth, and inspection pits
- bus wash bay
- Rectifier transformers from 1.2 MVA to 3.3MVA
- Office and facilities for 30 workers with key noise emitting plant including:
  - Air conditioning for buildings
  - Carpark exhaust
  - Electrical and plant room ventilation
- on-site parking for 163 cars

The greatest noise source would generally be generated from buses entering and leaving the site. The traffic and transport assessment has identified the future peak movements:

- AM peak max = 63 buses/hr out (6.45-7.45am), 40 buses/hr in (9-10am)

- PM peak max = 54 buses/hr out (2.30-3.30pm), 38 buses/hr in (6.00-7.00pm)

Light vehicle movements

- AM peak max = 40 cars/hr out (9-10am), 63 cars/hr in (7-8am)
- PM peak max = 42 cars/hr out (3.45-4.45pm), 54 cars/hr in (2.15-3.15pm).

Source noise emission levels

Presented below is a summary of the source noise levels incorporated in this assessment. Electric bus idling and passby noise measurements were undertaken at Leichardt bus depot. The noise measurements noted there was an audible hum associated with the acceleration of the vehicles, and air-conditioning dominated the stationary noise. The measured noise levels were consistent with the Acoustic Vehicle Alerting System (AVAS) maximum sound power levels provided by UN Regulation No. 138, *Uniform provisions concerning the approval of Quiet Road Transport Vehicles with regard to their reduced audibility.*

Table 4-6: Road generating development noise criteria, dB(A)

Source	Description	15-minute noise level, L_{Aeq} dB(A)	Maximum noise level, L_{AFmax}
Rectifier transformer	Noise level for conservatively large rectifier transformers	74	75
AC Condenser Units	Typical noise generated by commercial condenser units	85	87
Ventilation fans	Ventilation fans would be required on undercover carparks and the maintenance workshop	100	102
Light Vehicles	Typical light vehicle noise level operating within the carpark	94	101
Electric buses idling	Measured idling electric bus, including AC unit noise	90	92
Electric buses moving	Measured moving electric bus, including noise generated by AC unit and Acoustic Vehicle Alerting System (AVAS)	95	104
Spray booth	Assumed to be operating during the daytime period only	83	95
Maintenance workshop	Operational 24/7	90	108
Bus wash	Operational 24/7	86	94

The noise model has assessed the total number of vehicle movements leaving and exiting the site (i.e. arrival and departure movements) to complete a full lap of the site within a 15-minute period. This is a conservative assumption made to ensure that the greatest noise impacts are considered. The workshop, bus wash, and all mechanical services equipment have also been assumed to be operating during all assessment periods.

4.2.3 Annoying characteristics of noise

The NPfI requires annoying characteristics of noise to be taken into consideration in the assessment of noise. Annoying characteristics include:

- Tonal noise – noise containing a prominent frequency and characterised by a defined pitch.
- Low frequency noise – where a source has a significant component of noise in the 10 – 160 Hz range
- Intermittent noise – where the noise source at the receiver varies by more than 5 dB(A)

For the characteristics to be relevant, they must be assessed at the receiver location, so the propagation characteristics of noise and existing ambient noise level should be taken into consideration.

The site has been arranged so that the buses will not need to reverse and engage the reversing alarm. Site emissions are not considered to generated annoying characteristics. Penalties have not been included in the assessment to account for annoying characteristics.

Assessment scenarios

Three separate assessment scenarios have been considered, daytime, evening, and night-time. During each assessment all mechanical plant, including the maintenance workshop and wash bay have been assumed to be operating. During the night-time period it has been assumed that AC units would operate in night mode. Vehicle movements have been based on the bus movement timetable provided by the WSP Traffic Assessment. Half the number of movements in a hour period have been assumed to occur in a 15 minute period.

The assessed scenario considers the following movements in a 15minute period:

- Daytime – 28 buses departing, 32 light vehicles arriving / departing
- Evening – 19 buses arriving, 10 light vehicles arriving / departing
- Night-time – 24 buses departing, 10 light vehicles arriving / departing

4.2.4 Predicted noise impacts

Presented below is a summary of the worst-case daytime, evening, and night-time noise impacts during each period. Noise contours are presented in Appendix B.

Table 4-7: Daytime predicted noise levels, $L_{Aeq,15min}$ dB(A)

ID	Address	Criteria	$L_{Aeq,15min}$ noise level	Exceedance
R1	307 Lane Cove Road	63	42	-
R2	1 Fontenoy Road	53	39	-
R3	299 Lane Cove Road	63	48	-
R4	Marriott	58	39	-
R5	5 Talavera Road	63	52	-
R6	1 Talavera Road	63	45	-
R7	Quest	58	33	-
R8	137 Wicks Road	63	36	-

Table 4-8: Evening predicted noise levels, $L_{Aeq,15min}$ dB(A)

ID	Address	Criteria	$L_{Aeq,15min}$ noise level	Exceedance
R1	307 Lane Cove Road	63	42	-
R2	1 Fontenoy Road	48	39	-
R3	299 Lane Cove Road	63	48	-
R4	Marriott	48	39	-
R5	5 Talavera Road	63	52	-
R6	1 Talavera Road	63	45	-
R7	Quest	48	33	-

ID	Address	Criteria	$L_{Aeq,15min}$ noise level	Exceedance
R8	137 Wicks Road	63	36	-

Table 4-9: Night-time predicted noise levels, $L_{Aeq,15min}$ dB(A)

ID	Address	Criteria	$L_{Aeq,15min}$ noise level	Exceedance
R1	307 Lane Cove Road	63	39	-
R2	1 Fontenoy Road	43	36	-
R3	299 Lane Cove Road	63	45	-
R4	Marriott	48	37	-
R5	5 Talavera Road	63	51	-
R6	1 Talavera Road	63	44	-
R7	Quest	48	31	-
R8	137 Wicks Road	63	35	-

The predicted noise levels presented in Table 4-7,Table 4-8, and Table 4-9 indicates that compliance with the applicable noise criteria would be achieved during all time periods. Further consideration of noise mitigation measures is not required.

4.2.5 Maximum noise level assessment

Maximum noise levels have been predicted for the night-time period based on the source noise levels in Section 4.2.2. Presented below in Table 4-10 is a summary of the predicted L_{AFmax} noise levels, and the receiver specific screening criterion. An exceedance of the screening criterion indicates the potential for sleep disturbance to be an issue which would require further investigation.

Table 4-10: Night-time predicted maximum noise levels, L_{AFmax} dB(A)

ID	Address	Screening criterion	L_{AFmax} noise level	Exceedance
R1	307 Lane Cove Road	Not applicable	49	-
R2	1 Fontenoy Road	72	48	-
R3	299 Lane Cove Road	Not applicable	64	-
R4	Marriott	72	48	-
R5	5 Talavera Road	Not applicable	69	-
R6	1 Talavera Road	Not applicable	69	-
R7	Quest	72	47	-
R8	137 Wicks Road	Not applicable	35	-

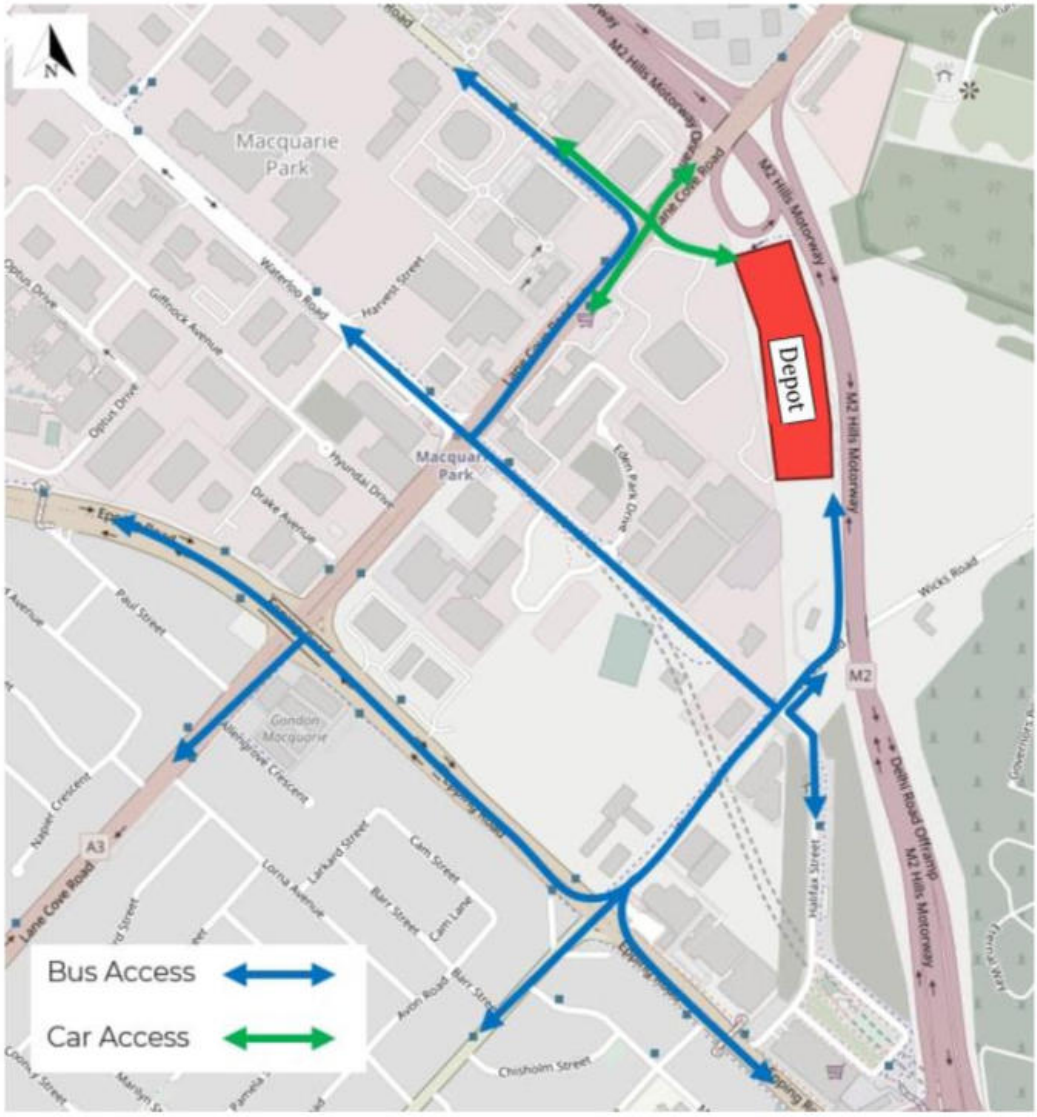
The results in Table 4-10 indicate that due to the existing high levels of background noise in the area and the limited noise generated by the site, sleep disturbance noise impacts are unlikely to be a concern for this project. Further consideration of noise mitigation measures is not required.

4.2.6 Operational road traffic

The purpose of this project is to store and charge buses while they are not in use. The nature of the proposal is to add vehicles to the road network which has the potential to increase road traffic noise. The site is in close proximity to major arterial roads, and away from noise sensitive receivers. Arterial roads such as Lane Cove Road and Epping Road have existing high traffic volumes which exceed the Road Noise Policy for the nearest residential receivers. However, the additional volumes this project will add to the network are comparatively small which typically results in very small changes in noise.

Light vehicles would access Lane Cove Road from Talavera Road. Buses would access Lane Cove Road from Waterloo Road, and Epping Road from Wicks Road. In both instances the buses do not pass residential receivers until they have joined the arterial roads. Presented below is an illustration of the bus and light vehicle access routes.

Figure 3 Bus and light vehicle access routes



A conservative screening assessment has been undertaken, assessing all light and heavy vehicles to access Epping Road and Lane Cove Road.

The site would add an additional 384 bus movements during the daytime, and 136 movements during the night-time. The site will provide 163 car parking spaces so has the potential to generate an additional 318 light vehicle movements on Lane Cove Road. Both Lane Cove Road and Epping Road have traffic volumes of over 40,000 vehicles a day. The change in noise from the additional movements is less than 0.1 dB. While the existing traffic noise on Epping Road and Lane Cove Road exceeds the arterial road noise criteria, the change in noise is well below 2 dB. It is not considered reasonable, nor feasible to provide noise mitigation to reduce road traffic noise impacts as part of this proposal.

5. Construction noise and vibration assessment

5.1 Existing Noise Levels

5.1.1 Sensitive Land Use

A survey of land use was conducted to identify the types of receivers and types and verify the presence of sensitive land users (including critical working areas such as operating theatres and precision laboratories) that might be susceptible to potential noise disturbances from the proposed construction work.

The existing noise environment across the proposal is dominated by road traffic noise from the M2 Hills Motorway. The local road network also contributes to background noise levels, though to a smaller extent than major roads.

The majority of sensitive receivers surrounding the site are industrial and commercial, however residential receivers are located directly to the north.

5.1.2 Noise Catchment Areas (NCA)

To assist the assessment process of the noise impact from the construction noise, noise catchment areas are identified to reflect land uses and types of receivers within each area. A description of the NCAs relevant to the works being undertaken is provided in Table 5-1: NCAs applicable to construction works. The description includes of the primary characteristics of each area. The maps for the noise catchment areas are provided in Figure 4.

Figure 4 Noise Catchment Areas

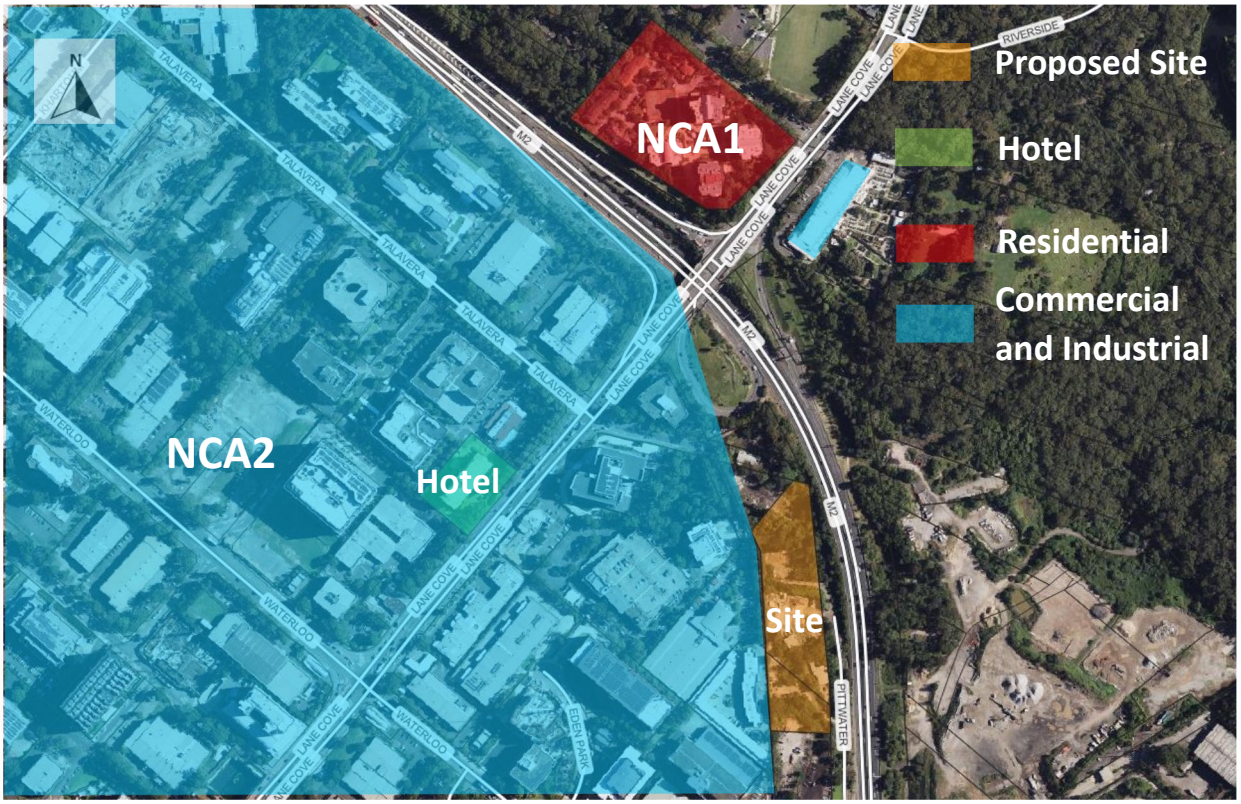


Table 5-1: NCAs applicable to construction works

NCA	Area Description
NCA1	High density residential receiver located within this noise catchment area. Residential tower located at Macquarie Gardens 1-15 Fontenoy Road, Macquarie Park. Noise sensitive receivers within this NCA potentially affected by the proposed construction work.
NCA2	The Ryde noise catchment area is dominated by commercial premises from both side of Lane Cove Road (A4). The ambient noise background level of the commercial receivers within NCA2 are mostly controlled by the traffic noise (Hills Motorway (M2) and Land Cove Road) and local industrial noise. In addition, hotel receiver courtyard by Marriott Sydney-North Ryde is located at 11 Talavera Road, North Ryde adjacent to Land Cove Road.

5.2 Relevant Noise Criteria

5.2.1 EPA Interim Construction Noise Guidelines (ICNG)

The assessment of noise impacts from construction work associated with the Macquarie Park Zero Emission Buses Depot proposal have been undertaken in accordance with the assessment and management approach outlined in the Interim Construction Noise Guidelines (ICNG). Table 2 within the ICNG sets out the noise management level at residences and restriction apply to activities which generate noise at residence above the 'highly noise affected' noise management level.

The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Noise Policy for Industrial (2017).

As a guide, the difference between the internal noise level and the external noise level is typically 10 dB with windows open for adequate ventilation.

Table 5-2: ICNG Noise Criteria

Time of Day	Management Level $L_{Aeq(15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 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

Time of Day	Management Level $L_{Aeq(15\ min)}$	How to apply
		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.
Note 1 Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.		

Airborne noise management levels (ANML) have been established for the sensitive land uses including commercial and industrial receivers. The unattended noise monitoring was performed at the residential boundary that is most exposed to the proposed construction area.

Table 5-3: Airborne Noise Management Levels (NMLs)

Time of Day	Management level L_{Aeq}(15min) dB(A)	Airborne Noise Management Levels (ANML) L_{Aeq}(15min) dB(A)
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	64 + 10 = 74 dB(A)
	Highly noise affected 75 dB(A)	75 dB(A)
	Noise affected RBL + 5 dB	61 + 5 = 66 dB(A) **Evening OOHW**
		57 + 5 = 62 dB(A) **Night-time OOHW**
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.		

Specific NMLs have been established for the proposed work based on the methodology outlined in Table 5-3.

Non-mandatory management levels for nearby property which are sensitive to noise impacts are presented in Table 5-4. The values are set to ensure that characteristic activities in each of these land uses would not be impacted by noise. The noise management levels are only applicable when the property is in use, such as classrooms or offices during working hours. When assessing noise levels, measurements are taken at the centre of occupied rooms for internal noise and at the most affected point within 50 metres of the area boundary for external noise.

Table 5-4: Noise Management Levels for other sensitive receivers

Land Use	Management Level, L_{Aeq} (15min) Applies when in use
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of worship	Internal noise level 45 dBA
Office, retail outlets	External noise level 70 dBA
Industrial premises	External noise level 75 dBA

Land Use	Management Level, L_{Aeq} (15min) Applies when in use
Active recreation areas (such as parks and sports grounds or playgrounds)	External noise level 65 dBA
Passive recreation areas (such as outdoor grounds used for teaching, outdoor cafes or restaurants)	External noise level 65 dBA

Other noise-sensitive businesses require separate specific noise goals and it is suggested in the ICNG that the internal construction noise levels at these premises are to be referenced to the 'maximum' internal levels presented in AS 2107. Recommended 'maximum' internal noise levels from AS 2107 are reproduced in Table 5-5 for other sensitive receiver types.

However, the ICNG and AS 2107 do not provide specific criteria for hotels. Hotels generally have internal and sleep areas. For these commercial receivers, where feasible and reasonable the objective should be to achieve levels for sleeping of 45 dB(A) (consistent with hospital wards/places of worship) and the external noise level objective to be set at 55 dB(A).

Table 5-5: AS 2107 Recommended Maximum Internal Noise Levels

Land Use	Time Period	AS 2107 Classification	Recommended "Maximum" Internal L_{Aeq} (dBA)
Hotel	Daytime & Evening	Bars and Lounges	50 dB(A)
	Night-time	Sleeping Area	40 dB(A)

5.3 Noise Modelling Methodology

Noise levels resulting from the proposed construction work have been predicted based on the review of the document *Macquarie Park Zero Emission Bus Depot – Constructability Report – 80% Concept Design, dated January 2024*. For each noise modelling scenario, the worst-case noise impacts have been assessed using the CONCAWE noise propagation algorithm and modelled in SoundPLAN v8.2 software. The algorithm calculates worst case downwind noise propagation and is considered appropriate for construction noise impacts in NSW.

The proposed construction schedule in section 5 of the reference document *Macquarie Park Zero Emission Bus Depot – Constructability Report – 80% Concept Design, dated January 2024* have been reviewed. Noise modelling scenarios have incorporated the proposed construction staging that stated in Table 5-6 below.

Table 5-6: Proposed Construction Staging

Stage	Activities	Site Facilities and Access
Site establishment, clearing and demolition		
1	• Removal of asbestos containing and contaminated materials • Clear and grub existing vegetation • Demolish existing structures and concrete slabs	• Establish site access via Pittwater Road and Talavera Road • Establish temporary site facilities on Pittwater Road • Establish temporary crossing of drainage line
Flood storage culvert, retaining wall MW01 and bulk earthworks		
2	• Construct new bikeway around underground car park • Construct retaining wall MW01 (CH120-CH376) • Construct retaining wall MW02 (CH0- CH70) • Earthworks bulk cut to fill around retaining wall MW01 (CH120-CH376) • Construct flood storage culvert	• Primary site access via Pittwater Road • Secondary site via Talavera Road where access is not possible across the drainage corridor from Pittwater Road • Temporary site facilities on Pittwater Road • Temporary crossing of drainage line
Bulk earthworks, retaining wall MW01 and administration building		

Stage	Activities	Site Facilities and Access
3	• Construct retaining wall MW01 (CH60-CH120) • Earthworks bulk fill around completed flood storage culvert. • Construct temporary access crossing of completed flood storage culvert and remove previous temporary crossing. • Commence construction of underground staff carpark, staff buildings and maintenance workshop.	• Primary site access via Pittwater Road • Secondary site access from Talavera Road for new staff buildings only where access is not possible across the drainage corridor from Pittwater Road. • Temporary site facilities on Pittwater Road. • Crossing of drainage corridor relocated to flood storage culvert.
Bulk earthworks, retaining wall MW02 and administration building		
4	• Construct remaining section of flood storage culvert • Construct retaining wall MW02 (CH70- CH235) • Earthworks bulk fill to remaining areas • Continue constructing underground staff carpark, staff buildings and maintenance workshop	• Primary site access via Pittwater Road • Secondary site access from Talavera Road for new staff buildings only where access is not possible across the drainage corridor from Pittwater Road • Temporary site facilities on Pittwater Road • Crossing of drainage corridor via flood storage culvert
Charging gantries and administration building		
5	• Construct charging gantries • Complete underground staff carpark, staff buildings and maintenance workshop	• Primary site access via Pittwater Road • Secondary site access from Talavera Road for new staff buildings only where access is not possible across the drainage corridor from Pittwater Road • Temporary site facilities on Pittwater Road

Each of the noise modelling scenarios is based on the construction staging presented above. The construction noise impact assessment has been prepared in accordance with the *Construction Noise and Vibration Guideline – Public Transport Infrastructure 2023* guideline. Airborne noise level has been predicted at all receivers and compared with the specified NMLs.

Where noise levels are predicted to exceed the NMLs, reasonable and feasible mitigation and work practices need to be investigated and implemented to minimise noise impacts.

Some plant and equipment emit high noise levels, known as highly noise-intensive plant. Examples include hydraulic rock breakers, concrete saws, and ballast tampers. The use of these highly noise-intensive items of plant can lead to noise levels exceeding the relevant assessment criteria, even if they are used for only short period of time. Following the methodology outlined in the ICNG, all construction plant and equipment are assumed to be operating at full power simultaneously, resulting in worst-case noise level predictions as documented later in this report. However, in practice, these levels are unlikely to be representative of the noise levels experienced by the majority of the community or over the majority of the construction period.

5.3.1 Construction Noise Sources Levels

Presented below in Table 5-7 is a summary of Sound Power Levels (Lw) of construction equipment has also been including in the noise modelling process. Each noise modelling scenario in Table 5-7 is presented with a total Sound Power Level with typical worst-case assumptions.

Table 5-7: Construction noise modelling scenarios and equipment sound power level

Scenario	Equipment	Sound Power Level, SWL dB(A)[1]
Site establishment, clearing and demolition	20-30t excavators, Semi-trailer tipper, Truck and dogs, Tub grinder/mulcher, Water truck, Motor grader, Demolition hammers, Power tools, Generators, compressors, Water pump	120
Flood storage culvert, retaining wall MW01 and bulk earthworks	Franna crane, Mobile hydraulic crane, Concrete pump, Formwork, Concrete vibrators, Power tools, Generators and air	121

Scenario	Equipment	Sound Power Level, SWL dB(A)[1]
	compressors, Water pump	
Bulk earthworks, retaining wall MW01, MW02 and administration building	Shotcrete pump, Drill rig, Formwork and falsework, 12-20t excavator, Vibrating roller, Concrete vibrators, Power tools, Generators and air compressors, Franna crane, Mobile hydraulic crane.	122
Charging gantries and administration building	Piling rig, 5-20t excavators, Franna crane, Forklift / materials handler, Mobile cranes, Self-erecting crane, Concrete pump, Formwork and falsework, Scaffolding, Concrete vibrators, Welder, Power tools, Generators and air compressors	115

Note 1 The overall sound power level is based on the equipment SWLs in Appendix C CNVG 2023, and equipment duty cycles based on typical worst-case 15 minute period operation.

In review of the *Construction Noise and Vibration Guideline – Public Transport Infrastructure 2023* document, all plant and equipment used for construction must have operating Sound Power or Sound Pressure Levels below or equal to the allowable noise levels in Table 19 of CNVIG 2023 Appendix C.

Equipment not listed in Table 19 of the CNVG 2023, shall achieve compliance to the most applicable equipment listed in Australian Standard *AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites*, British Standard *BS 5228-1 Code of practice for noise and vibration control on construction and open sites* or DEFRA noise database14 (2006). The list of construction plant and associated sound power levels used in noise modelling is provided in Table 5-8.

Table 5-8: Construction plant and associated works and sound power levels

Plant	Site establishment, clearing and demolition	Flood storage culvert, retaining wall MW01 and bulk earthworks	Bulk earthworks, and building work	Charging gantries and building work	**Sound power level - SWL**
Scraper	X	X	X		113
Tub grinder/mulcher	X				116
Truck -dump	X	X	X		110
Front-end loader	X	X	X		112
Vibrating roller (10 Tonne)		X	X	X	114
Excavator 30 tonne	X	X	X	X	110
Shotcrete pump		X	X	X	109
Drill rig			X		112
Compressor	X	X	X	X	109
Concrete vibrators		X	X	X	113
Generators	X	X	X	X	103
Wrench – impact	X	X	X	X	111
Concrete pumps		X			109
Dump truck	X	X			110

Plant	Site establishment, clearing and demolition	Flood storage culvert, retaining wall MW01 and bulk earthworks	Bulk earthworks, and building work	Charging gantries and building work	**Sound power level - SWL**
Water truck	X	X	X	X	107
Motor grader	X				113
Compactor			X		106
Rock breaking	X				115
Crane		X	X	X	113
Asphalt truck and sprayer		X		X	106
Piling rig				X	112
Activity sound power level	**120**	**121**	**122**	**115**	-

The nearest residential and non-residential sensitive receives are identified that are closest to the point at which the noisiest piece of plant or equipment will be operated. The predicted level is then compared against the NMLs and an exceedance is calculated. The receiver with exceedance determines the level of Additional Mitigation Measures which was considered based on section 7.2.2 of the CNVG 2023.

5.4 Noise Modelling Results

An assessment of the proposed construction noise impacts has been calculated using the CONCAWE noise propagation algorithm in SoundPLAN 8.2. The assessment has been based on the equipment which would be used during the proposed works as identified in Section 5.3.1.

Presented below in Table 5-9 is a summary of the worst-case predicted noise impacts. Noise contours are also presented in Appendix C.

Table 5-9: Construction works and predicted construction noise levels

Noise catchment area	Noise management level (NML)	Site establishment, clearing and demolition	Flood storage culvert, retaining wall and bulk earthworks	Bulk earthworks, and building work	Charging gantries and building work
NCA 1	74	42 – 59 dB(A)	42 – 60 dB(A)	42 – 61 dB(A)	42 – 54 dB(A)
NCA 2	70	69 – 86 dB(A)	69 – 87 dB(A)	69 – 88 dB(A)	67 – 79 dB(A)

The predicted construction noise impacts provided in Table 5-9 identify that exceedance of the noise management levels are unlikely for receivers at NCA1 which consist of multilevel residential apartment and residential dwellings. No sensitive receivers have been identified to be highly noise affected by the works, particularly at the nearest sensitive receiver location. Provided in Section 5.7 is a summary of recommended management and mitigation measures which should be followed to reduce the impacts on the nearby commercial land use.

A summary of highly noise affected catchment areas is provided in Table 5-10.

Table 5-10: Highly noise affected (residential receivers)

Noise catchment area	Highly noise affected level (NML)	Site establishment, clearing and demolition	Flood storage culvert, retaining wall and bulk earthworks	Bulk earthworks, and building work	Charging gantries and building work
NCA 1	75	No	No	No	No

Given the distance to the nearest sensitive receivers, there are no sensitive receivers which are predicted to be highly noise affected by this project.

5.5 Construction traffic assessment

Based on review of the construction traffic movements, the anticipated truck and vehicle movement would be:

- 12 heavy vehicle deliveries/spoil removals (24 movements) and up to two light vehicles (four movements) on proposed construction site per day
- Five heavy vehicles (10 movements) and up to six light vehicles (12 movements); and

For construction traffic to generate an increase in noise levels of greater than 2 dB, existing traffic levels along construction traffic routes would need to increase by around 60%. Noise level increases due to proposal-related construction traffic on arterial roads are expected to be less than 2 dB during both daytime and nighttime periods, given existing high levels of traffic on the M2 Motorway, Lane Cove Road, and Epping Road. The potential noise impact is considered barely perceptible, and no further assessment is required, in accordance with the RNP. The majority of truck movements would be associated with demolition and earth work stage of the proposed work, such as excavation trenching. Truck movements would occur at any time throughout the proposed work shift but would not be continuous.

5.6 Vibration

5.6.1 Construction vibration criteria

Effects of ground borne vibration on buildings may be segregated into two major categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself

Vibration criteria – human comfort

Vibration effects relating specifically to the human comfort aspects of the proposal are taken from the guideline titled "Assessing Vibration – A Technical Guideline" (AVATG). Vibration impacts can be defined based on the nature of the construction works and vibration generated, specifically:

- Continuous vibration – from uninterrupted sources (refer to Table 6).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 7).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 8).

Presented below in Table 5-11: Continuous vibration acceleration criteria (m/s^2) 1 Hz-80 Hz, Table 5-12 and Table 5-13 is a summary of the applicable human comfort vibration criteria, for continuous, impulsive, and intermittent vibration respectively.

Table 5-11: Continuous vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment Period	Preferred Values		**Maximum Values**	
		z-axis	x- and y-axis	z-axis	x- and y-axis

Residence	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 5-12: Continuous vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment Period	Preferred Values		**Maximum Values**	
		z-axis	**x- and y-axis**	**z-axis**	**x- and y-axis**
Residence	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 5-13: Intermittent vibration impacts criteria ($m/s^{1.75}$) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Residences	0.20	0.40	0.13	0.26
Offices, Schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
workshops	0.80	1.60	0.80	1.60

Vibration criteria – building contents and structures

The vibration effects on the building are provided by British Standard BS 7385: Part 2-1993 “Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration” (BSI 1993)

The criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 5-14 and illustrated in Figure 5.

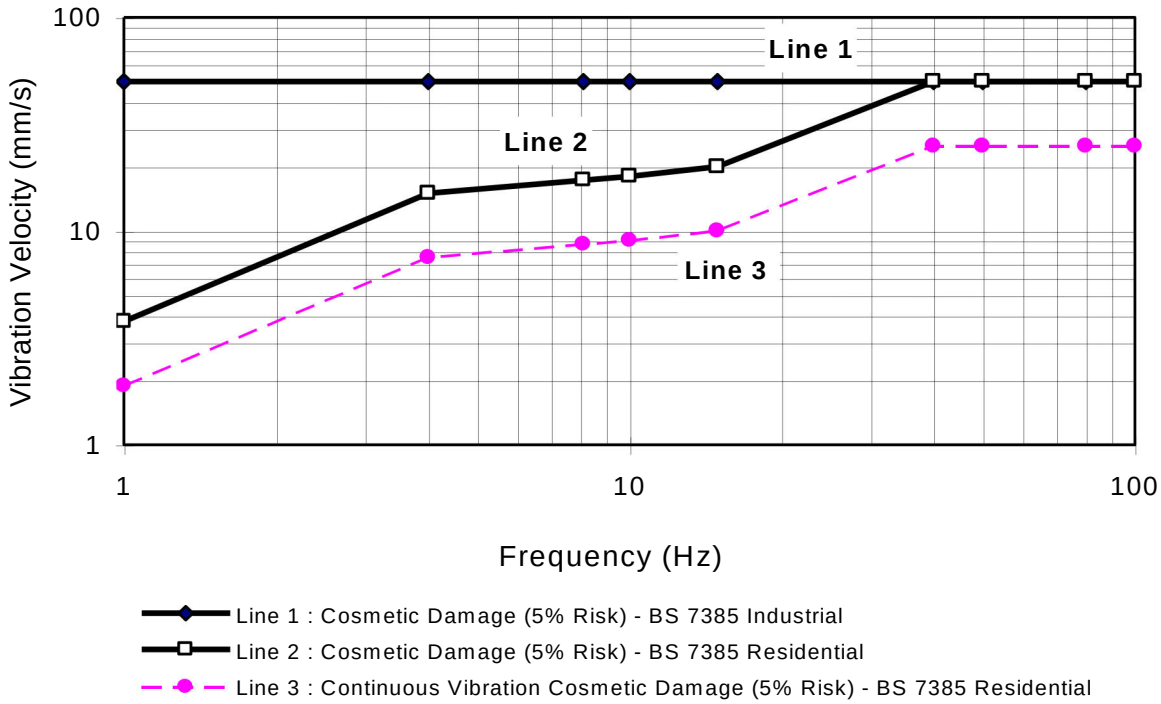
Table 5-14: Transient vibration criteria as per standard BS 7385 Part 2 – 1993

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

The vibration standard BS 7385 Part 2 – 1993 states that the values in Table 5-14 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 5-14 may need to be reduced by up to 50% (refer to Line 3 in Figure 2).

Figure 5 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 5-14, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 5-14 should not be reduced for fatigue considerations.

Project vibration criteria

Based on the details included in the sections above the project specific vibration criteria to protect the surrounding residential receivers from structural or architectural damage includes the following:

- Proposed construction vibration management level at all surrounding building structures – 7.5 mm/s.

In the event that this vibration criterion is exceeded, further investigation is required, including an assessment of the nature of the vibration and frequency characteristics to determine if the vibration criterion can be relaxed for the specific nature of the works.

5.6.2 Construction vibration assessment

To maintain compliance with the human comfort vibration criteria identified in Section 5.6.1, it is recommended that the indicative safe distances listed in Table 5-15 should be maintained. These indicative safe distances should be validated prior to the start of construction works by undertaking operator-attended measurements of vibration levels generated by construction equipment to be used on site.

If applicable, the criteria for scientific or medical equipment (should any of these exist close to the site) can be more stringent than those required for human comfort. Vibration validating measurements should be conducted at each site to determine the vibration level and potential impact onto this sensitive equipment.

Recommended safe working distances for various typical items of plant are included in the following table.

Table 5-15: Recommended indicative safe working distances for vibration intensive plant

Plant	Rating / Description	Safe Working Distances (m)	
		Cosmetic Damage	Human Comfort
Vibratory roller	< 50 kN (Typically 1 – 2 tonnes)	5	15 – 20
	< 100 kN (Typically 2 – 4 tonnes)	6	20
Small hydraulic hammer	300 kg, typically 5 – 12 tonnes excavator	2	7
Medium hydraulic hammer	900 kg, typically 12 – 18 tonnes excavator	7	23
Large hydraulic hammer	1600 kg, typically 18 – 34 tonnes excavator	22	73
Vibratory pile driver	Sheet piles	2 – 20	20
CFA Piling	⩽ 800 mm	2	<1m
Jackhammer	Hand held	1	Avoid contact with structure and steel reinforcements

An assessment of the potential for vibration generated as part of the required construction activities on the project (including excavation) has been undertaken based on the project safe working distances. Dependant on the location of the vibration intensive work and size of the equipment, exceedances of the vibration safe working distances are possible at adjacent industrial receivers. Compliance can be achieved by adhering to the management measures presented in Section 5.7.1. Residential receivers are very unlikely to exceed the project vibration criteria.

5.7 Management and Mitigation

5.7.1 Construction Management Measures

The construction predicted noise levels identified in Section 5.4 indicate that the noise impacts have the potential occur from the proposed works. These impacts are typical for a construction such as this and highlight the importance for appropriate noise management and mitigation measures.

Presented in Table 26 is a summary of site-specific management procedures recommended to manage the predicted airborne noise and vibration impacts based on the CNVG 2023.

Table 5-16: Summary of mitigation procedures

Procedure	Abbreviation	Description	Further reference
Project Notification	PN	For each Transport project, a notification is produced and distributed to stakeholders via letterbox drop or distributed to the project postal and/or email mailing lists. The same information will be published on the Transport corporate website (Transport Projects) or equivalent. Periodic notifications provide an overview of current and upcoming work across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (e.g., traffic changes or noisy works) can assist in	Refer to Section 5.7.6

Procedure	Abbreviation	Description	Further reference
		reducing the impact on stakeholders. The approval conditions for projects specify requirements for notification to sensitive receivers where work may impact them. Content and length are determined on a project-by-project basis and must be approved by Transport prior to distribution. Most projects distribute notifications monthly. Each notification is graphically designed within a branded template. In certain circumstances media advertising may also be used to supplement Periodic Notifications, where considered effective. Periodic Notification may be advised by the Transport Community Engagement Team in cases where AMMM are not triggered, for example where community impacts extend beyond noise and vibration (traffic, light spill, parking, etc.). In these circumstances the Transport Community Engagement Team will determine the community engagement strategy on a case-by-case basis.	
Verification Monitoring	V	Verification monitoring of noise and/or vibration during construction may be conducted at the affected receiver(s) or a nominated representative location (typically the nearest receiver where more than one receiver has been identified). Monitoring can be in the form of either unattended logging (i.e., for vibration provided there is an immediate feedback mechanism such as SMS capabilities) or operator attended surveys (i.e., for specific periods of construction noise). Verification must be undertaken by suitably qualified, trained and experienced personnel using appropriate equipment and methodology, with reference to AS1055. Refer to EPA's guideline 'Approved methods for the measurement and analysis of environmental noise in NSW' for additional guidance on personnel, methodology and equipment requirements. The purpose of monitoring is to confirm that: • Construction noise and vibration from the project are consistent with the predictions in the noise assessment. • Mitigation and management of construction noise and vibration is appropriate for receivers affected by the work. Where noise monitoring finds the actual noise levels exceed those predicted in the noise assessment then immediate refinement of mitigation measures may be required and the CNVIS amended.	For noise impact, refer to Section 5.7.4. For vibration impact, refer to Section 5.6.2
Specific Notification	SN	Specific notifications are in the form of a personalised letter or phone call to identified stakeholders no later than seven calendar days ahead of construction activities that are likely to exceed the noise objectives. In addition to Specific Notifications and letters 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, hand distributed or emailed. • 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	Refer to Section 5.7.6

Procedure	Abbreviation	Description	Further reference
		the impacts of noisy activities and mitigation measures that will be implemented. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project. • Specific notifications are used to support periodic notifications, or to advertise unscheduled or high impact work and must be approved by Transport prior to implementation/distribution. Where impacts have already been captured in a Periodic Notification, a Specific Notification may not be required	
Respite Offer	RO	The purpose of a project specific respite offer is to provide residents subjected to lengthy periods of noise or vibration respite from an ongoing impact. The offer could comprise pre-purchased movie tickets, bowling activities, meal vouchers or similar offers designed to provide residents with a short break from impact of construction activity outside of their home. This measure is determined on a case-by-case basis and may not be applicable to all Transport projects	-
Alternative accommodation	AA	Alternative accommodation options may be provided for residents living near construction activities likely to incur unreasonably high impacts. Alternative accommodation will be determined on a case-by-case basis and should provide a like-for-like replacement for permanent residents, including provisions for pets, where reasonable and feasible.	
Alternative Construction Methodology	AC	Where the vibration assessment identifies that the proposed construction method has a high risk of causing structural damage to buildings near the work, the proponent needs to consider alternative construction options to achieve compliance with the VMLs for building damage. For example, replace large rock breaker with smaller rock breakers or rock saws	-
Respite period	RP	OOHW during evening and night periods will be restricted so 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 there is Duration Reduction. A minimum respite period of four evenings/five nights shall be implemented between periods of consecutive evening and/or night work. Strong justification must be provided where it is not reasonable and feasible to implement these period restrictions (e.g. to minimise impacts to rail operations), and approval must be given by Transport through the OOHW Approval Protocol (Section 5). Note: this management measure does not apply to OOHW Period 1 – Days	Refer to Section 5.7 For vibration impact, also refer to section 5.6.2
Duration reduction	DR	Where Respite Periods (see management measure above) are counterproductive to reducing noise and vibration impacts to the community, it may be beneficial to increase the number of consecutive evenings and/or nights through Duration Reduction to minimise the duration of the activity. This measure is determined on a project-by project basis and may not be applicable to all Transport projects. Impacted receivers must be consulted and evidence of community support for the Duration Reduction must be provided as justification for the Duration Reduction. A community engagement strategy must be agreed with and	

Procedure	Abbreviation	Description	Further reference
		implemented in consultation with Transport Community and Stakeholder Engagement Representatives.	

The application of these procedures is in relation to the exceedances over the relevant criteria. For airborne noise, the criteria are based on NMLs. The allocation of these procedures is discussed in Section 5.7.2.

For vibration, the criteria either correspond to human comfort, building damage or scientific and medical equipment. The application of these procedures is discussed in Section 5.6.1.

5.7.2 Allocation of Noise Management Procedures

For residences, the management procedures have been allocated based on noise level exceedances at the affected properties, which occur over the designated NMLs (refer to section 5.2.1). The allocation of these procedures is summarised in Table 5-17 below.

Table 5-17: Allocation of noise management procedures

Construction Hours	**Receiver perception**	**dB(A) above RBL**	dB(A) above ANML	Management procedures
Standard Hours Mon – Fri: 8:00 am to 7:00 pm Sat: 8:00 am – 1:00 pm	Noticeable	5 to 10	0	-
	Clearly audible	>10 to 20	≤ 10	-
	Moderately intrusive	> 20 to 30	> 10 to 20	PN, V
	Highly intrusive	> 30	> 20	PN, V
	75 dB(A) of greater	N/A	N/A	PN, V, SN
OOHW Period 1 **Monday-Friday 6pm-10pm** **Saturday 7am-8am** **1pm-10pm** Sunday/PH 8am-6pm	Noticeable	5 to 10	≤ 5	-
	Clearly audible	>10 to 20	> 5 to 15	PN, RP#, DR#
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO, RP#, DR#
	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP#, DR#
OOHW Period 2 Monday-Saturday 12am – 7am **10pm - 12am** Sunday / PH 12am – 8am 6pm – 12pm	Noticeable	5 to 10	≤ 5	-
	Clearly audible	>10 to 20	> 5 to 15	PN, RP#, DR#
	Moderately intrusive	> 20 to 30	> 15 to 25	PN, V, SN, RO, RP#, DR#
	Highly intrusive	> 30	> 25	PN, V, SN, RO, RP#, DR#

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

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

Please note the following regarding the allocation of these procedures:

- The exceedances have been predicted as part of the acoustic assessment, and these are summarised in Section 5.4.
- The allocation of procedures is based on the assumptions used for noise level predictions (refer to Section 5.4).

5.7.3 Allocation of Vibration Management Procedures

Summarises the vibration management procedures to be adopted based on exceedance scenarios (i.e., whether the exceedance occurs over human comfort criteria, building damage criteria, or criteria for scientific and medical equipment). Please note these management procedures apply for any type of affected receiver.

Table 5-18: Allocation of vibration management procedures

Construction Hours	**Receiver perception**	dB(A) above ANML	Management procedures
Standard Hours Mon – Fri: 8:00 am to 7:00 pm Sat: 8:00 am – 1:00 pm	Human disturbance	> HVML	PN, V, RO
	Building damage	> DVML	V, AC
OOHW Period 1 **Monday-Friday 6pm-10pm** **Saturday 7am-8am, 1pm-10pm** Sunday/PH 8am-6pm	Human disturbance	> HVML	PN, V, SN, RO, RP, DR
	Building damage	> DVML	V, AC
OOHW Period 2 **Monday-Saturday 12am – 7am, 10pm - 12am** Sunday / PH 2am – 8am, 6pm – 12pm	Human disturbance	> HVML	PN, V, SN, RO, RP, DR, AA
	Building damage	> DVML	V, AC

Notes – HVML – human disturbance vibration management level, DVML - cosmetic damage to buildings or structures vibration management level

The contractor will, where reasonable and feasible, apply best practice noise mitigation measures. These measures shall include the following:

- Maximising the offset distance between plant items and nearby noise sensitive receivers.
- Preventing noisy plant working simultaneously and adjacent to sensitive receivers.
- Minimising consecutive works in the same site area.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

To minimise noise impacts during the works, the contractor will take all reasonable and feasible measures to mitigate noise effects.

The contractor will also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

The contractor should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

Presented below in Table 5-19 is a summary of the noise management measures and approximate noise reductions. Further information is provided in the proceeding section.

Table 5-19: Standard Noise and Vibration Mitigation Measures

Term	Definition	Noise Reduction
Management Measures		
Implement community consultation measures	Providing the community ongoing updates about potential noise impacts can reduce the impacts and annoyance from the project	Reduced annoyance
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction which would include consideration of	

Term	Definition	Noise Reduction
	noise and vibration impacts.	
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.	
Monitoring	See Section 5.7.5	
Work scheduling	Includes scheduling noise intensive works and respite periods	Annoyance reduction
Source controls		
Alternative equipment or process	Use quieter and less vibration emitting construction methods where feasible and reasonable.	5 to 15 dB
Plan worksites and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site	1 to 3 dB
Minimise the movement of materials	Reduces noise generated through reduced plant operations	1 dB to 3 dB
Broadband reversing alarm	Site based vehicles should be fitted with broadband reversing alarms to reduce tonal noise impacts.	5 dB
Siting of equipment	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers	3 to 15 dB
Silencers on mobile plant	Where possible reduce noise from mobile plant through additional fittings	5 dB to 8 dB
Maximise hammer penetration	Reduces the time required and associated noise impacts	Reduced duration
Path controls		
Acoustic enclosure or screening	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.	5 dB to 10 dB

Acoustic enclosures/screening

Typically, on a construction site there are three different types of plant that will be used: mobile plant (i.e., excavators, skid steers, etc.), semi mobile plant (i.e., hand tools generally) or static plant i.e. (diesel generators).

For plant items which are static it is recommended that, in the event exceedances are being measured due to operation of the plant item, an acoustic enclosure/screen is constructed to reduce impacts. These systems can be constructed from Fibre Cement (FC) sheeting or, if airflow is required, acoustic attenuators or louvres.

For semi mobile plant, relocation of plant should be investigated to either be operated in an enclosed space or at locations away from a receiver.

With mobile plant it is generally not possible to treat these sources. However, investigations into the machine itself may result in a reduction of noise (i.e., mufflers/attenuators etc).

General mitigation measures (Australia Standard 2436-2010)

As well as the above project specific noise mitigation controls, AS 2436-2010 *"Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the proposal are listed below, including the typical noise reduction achieved, where applicable.

Adoption of universal work practices

- Regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
- Regular identification of noisy activities and adoption of improvement techniques.
- Avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby sensitive receivers.
- Where possible, avoiding the use of equipment that generates impulsive noise.
- Minimising the need for vehicle reversing for example (particularly at night), by arranging for one-way site traffic routes.
- Use of broadband audible alarms on vehicles and elevating work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

Plant and equipment

The operation of plant and equipment on the site should be undertaken, including the following:

- Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Selecting plant and equipment with low vibration generation characteristics.
- Operating plant and equipment in the quietest and most efficient manner.

Work scheduling

- Providing respite periods which could include restricting very noisy activities to time periods that least affect the nearby noise sensitive locations, restricting the number of nights that after-hours work is conducted near residences or by determining any specific requirements.
- Scheduling work to coincide with non-sensitive periods.
- Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers.
- Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.

Source noise control strategies

Some ways of controlling noise at the source are:

- Where reasonably practical, noisy plant or processes should be replaced by less noisy alternatives.
- Modify existing equipment: Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, trucks, etc. To minimise noise emissions, residential grade mufflers should be fitted on all mobile plant utilised on site.
- Siting of equipment: locating noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Regular and effective maintenance.

Miscellaneous comments

Deliveries should be undertaken, where possible, during standard construction hours.

Maximise hammer penetration (and reduce blows) by using sharp hammer tips. Keep stocks of sharp profiles at site and monitor the profiles in use.

It is advised that mobile plant and trucks operating on site for a significant portion of the project are to have reversing alarm noise emissions minimised. This is to be implemented subject to recognising the need to maintain occupational safety standards.

No public address system should be used on site.

5.7.4 Construction Vibration Mitigation Measures

The following vibration mitigation measures should be implemented:

- Any vibration generating plant and equipment is to be in areas within the site to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of construction plant and equipment; that is, smaller capacity plant.
- Minimise conducting vibration generating works consecutively in the same area (if applicable).
- Undertake the removal of concrete within the building using saw cutting or pulverising where possible.

To ensure the vibration impact criteria detailed in this report are complied with the following safe working mitigations and/or working distances should be implemented as detailed in the table below.

Table 5-20: Vibration mitigation requirements

Construction Activity	Activity	Vibration Mitigation
Excavation	Removal of Rock	Prior to the use of hydraulic hammering within 20 m of neighbouring buildings a saw cut to the rock to be excavated is required to the undertaken.

5.7.5 Noise and vibration monitoring

Construction noise and vibration should be managed by the implementation of a detailed Construction Noise and Vibration Management Plan (CNVMP) to be prepared by the construction contractor prior to commencement of works on site. This will utilise updated information in relation to the proposed construction methodology, location of works sites, activities, durations and equipment type and numbers.

The attended measurements shall be carried out by an appropriately trained person in the measurement and assessment of construction noise and vibration, familiar with applicable standards and procedures.

Noise monitoring is recommended to be undertaken by attended noise measurements at the start of any new phase of works identified in section 5.4. Attended noise monitoring is required to follow the requirement set out within section 7.4 of Construction Noise and Vibration Guideline (Public Transport Infrastructure) 2023 (CNVG-PTI).

Attended noise monitoring need to be conducted at the nearest sensitive receivers. Compliance with the approved construction noise and vibration objectives is to be audited at the commencement of works and at least every three months, where this is reasonable and feasible. The statistical parameters to be measured should include the following noise descriptors: L_{Amin}, L_{A90}, L_{A10}, L_{A1}, L_{Amax} and L_{Aeq}. Attended noise measurements should be conducted over consecutive 15-minute periods.

In accordance with the CNVG-PTI 2023, the following monitoring procedures are required to be carried out to determine the influence of construction noise:

Timing of Measurements: Measurements should be conducted within 14 days from the start of construction activities or as agreed with the relevant authority (EMR/Transport). This is to confirm that noise and vibration levels at receiver locations align with predictions and approval/licensing conditions.

Location of Measurements: Measurements should be carried out at the potentially most impacted receiver locations.

Noise Measurement Standards: Noise measurements should follow the procedures outlined in AS1055.1-1997 for the description and measurement of environmental noise.

Vibration Measurement Standards: Vibration measurements should adhere to procedures documented in the EPA's guideline "Assessing Vibration" (2006) and BS7385 Part 2-1993 for the evaluation and measurement of vibration in buildings.

Frequency of Measurements: For projects lasting more than three months, attended measurements should be repeated every three months, if reasonable and feasible, to ensure consistency with predicted levels. Additional measurements may be required for out-of-hours works as per the CNVIS, out-of-hours assessment, approval, and/or licensing conditions.

Noise Monitoring Implementation: Noise monitoring should be implemented as specified in Additional Management Measures (Section 7.2) or as an ongoing management measure during critical periods, such as during piling and hammering activities when noise emissions are expected to be high.

5.7.6 Community consultation

Active community consultation and the maintenance of positive relations with nearby local residents, and businesses would assist in alleviating concerns and thereby minimising complaint.

This form of notification should provide specific notification of the duration and timing of the required ground works activities so that residents are informed about the works ahead of time. The letter should also provide the community with a hotline number for a community liaison officer available to adequately respond to all project related enquiries.

Ideally the hotline number should provide concerned locals an opportunity to raise any concerns with the project proponent and provide an opportunity to determine the best method to satisfy all requirements.

Prior to the works onsite being undertaken, community consultation with the neighbouring affected parties be undertaken. Community engagement and consultation should not be limited to the beginning of the onsite works but throughout, providing the community with constant updates on the progress and upcoming works. In our experience these could include:

- Site noticeboard,
- Email notifications; and
- Letterbox drops.

Complaints management system

Should complaints arise they must be dealt with in a responsible and uniform manner, therefore, a management system to deal with complaints is detailed below:

Local residents and landowners should be informed by direct mail of a direct 24-hour telephone line where any noise complaints related to the required ground works will be recorded. The 24-hour telephone line number will be made available on the construction site signage.

All complaints should be investigated by the Contractor in accordance with the procedures outlined in Australia Standard 2436-2010. Consequently, a complaint response procedure should be implemented. Information to be gathered as part of this process should include:

- location of complainant
- time/s of occurrence of alleged noise or vibration impacts
- nature of impact particularly with respect to vibration
- Perceived source
- Prevailing weather conditions and similar details that could be utilised to assist in the investigation of the complaint.

All resident complaints will be responded to in the required timeframe and action taken recorded.

Post receiving a noise and or vibration complaint, the process outlined in the Contingency Plans below should be undertaken.

Contingency plans

Contingency plans are required to address noise or vibration problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans include:

- Stop the onsite works.
- Identify the source of the main equipment within specific areas of the site which is producing the most required ground works noise and vibration at the sensitive receivers; and
- Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered.
- In the event an alternate piece of equipment or process can be used, works can re-commence.
- In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant.
- Respite periods to be scheduled during potentially noise sensitive periods of the surrounding receivers.

The Superintendent shall have access to view the Contractor's noise measurement records on request. The Superintendent may undertake noise monitoring if and when required.

6. Conclusion

Transport for NSW is proposing to construct a new Zero Emission Bus Depot at Macquarie Park. This depot would store, charge and maintain Zero Emission buses while they are active on the local bus network. This report provides a Noise and Vibration Impact Assessment (NVIA) for the proposed development. This NVIA is required to address noise and vibration impacts that have the potential to be generated by the proposal.

Existing environment

The site is located adjacent to the M2 Hills Motorway to the east and the Macquarie Park commercial precinct to the north, south, and west. The noise environment for all sensitive receivers is controlled by significant amounts of road traffic noise from the M2 Motorway and Lane Cove Road. The noise environment throughout the assessment is considered to be Urban due to the high traffic volumes controlling the road traffic noise levels.

Background noise logging was undertaken at one location from 8 to 18 December 2023 to determine the existing noise environment at nearby sensitive receiver locations. The measurements identified that residential receivers are controlled by road traffic noise from nearby arterial roads.

Construction Noise and Vibration Assessment

To facilitate the assessment, noise and vibration sensitive receivers and NCAs were identified. Noise and vibration sensitive receivers include residential properties, commercial and industrial properties. In addition, a hotel located on the north side of Land Cove Road was also assessed for the construction impacts. NMLs have been established for each identified NCA based on the unattended noise monitoring results to characterize the existing noise environment.

The construction noise assessment was conducted in accordance with the Interim Construction Noise Guideline (ICNG). The construction scenarios in this assessment have been considered, these are considered to be the noisiest activities likely to occur.

The proposed construction work on-site is expected to have a minor impact on nearby residential properties due to the distance between them. Given the separation distance and existing background noise level is controlled by the M2 Hills Motorway, it is anticipated that any potential effects on residential properties would be minimal. However, it is anticipated that there may be potential noise and vibration impacts on the nearby commercial and industrial premises located on the west side of the proposed site. Given the proximity of these premises to the construction site, it is likely that they will experience some level of disturbance due to the construction activities.

Noise mitigation measures have been recommended to reduce the construction noise impact at adjacent receivers. These measures are outlined in section 5.7 of this report. It is important to note that management and mitigation measures stated in section 5.7 to be carried out to minimize the noise and vibration impact of the proposed construction work on identified sensitive receivers.

To mitigate the impact from vibration-intensive activities, it is advised to establish minimum working distances for both human comfort and structural protection. Such activities include the use of rock breakers, piling rigs, and jackhammers during trenching, excavation, and joint bay work. These activities are expected to affect nearby receivers for approximately one week.

For vibration-intensive activities within the recommended distances, the following measures are suggested:

1. Vibration Assessment: Conduct vibration assessments during the initial stages of vibration-intensive activities to establish site-specific minimum working distances.
2. Work Scheduling and Breaks: Plan work schedules to incorporate breaks, allowing for reduced impact on nearby locations.
3. Equipment Selection and Maintenance: Ensure appropriate selection and maintenance of equipment to minimize vibration levels.
4. Building Integrity Surveys: Perform surveys to assess and monitor potential structural impacts resulting from vibration-intensive activities.

Additionally, it should be noted that several noise mitigation measures stated in section 5.7.2 may also assist in mitigating construction-related vibrations.

Operational Noise

Operational noise emission criteria have been derived from the background noise logging in accordance with the EPAs Noise Policy for Industry and background noise logging undertaken for this proposal.

An operational noise model has been developed using SoundPLAN v8.2. The noise model assessed the dominant noise sources generated from the operation of the site. The predicted noise levels identified compliance with the applicable noise criteria at all sensitive receiver locations and additional noise mitigation measures are not required.

Sleep disturbance noise impacts have been assessed against the NPfI screening criterion. Compliance is achieved at all locations and further consideration of impacts and noise mitigation is not required.

Operational road noise criteria have been derived from the NSW Road Noise Policy. The predicted operational road traffic noise levels identify that road traffic noise levels currently exceed the RNP noise criteria and will continue to do so in the future. Road traffic noise levels will increase by less than 1 dB, which is considered to be an indiscernible change in noise. Further considerations of road traffic noise impacts are not required.

7. Definitions

Term	Definition
Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter.
dBA	A-weighted decibels
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
Lmax	The maximum sound pressure level measured over a given period.
Lmin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dBA.
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Sound Pressure Level, LP dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.
Sound Power Level, Lw dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt.
REF	Review of Environmental Factors

Appendix A: Ambient Noise Logging

1 Fontenoy Road, Macquarie Park

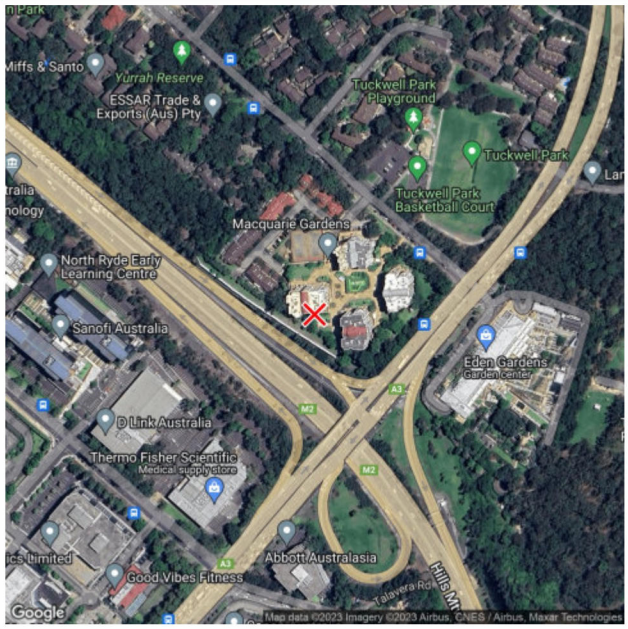
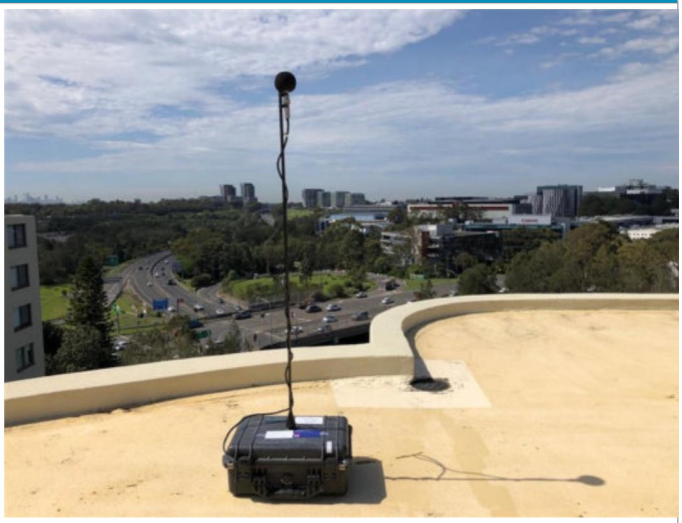
Ambient noise monitoring report

Item	Information
Logger Type	NL-42
Serial number	396932
Address	1 Fontenoy Road, Macquarie Park
Location	Roof of building overlooking M2
Facade / free field	Free field
Environment	Ambient nosie controlled by road traffic noise on M2

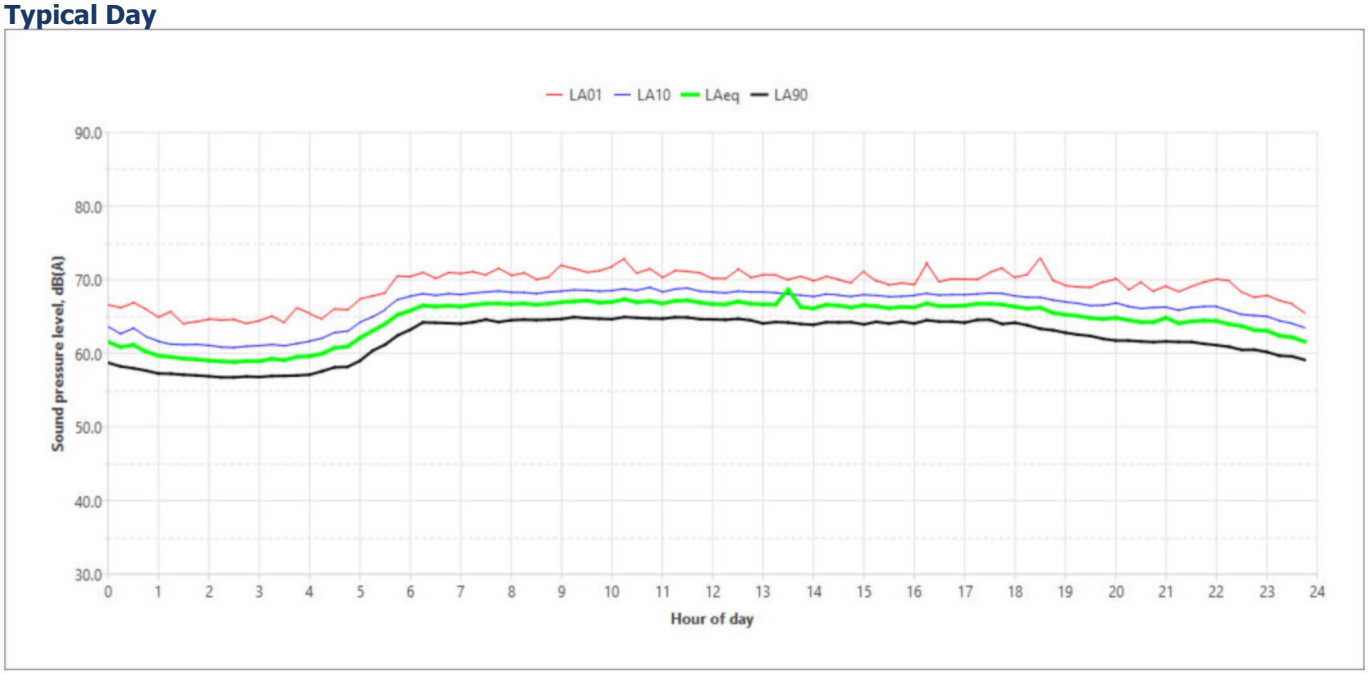
Measured noise levels

Logging date	Rating Background Level			$L_{Aeq,period}$		
	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am
Fri 08 Dec 2023	-	61	-	67	65	64
Sat 09 Dec 2023	63	-	57	66	66	65
Sun 10 Dec 2023	62	61	57	66	65	62
Mon 11 Dec 2023	65	60	56	67	65	62
Tue 12 Dec 2023	64	60	57	67	65	63
Wed 13 Dec 2023	64	61	57	67	65	63
Thu 14 Dec 2023	-	62	-	67	66	65
Fri 15 Dec 2023	65	61	57	67	65	63
Sat 16 Dec 2023	63	62	57	66	66	62
Sun 17 Dec 2023	61	61	57	66	65	61
Mon 18 Dec 2023	-	-	-	68	-	63
Summary	**64**	**61**	**57**	**67**	**65**	**63**

Note: Results with a '-' identify that there were not enough measurements available to correctly calculate the level, in accordance with the Noise Policy for Industry. The data has been excluded either from weather or manual exclusions. See the charts for more information

Logger location	Logger deployment photo
	

Typical Day



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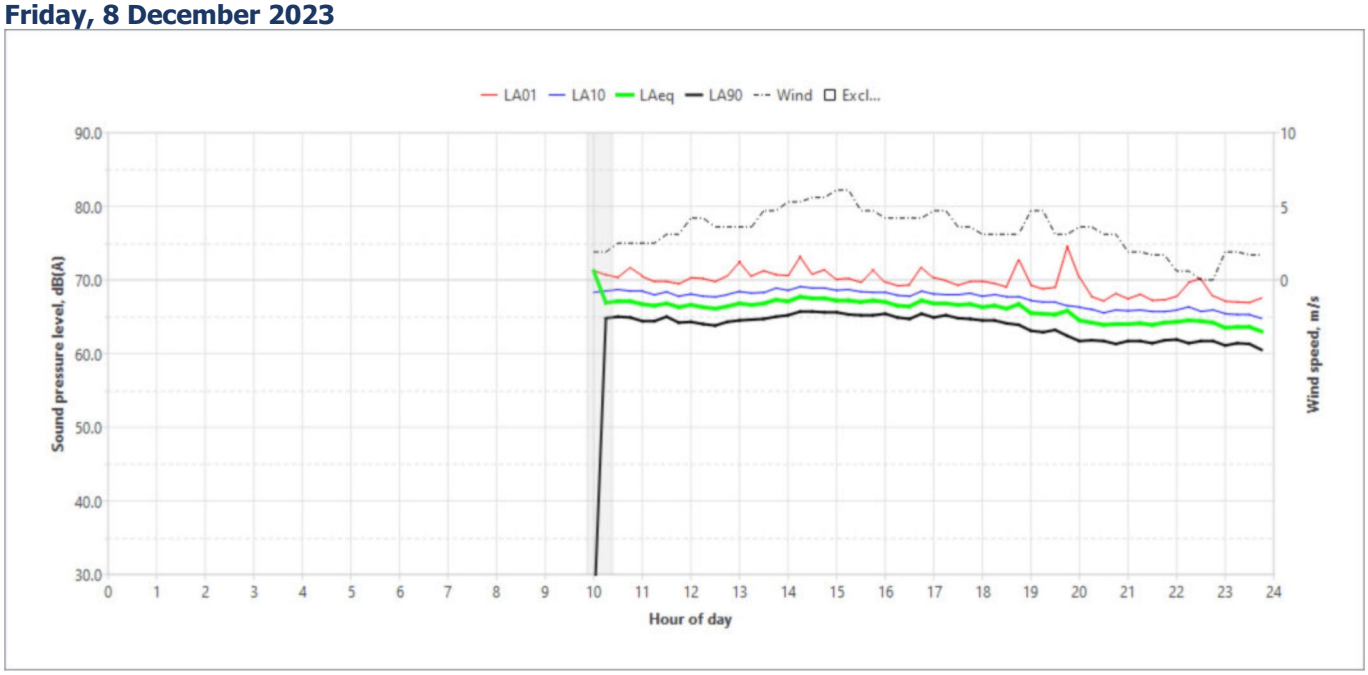
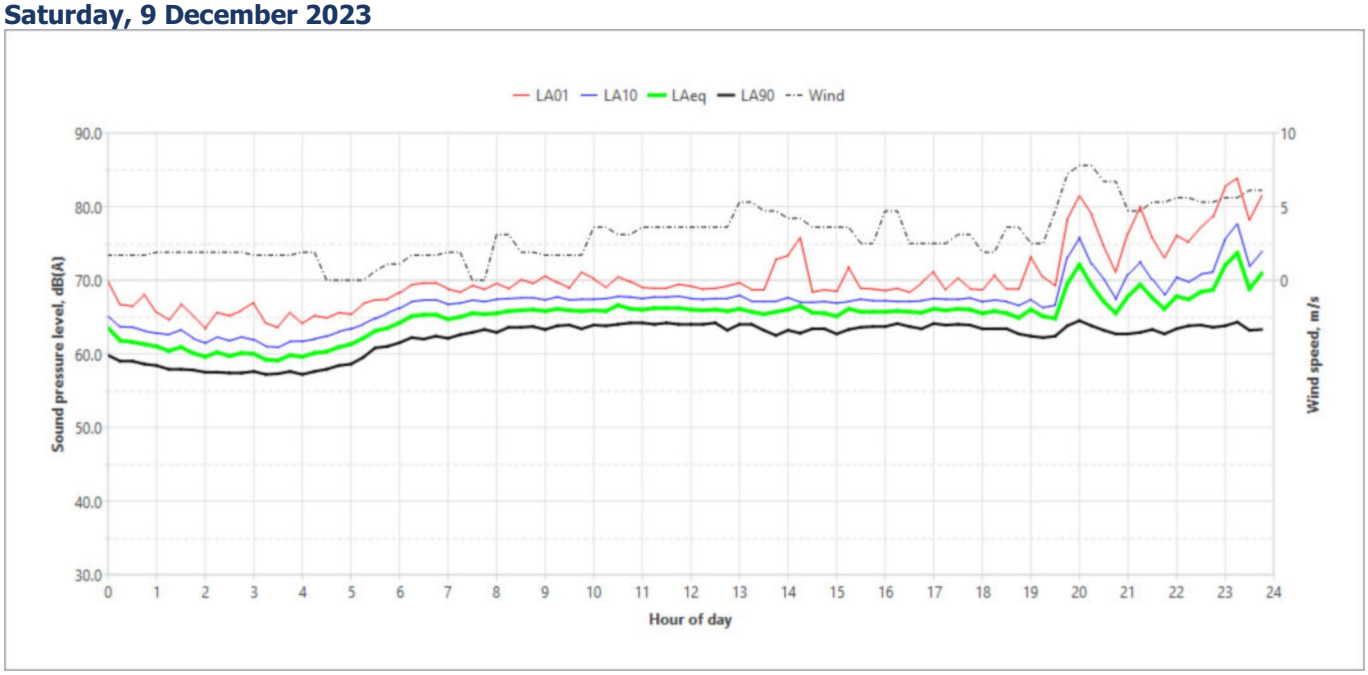
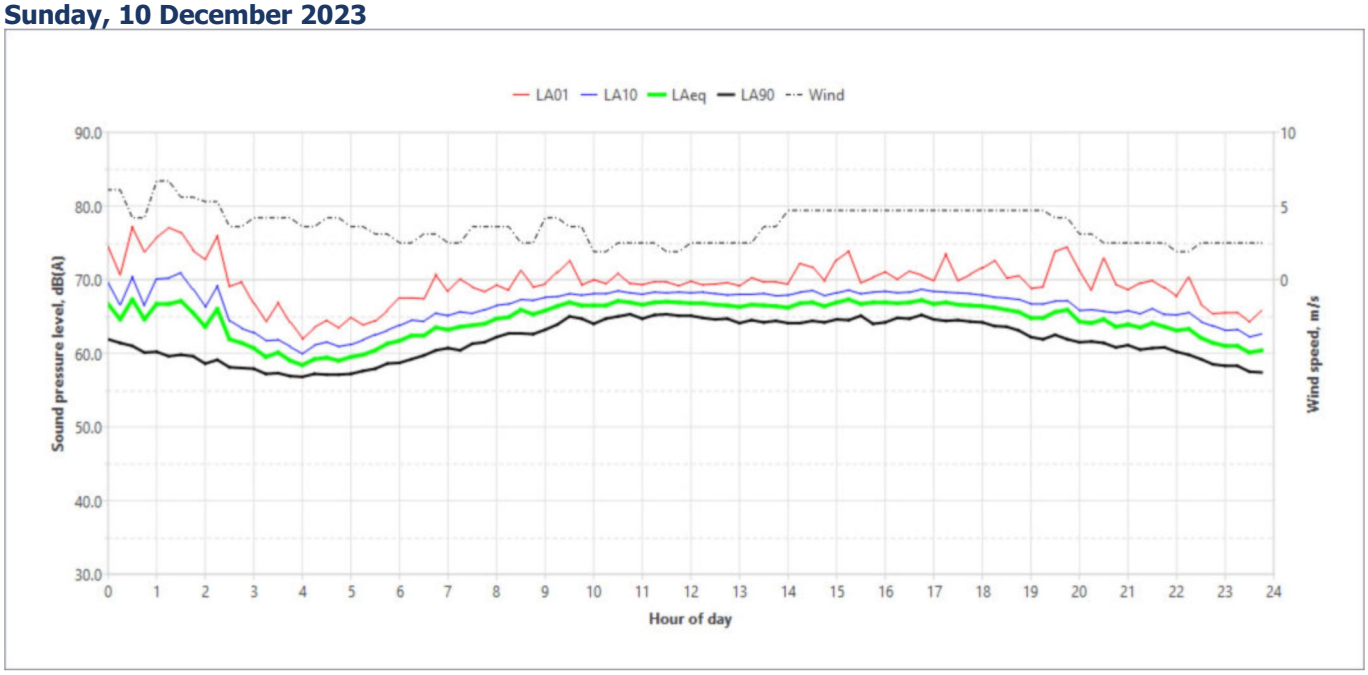


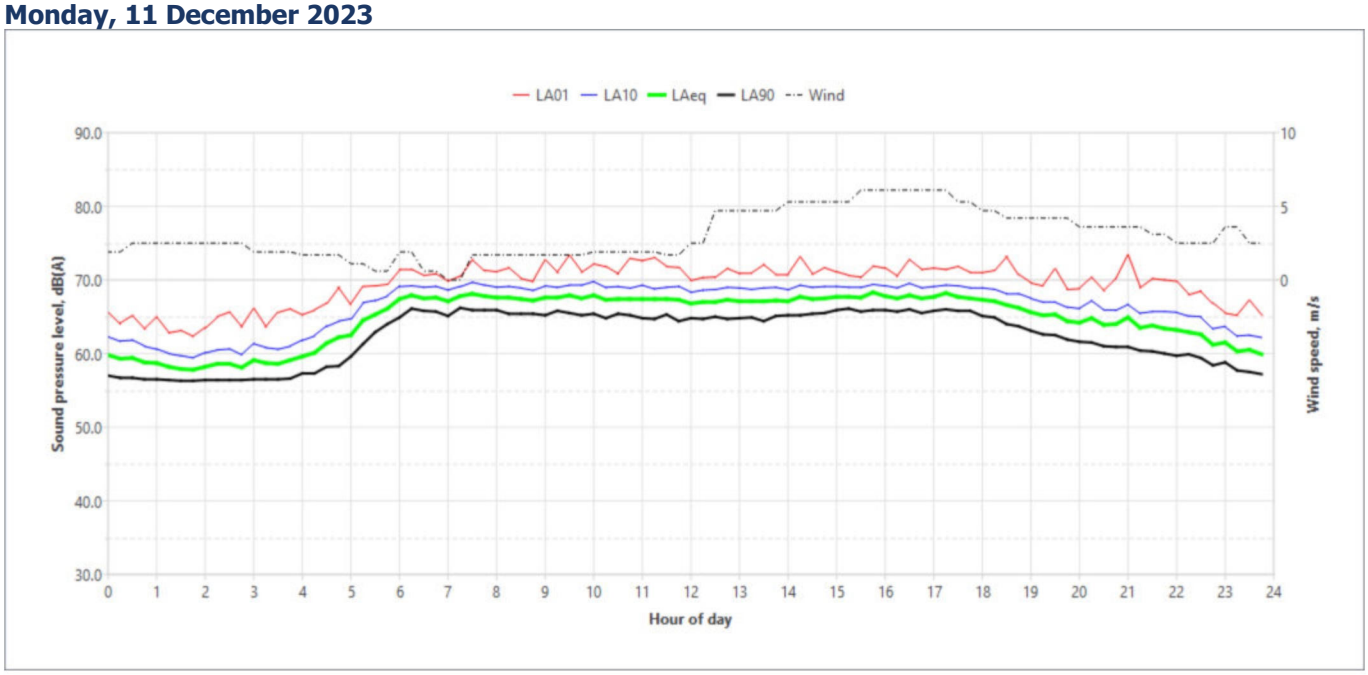
Saturday, 9 December 2023



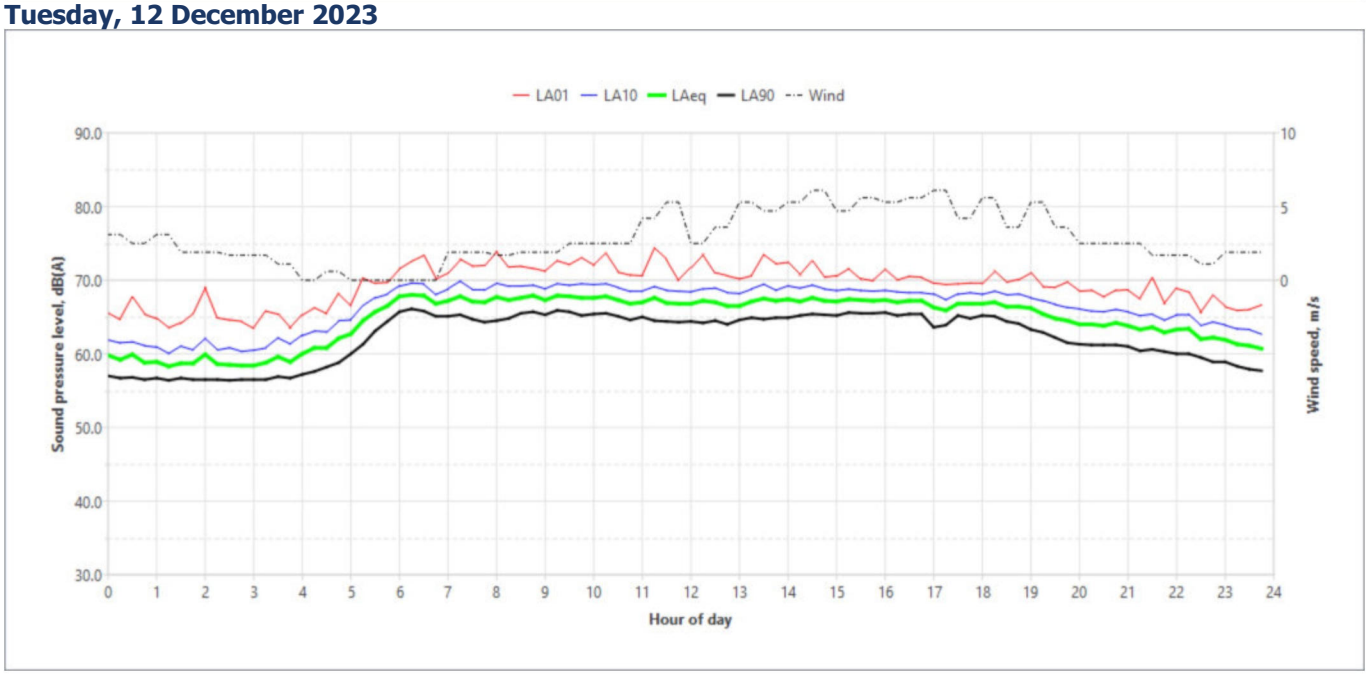
Sunday, 10 December 2023



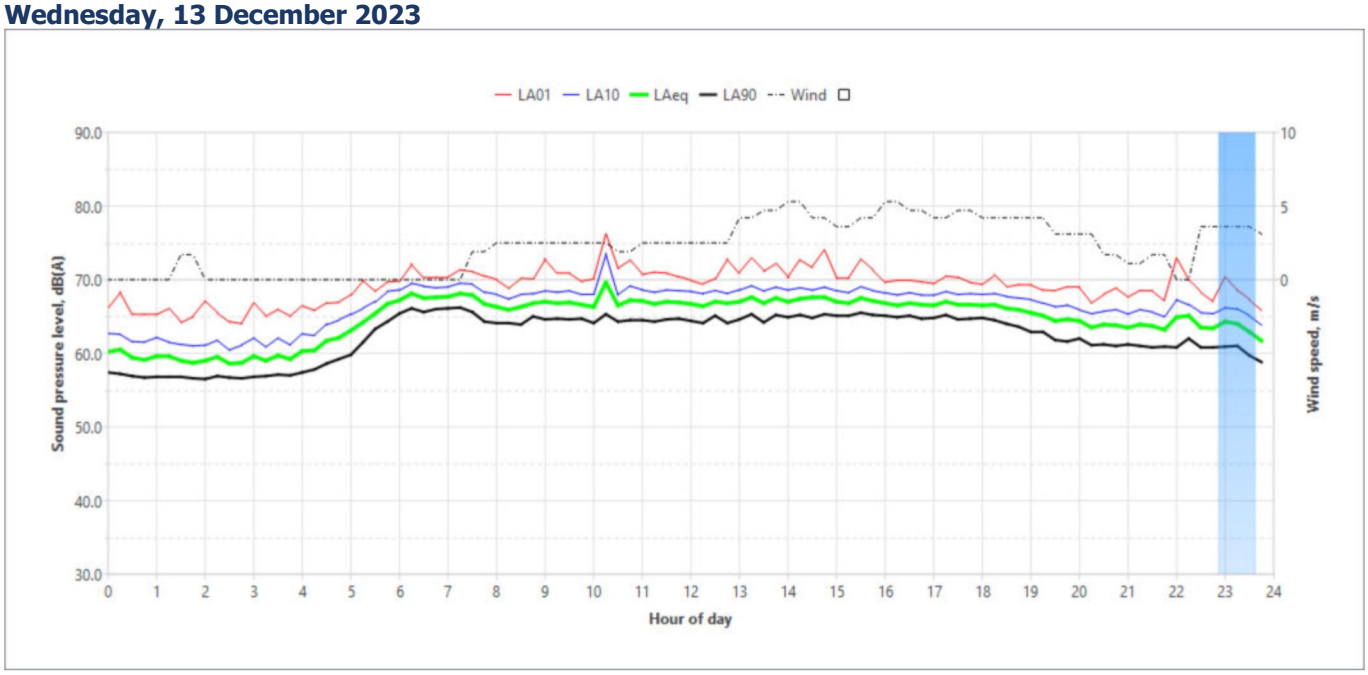
Monday, 11 December 2023



Tuesday, 12 December 2023

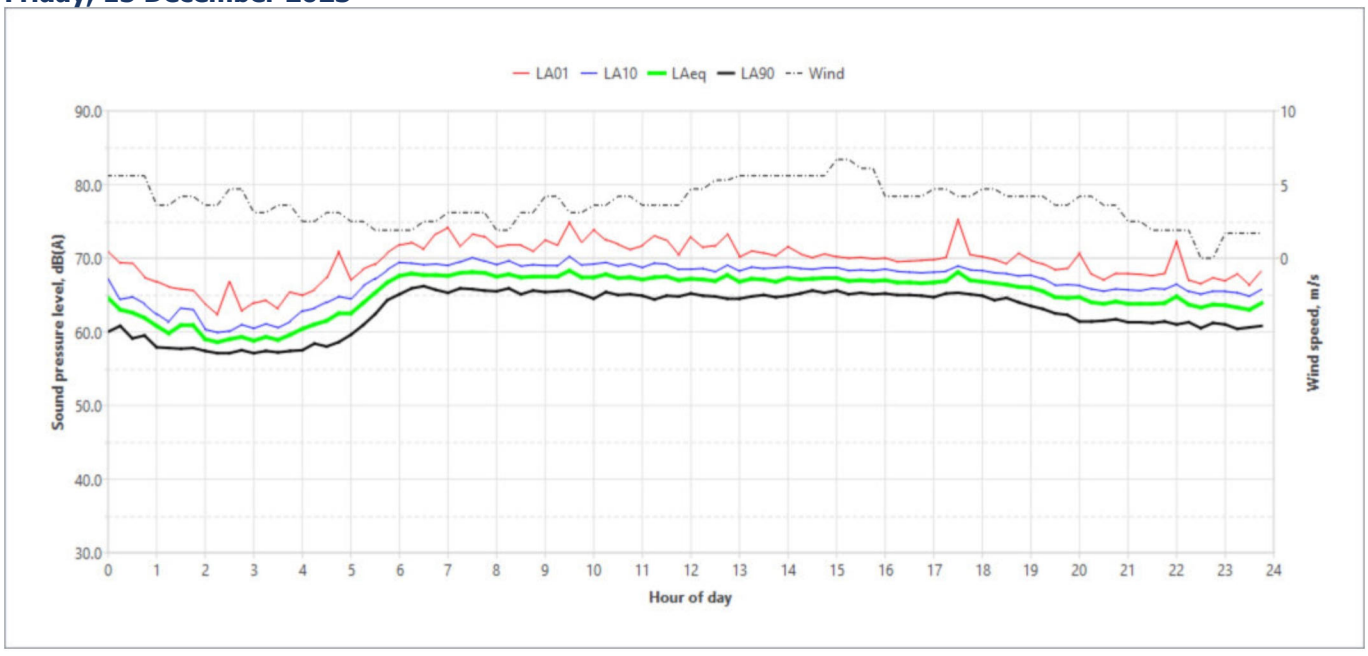


Wednesday, 13 December 2023



Thursday, 14 December 2023

Friday, 15 December 2023



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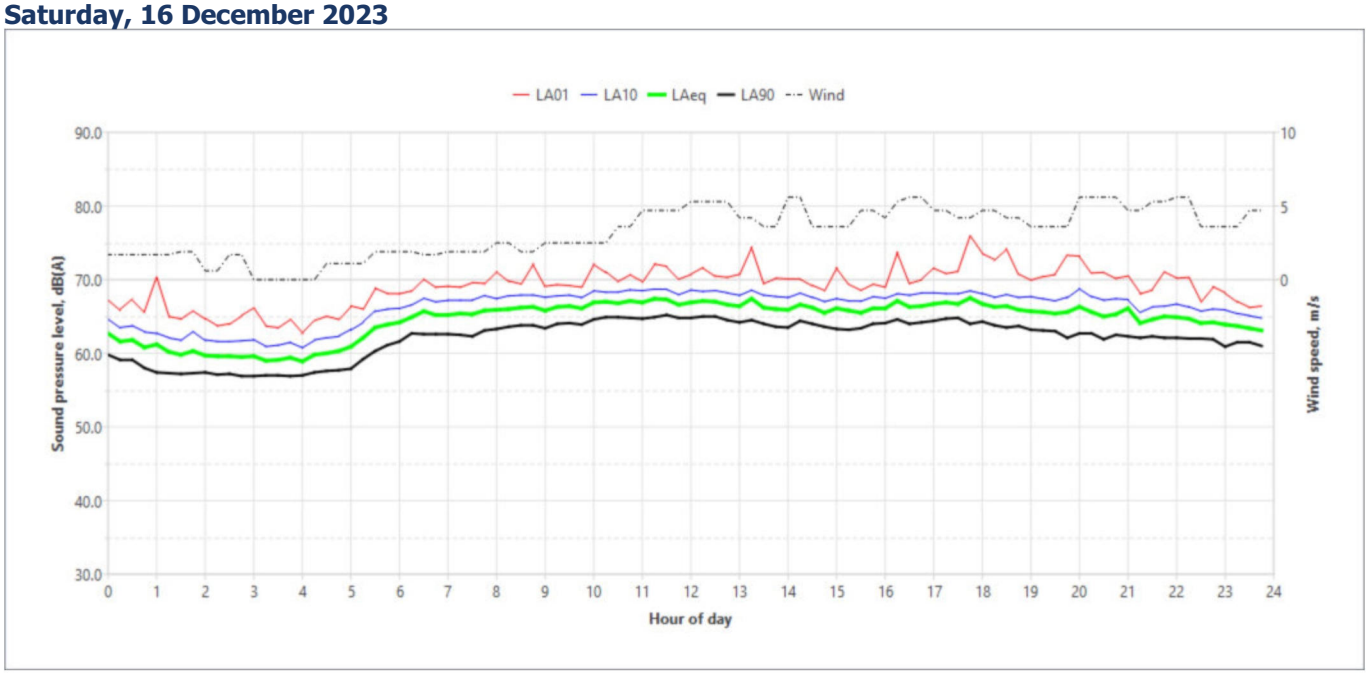

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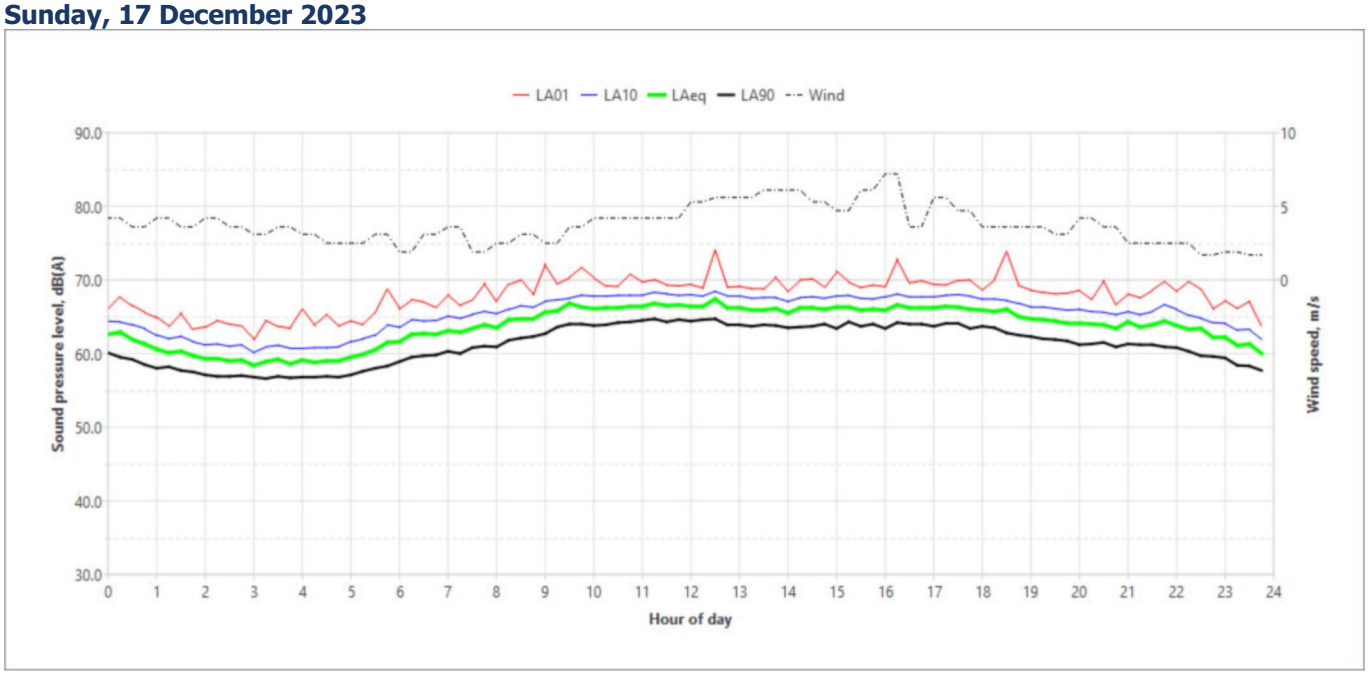
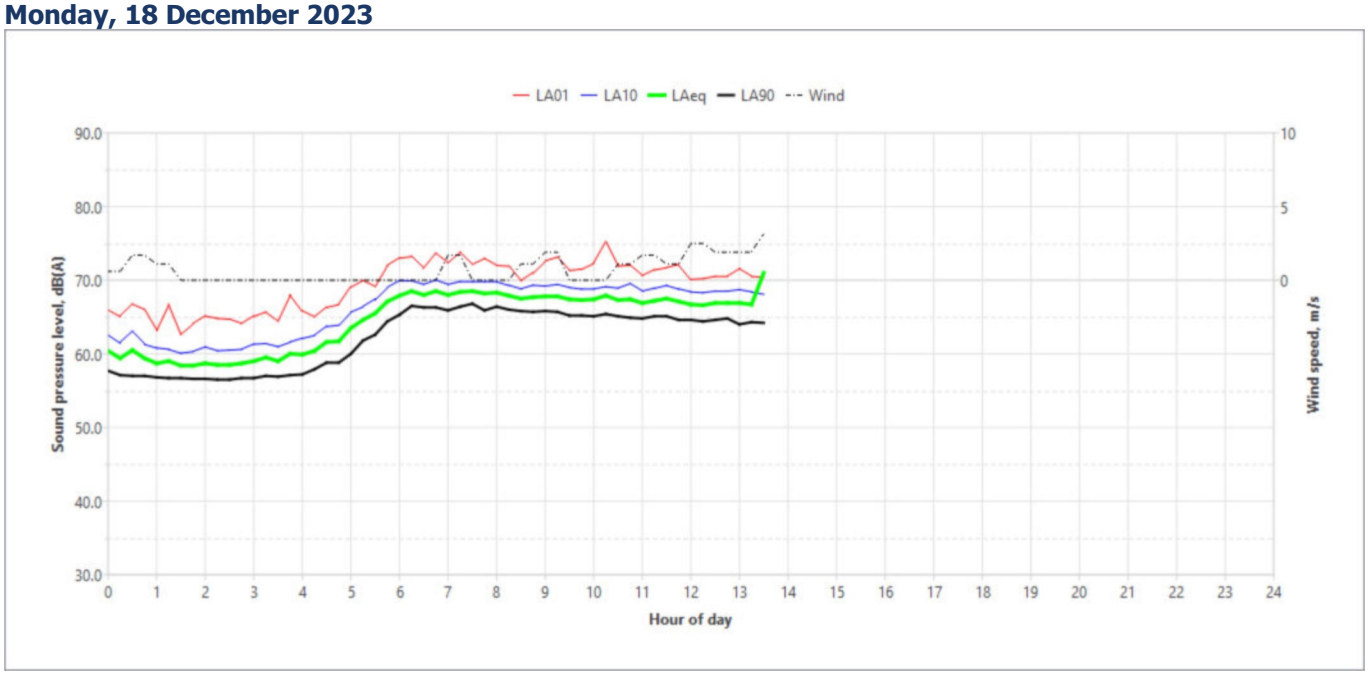
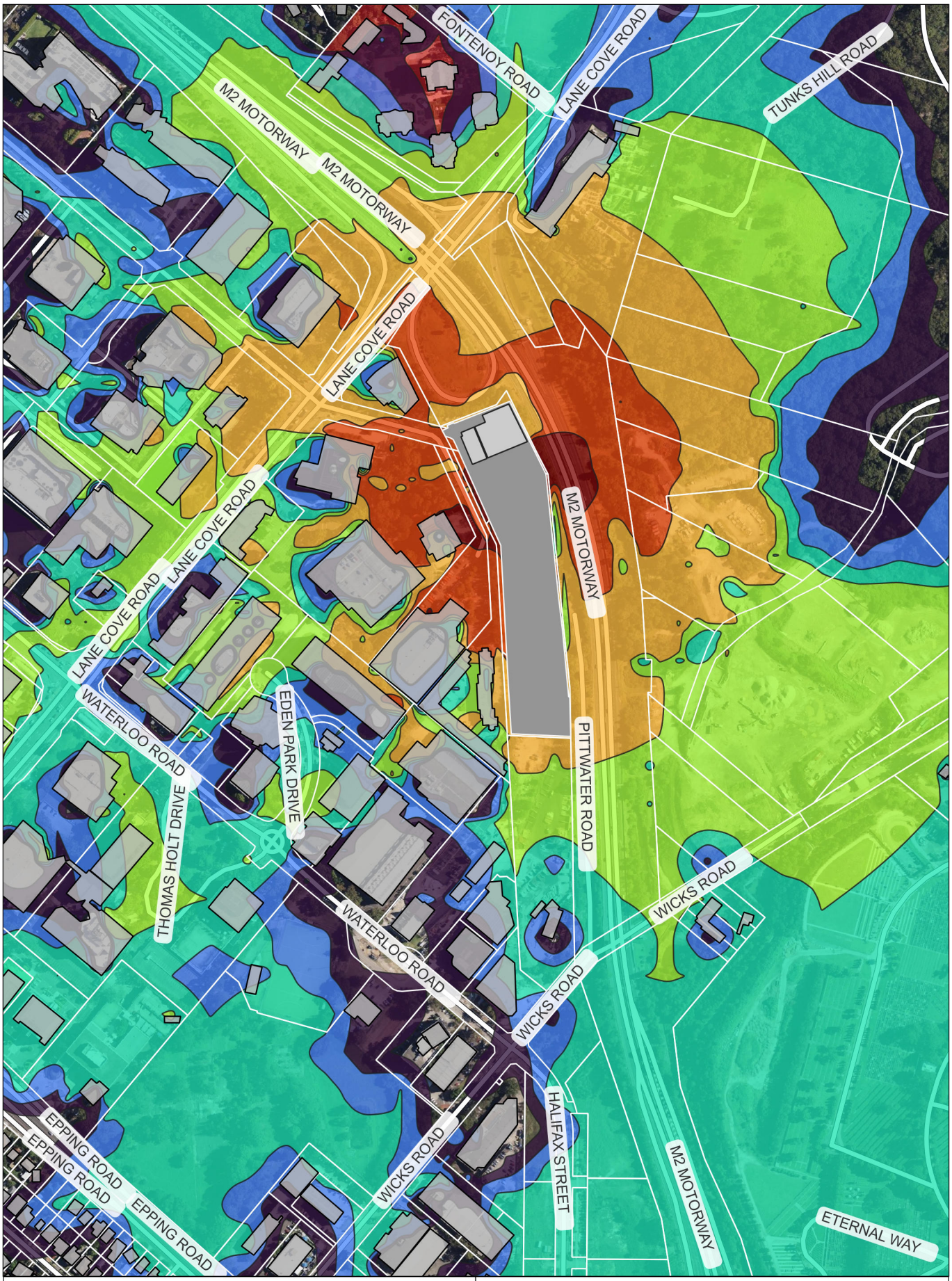


Monday, 18 December 2023



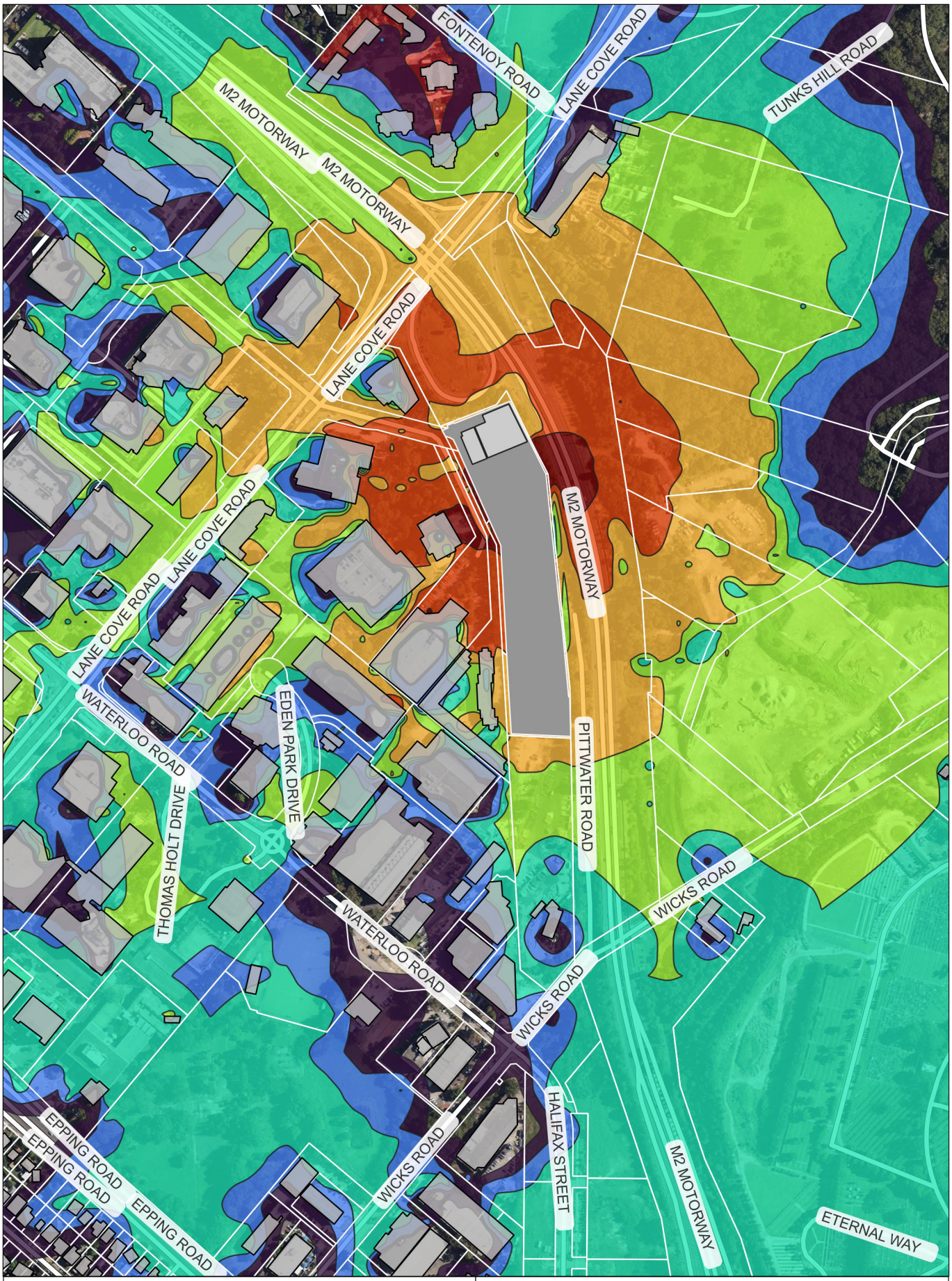
Appendix B: Operational Noise Contours



LAeq,15min noise levels, dB(A)

20 t0 25	35 to 40	> 50
25 to 30	40 to 45	
30 to 35	45 to 50	

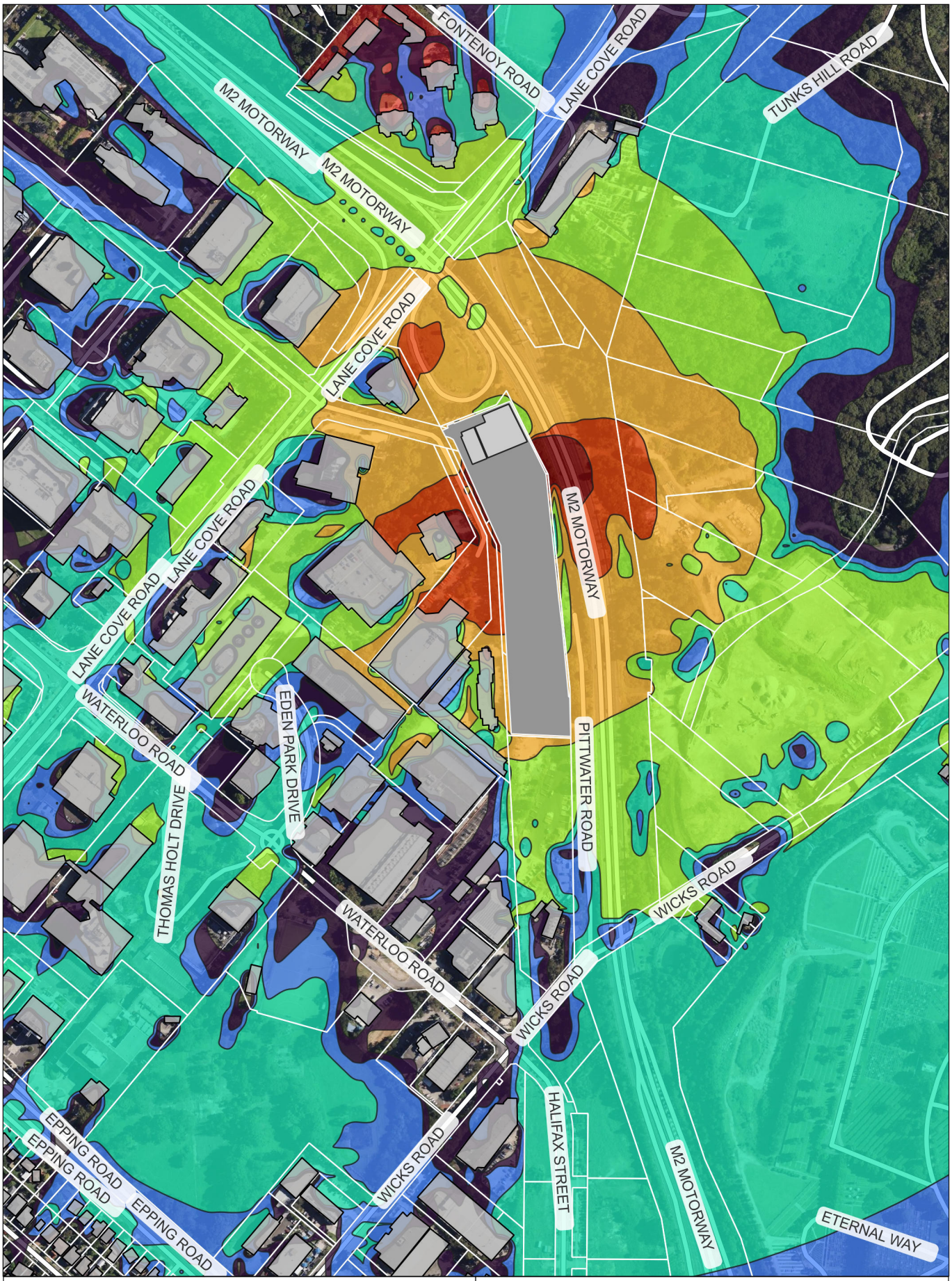
Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Daytime Worst-Case Noise Contours



LAeq,15min noise levels, dB(A)

20 to 25	35 to 40	> 50
25 to 30	40 to 45	
30 to 35	45 to 50	

Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Evening Worst-Case Noise Contours

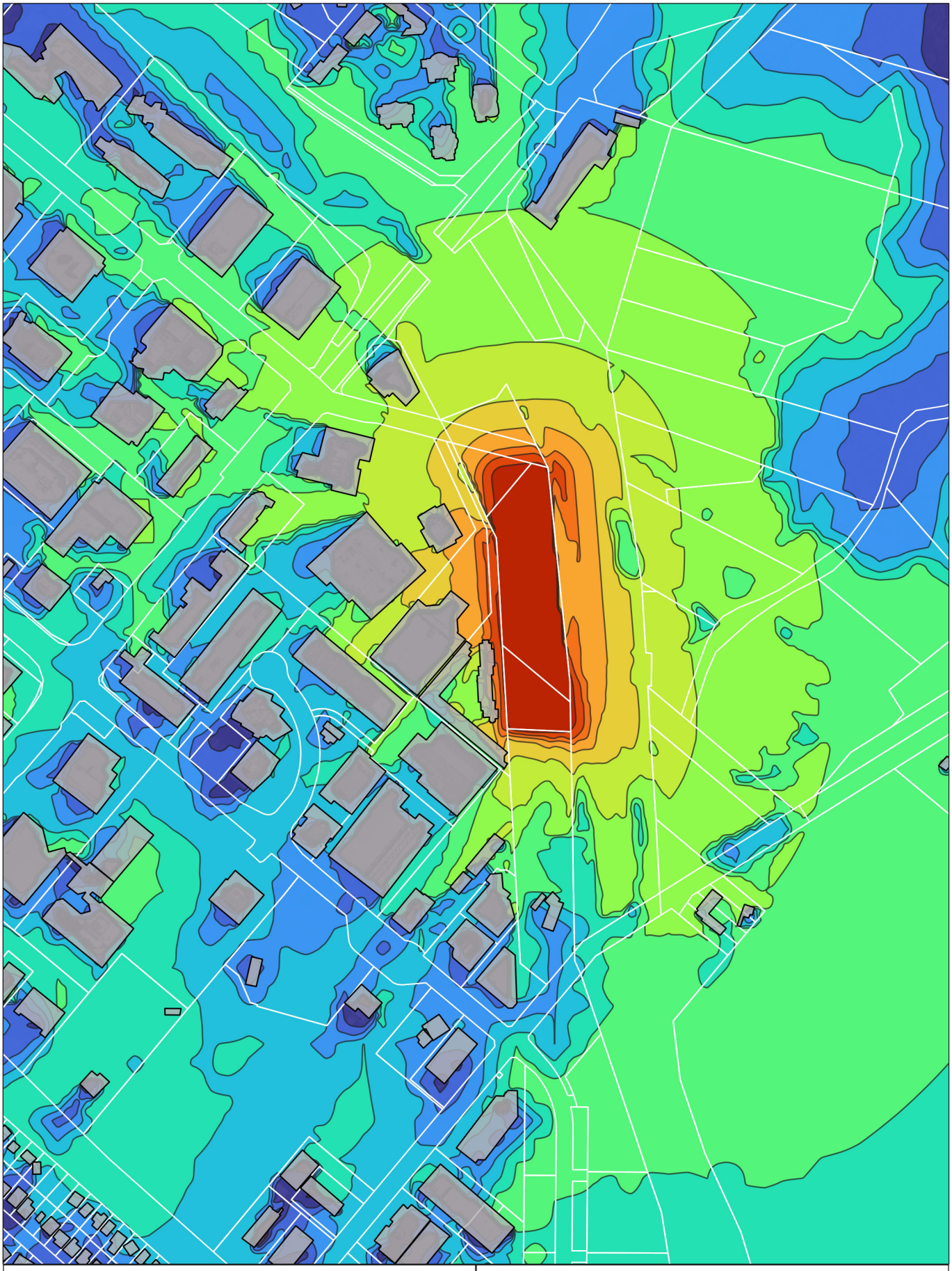


LAeq,15min noise levels, dB(A)

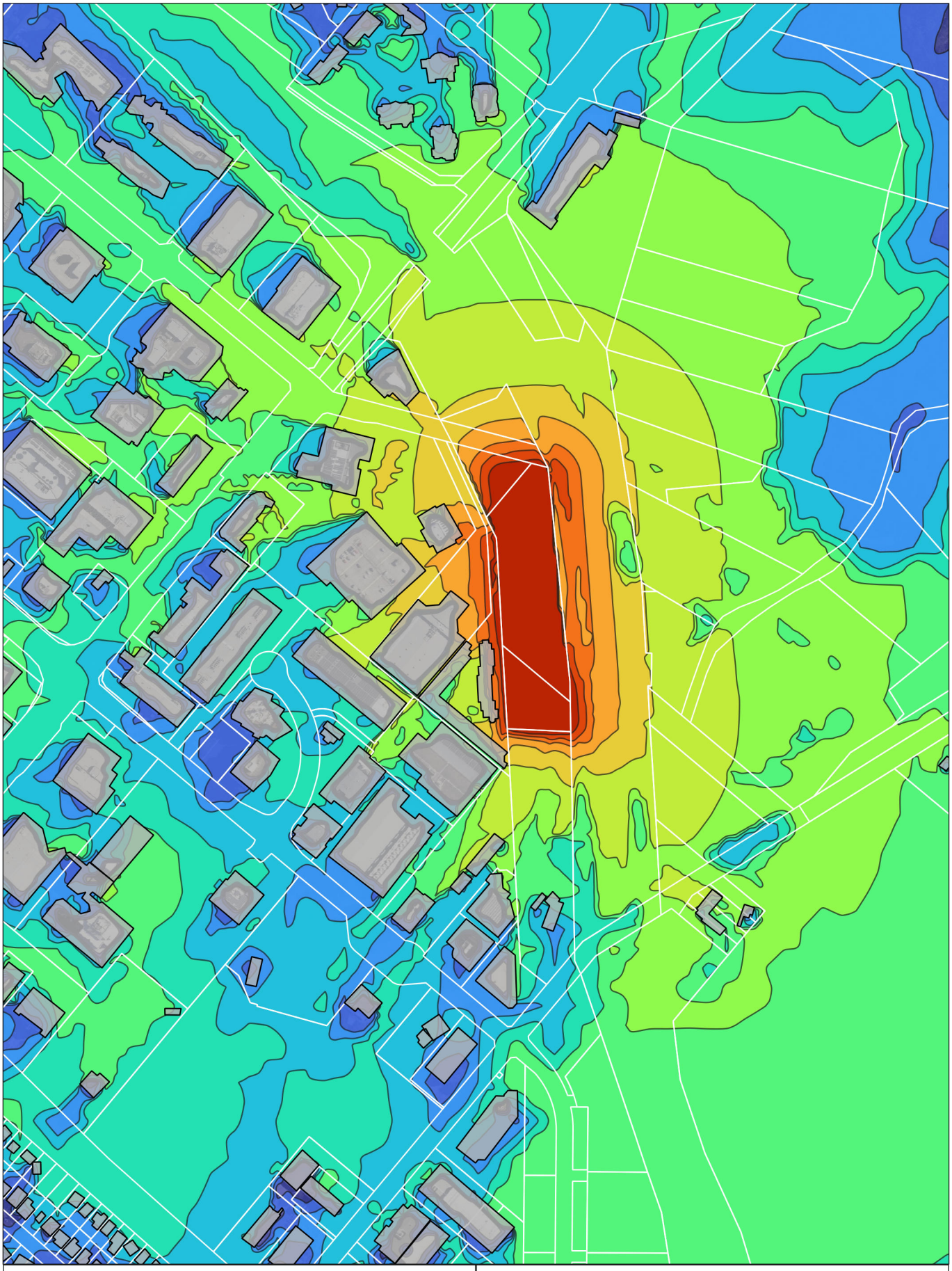
20 to 25	35 to 40	> 50
25 to 30	40 to 45	
30 to 35	45 to 50	

Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Night-time Worst-Case Noise Contours

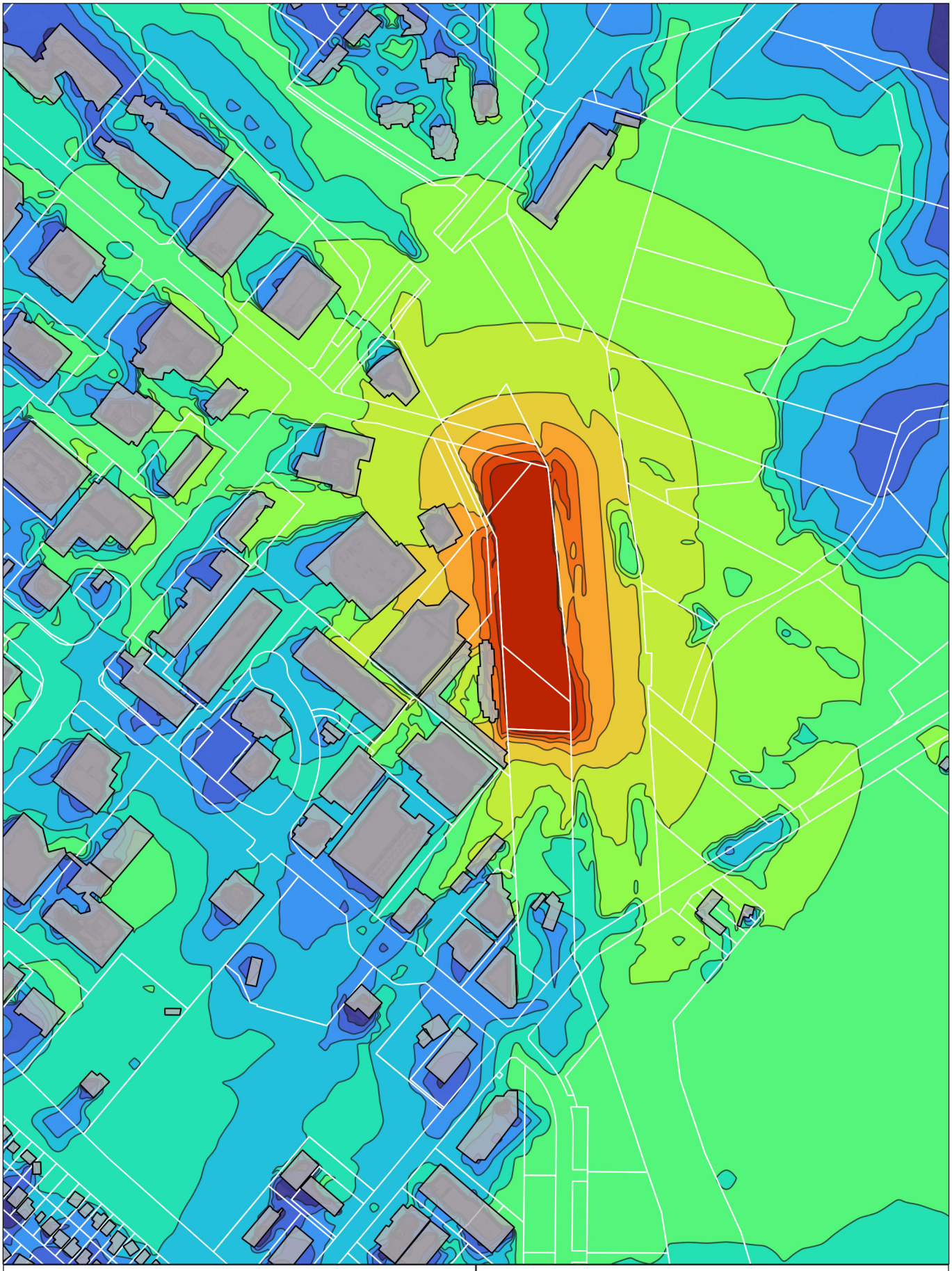
Appendix C: Construction Noise Contours



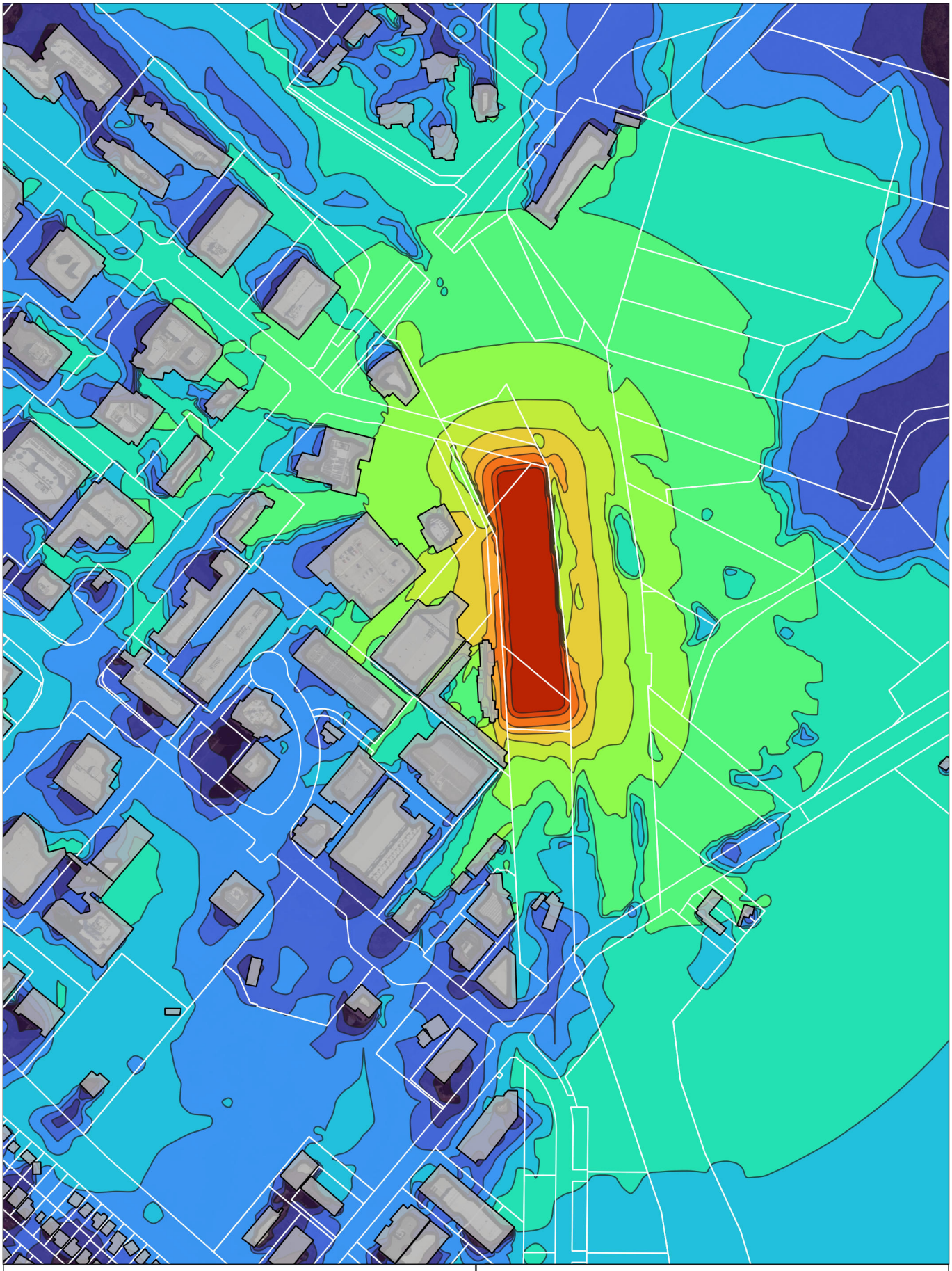
Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Demolition Worst-Case Noise Contours



Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Earthwork Worst-Case Noise Contours



Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Building Work Worst-Case Noise Contours



Macquarie Park ZEB Terminal
Noise and Vibration Impact Assessment
Gantry Work Worst-Case Noise Contours