Acoustics
Vibration
Structural Dynamics

192 NARELLAN ROAD, CAMPBELLTOWN

Traffic Noise Impact Assessment

6 July 2021

INDESCO

TM055-01F02 Traffic Noise Impact Assessment (r3)

Sydney Melbourne Brisbane Gold Coast Kuwait Singapore
Renzo Tonin & Associates ABN 29 117 462 861
Level 1/418A Elizabeth St SURRY HILLS NSW 2010 | PO Box 877 STRAWBERRY HILLS NSW 2012
P (02) 8218 0500 F (02) 8218 0501 sydney@renzotonin.com.au www.renzotonin.com.au

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Address:	100 Walker St, North Sydney NSW 2060
Attention:	Oliver Walsh

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1 Introduction

Renzo Tonin & Associates was engaged by INDESCO to undertake a traffic noise assessment for the proposed residential development at 192 Narellan Road, Campbelltown. The subject site is adjacent to the Hume Motorway and affected by road traffic noise. The purpose of the assessment is to determine the noise mitigation measures required to address traffic noise impact to the future residential dwellings.

This assessment follows on from 2013 when Renzo Tonin & Associates prepared a noise assessment for rezoning application of the site at 168 - 192 Narellan Road [1], and in 2015 when a further noise barrier feasibility study was conducted to understand the potential effectiveness of noise walls in mitigating Hume Motorway traffic noise [2].

The traffic noise levels that have been modelled in this assessment are based on predicted 2026 traffic volumes. In addition, noise measurements were undertaken on the site as part of this assessment to validate the modelled noise levels.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. APPENDIX A contains a glossary of acoustic terms used in this report.

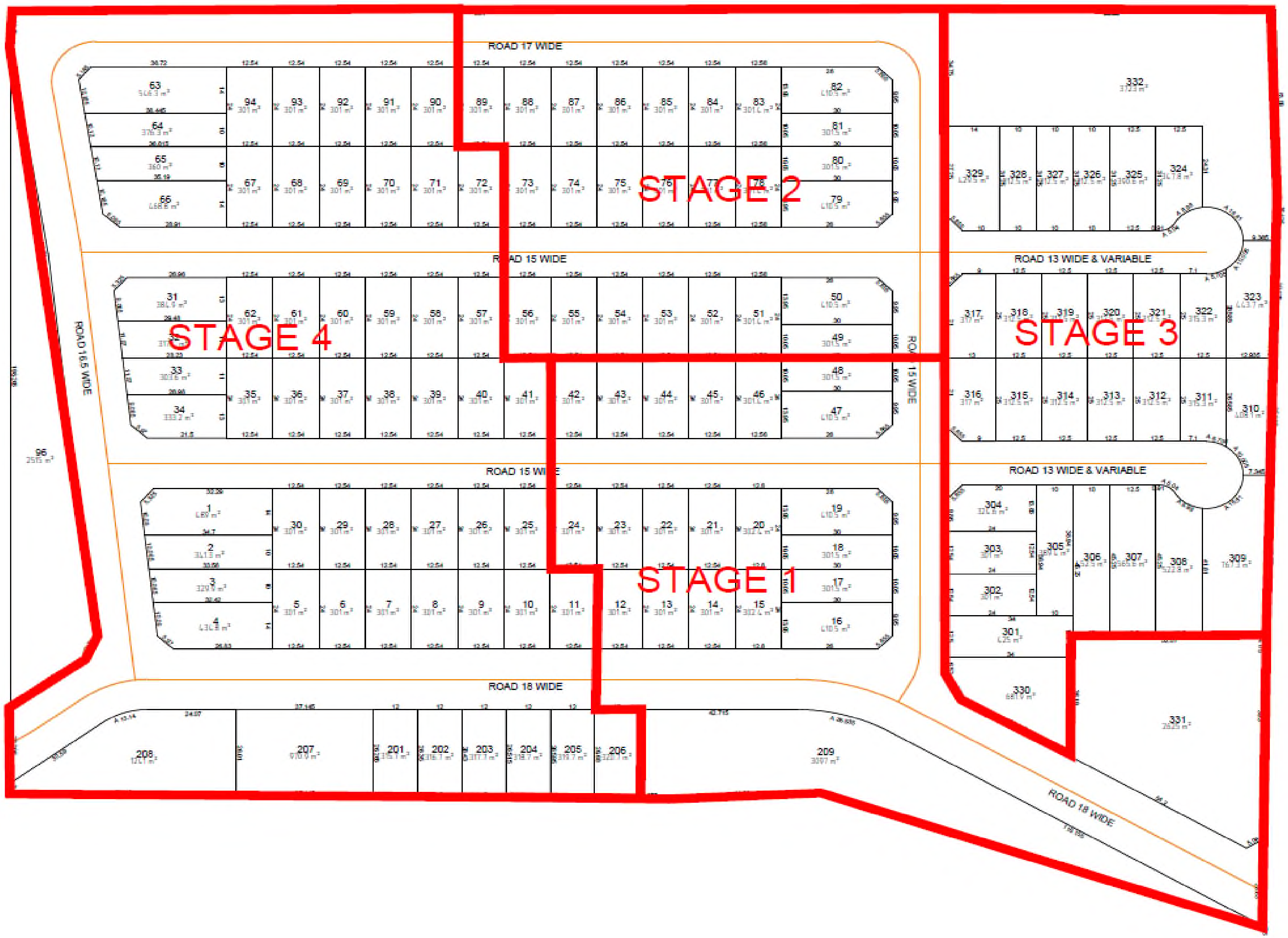
2 Project description

The subject site occupies Lot 4 DP 1213869 and is located north-east of the intersection of Hume Highway and Narellan Road. The site falls under the jurisdiction of Campbelltown City Council to which the DA is to be submitted.

The proposed subdivision includes 131 residential lots in total. It is a greenfield site with a medium density residential surrounding area. Without any industrial or commercial adjacent premises, the existing site's noise environment is predominantly of traffic nature from the surrounding motorways.

The lot layout and staging plan for the site is outlined below in Figure 1.

Figure 1 Lot layout and staging plan



3 Noise monitoring

Traffic noise measurements were undertaken on site at the three locations as shown in Figure 2. The purpose of this monitoring was to validate the noise model and confirm that the modelled traffic noise accurately depicts the existing noise environment. The noise monitoring equipment and methodology used to measure noise levels is presented in APPENDIX B.

While on site it was confirmed that the existing noise environment was controlled by traffic. Unattended noise monitoring was conducted between Wednesday 21st April and Thursday 29th April 2021. Monitoring was conducted at three different locations so that noise data that capture's the site's varying topography was obtained. The locations were also chosen to be at different distances from Hume Motorway to allow for a robust traffic noise validation process.

The measured existing traffic noise levels are presented in Table 1 below.

Table 1 Measured traffic noise levels

Monitor	Location	L_{Aeq} traffic noise levels dB(A)	
		Day	Night
M1	192 Narellan Road, setback in eastern field	59	58
M2	192 Narellan Road (East), near northern lot boundary	63	61
M3	192 Narellan Road (West), near northern lot boundary	58	59

Note:
Day period is 7am to 10pm
Night period is 10pm to 7am

Figure 2 Noise monitoring locations

4 Road traffic noise criteria

4.1 State Environmental Planning Policy (Infrastructure) 2007 (ISEPP)

The NSW State Environmental Planning Policy (Infrastructure) 2007 (known as 'ISEPP') came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

Pertinent to noise assessment, the ISEPP includes the following clauses:

102 Impact of road noise or vibration on non-road development

1. *This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:*
   - a. *a building for residential use,*
   - b. *a place of public worship,*
   - c. *a hospital,*
   - d. *an educational establishment or child care centre.*
2. *Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.*
3. *If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:*
   - a. *in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,*
   - b. *anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.*
4. *In this clause, "freeway", "tollway" and "transitway" have the same meanings as they have in the Roads Act 1993*

4.2 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

To support the ISEPP, the NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008). The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality. While the ISEPP applies only to roads with an AADT greater than 40,000 vehicles, the guideline is also recommended for other road traffic noise affected sites.

4.3 Campbelltown (Sustainable City) Development Control Plan 2015

Part 3 of Campbelltown (Sustainable City) Development Control Plan 2015 outlines requirements regarding low and medium density residential developments. Section 3.4.3.1 outlines the design requirements concerning acoustic privacy and the relevant clauses are reproduced below:

a) *Development that adjoins significant noise sources, (such as main roads, commercial/industrial development, public transport interchanges and railways) shall be designed to achieve acceptable internal noise levels, based on recognised Australian Standards and any criteria and standards regulated by a relevant State Government Authority.*

b) *Development shall incorporate noise attenuation measures that are compatible with the scale, form and character of the street.*

c) *On-site noise generating sources including, but not limited to, plant rooms and equipment, air conditioning units, pool pumps, and recreation areas shall be designed and located to ensure that the noise levels generated by such facilities do not exceed 5 dBA above background levels at the property boundary.*

d) *Multi dwelling housing and attached dwellings near railway corridors and major roads shall demonstrate to Council's satisfaction compliance with the requirements under the Guidelines entitled Development Near Rail Corridors and Busy Roads – Interim Guideline, 2008)*

Therefore, as per clauses above, the Development Near Rail Corridors and Busy Roads – Interim Guideline, 2008 and its corresponding ISEPP are used to set the criteria for this assessment.

4.4 Clarification of ISEPP noise limits

The Guideline clarifies the time period of measurement and assessment. Section 3.4 '*What Noise and Vibration Concepts are Relevant*' and Table 3.1 of Section 3.6.1 confirms that noise assessment is based over the following time periods:

Daytime	7am to 10pm	$L_{Aeq,15hour}$
Night-time	10pm to 7am	$L_{Aeq,9hour}$

The noise criteria nominated in the ISEPP apply to internal noise levels with windows and doors closed. However, as the noise assessment is based on measurements/predictions at external locations, equivalent external noise criteria has been established. The equivalent external noise criterion is used to determine which areas of the development may require acoustic treatment in order to meet the internal noise requirements of the ISEPP. The equivalent external goals have been determined on the following basis:

- The ISEPP states: "*If internal noise levels with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia*." The internal criteria with windows open is therefore 10 dB(A) above the criteria explicitly outlined in the ISEPP.

- The generally accepted noise reduction through an open window from a free-field external position is 10 dB(A). Windows/doors are assumed to be open no more than 5% of room floor area, in accordance with the Building Code of Australia (BCA) ventilation requirements.

Table 3 presents the ISEPP internal noise criteria along with the equivalent external noise criteria for residential premises.

Table 2 ISEPP noise criteria for new residential development

Room	Location	$L_{Aeq,15hour}$ Day 7am to 10pm	$L_{Aeq,9hour}$ Night 10pm to 7am
Living rooms*	Internal, windows closed	40	40
	Internal, windows open	50	50
	External free-field (allowing windows to remain open)^	60	60
Bedrooms*	Internal, windows closed	40	35
	Internal, windows open	50	45
	External free-field (allowing windows to remain open)^	60	55

Notes: ^ ISEPP Guideline states that where internal noise criteria are exceeded by more than 10 dB(A) with windows open mechanical ventilation is required. External goals have been calculated based on nominal 10 dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA requirements.

5 Road traffic noise assessment

5.1 Road noise prediction model

Noise predictions are based on a method developed by the United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)" known as the CoRTN (1988) method. This method has been adapted to Australian conditions and extensively tested by the Australian Road Research Board and as a result it is recognised and accepted by the Environment Protection Authority. The model predicts noise levels for steady flowing traffic and noise from high truck exhausts is also taken into account.

The CORTN algorithms are contained within the 'CadnaA' noise modelling software which has been used to calculate traffic noise levels at receivers. The noise prediction model takes into account the following:

Table 3 Summary of modelling inputs

Input Parameters	Data Acquired From
Traffic volumes and mix	See Table 4
Vehicle speed	Hume Motorway - 110km/h Narellan Road – 80km/h
Gradient of roadways	Based upon 3D topographic data obtained from NSW Land and Property Information
Source height	0.5 metre for car exhaust, 1.5 metres for car and truck engines and 3.6 metres for truck exhaust
Ground topography	Natural ground from NSW Land and Property Information for validation model Graded design surface provided by Indesco for future model
Ground absorption	1.0 for validation model when site is grass covered soft ground 0.5 for future model to represent part hardstand road/footpath and part landscaped area
Receiver Heights	1.5 metre above ground level for ground floor and 4.5 metre above ground level for 1st floor
Facade correction	+0 dB(A)
Road surface correction	Dense Graded Asphalt: 0 dB(A)

5.2 Traffic flow and composition summary

The traffic data used for noise modelling is consistent with that used for the recent Narellan Road Upgrade project, where Roads and Maritime Service (RMS) supplied 2016 and 2026 traffic data for Narellan Road and Hume Motorway. The 2026 traffic predictions were used for this project since they are expected to be a slightly conservative representation of the current 2021 traffic volumes.

Table 4 below presents the traffic data used as inputs to the noise model.

Table 4 Traffic volumes used in modelling

Road	Direction	Day time traffic volume (7am to 10pm)		Night time traffic volume (10pm to 7am)		Posted speed km/h
		Total	HV%	Total	HV%	
Hume Highway	NB	31049	6.3%	7543	7.9%	110
	SB	36146	5.2%	5284	7.3%	110
Narellan Road, west of USW entrance	EB	31215	4.1%	3861	4.2%	80
	WB	30675	3.9%	4392	4.4%	80

5.3 Traffic noise validation

To ensure reliability of the noise model, traffic noise levels were modelled in CadnaA with receivers placed at the same locations where noise measurements were conducted (Figure 2) to allow direct comparison of measured versus modelled noise levels. Current ground topography was obtained from NSW land and property information to ensure a realistic model.

Table 5 below outlines the comparison between the modelled and measured traffic noise. The noise model overpredicts by around 5dB(A) during daytime, and over predicts by 1 - 2dB(A) during the night time. The over prediction may be due to higher estimated traffic volumes in 2026 than what is currently on the Hume Motorway currently in 2021, and potentially an over estimation of the number of heavy vehicles.

In terms of noise assessment, since the measured traffic noise levels for day and night are within 5 dB, and Table 2 outlines the night-time criteria for bedrooms to be 5 dB below the daytime, then the acoustic design in this assessment is governed by the night-time traffic noise. Hence, the noise mitigation measures in this report have been determined to meet the night-time criteria, which would then also be sufficient to meet the daytime criteria. It was also determined that no correction should be applied to the night time model to retain a slight conservativeness in the results.

Table 5 Traffic noise model validation

Location	Address	Measured L_{Aeq} traffic noise level		CadnaA L_{Aeq} model prediction		Difference (Modelled - Measured)	
		Day	Night	Day	Night	Day (15h)	Night (9h)
M1	192 Narellan Road, setback in eastern field	59	58	64	59	+5	+1
M2	192 Narellan Road (East), near northern lot boundary	63	61	68	63	+5	+2
M3	192 Narellan Road (West), near northern lot boundary	58	59	65	60	+7	+1

5.4 Noise modelling assumptions

The assumptions that have been included in the traffic noise modelling include:

- Indicative building envelopes on each lot as per Figure 1.
- Ground floor recommendations assume all dwellings are single storey.
- First floor recommendations assume all dwellings are double storey.
- Residential floor areas and window sizes are assumed to not exceed those outlined in Appendix B of the Department of Planning "Development near Rail Corridors and Busy Roads – Interim Guideline".
- Various noise wall heights and extents were investigated to understand their potential effectiveness. After taking into consideration visual impacts of high walls, cost/benefit of walls versus property treatment, and tie-in to the existing noise wall on the adjacent Blair Athol residential development, the final noise wall proposal is as shown in APPENDIX D.
- Noise walls 3m or greater in height should be constructed of masonry, Hebel or similar to ensure sufficient mass to prevent noise transmission through the wall. Sectins or panels of transparent Perspex or polycarbonate are also permissible. Any 2m high sections of noise wall could be constructed of lapped and capped timber if required.

5.5 Noise prediction results

Road traffic noise levels at all dwellings with the development have been predicted and calculations have been conducted to predict internal noise levels for bedrooms and living rooms. Noise predictions have been conducted at ground floor and first floor receivers for the controlling night time period, with noise contours presented in APPENDIX C. Where necessary, building treatment recommendations have been identified on the figures as shown in APPENDIX D to achieve the internal noise goals identified in Section 4 of this report.

APPENDIX E details the facade treatment categories and recommended constructions. The facade recommendations assume room volumes and areas as per Table B1 of the ISEPP Guideline.

5.6 Mechanical ventilation

The Department of Planning's publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008 states;

If internal noise levels with windows or doors open exceed the criteria by more than 10dB(A), the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia.

Dwellings with facade recommendations of category 2 and above as shown on the figures in APPENDIX D would also require mechanical ventilation.

5.7 Development Staging

The above recommendations apply when the entire site and noise wall are constructed. Ideally the noise wall would be constructed prior to the completion of the first dwellings. However if construction of the site is undertaken in stages (stages shown in Figure 1), then it is assumed some portions of the noise wall may be delayed in their construction. If this is the case the following additional measures will need to be considered:

- If Stage 1 is developed prior to other stages - no additional measures are required since the Stage 1 dwellings are set well back from Hume Motorway and are shielded from traffic noise by the natural topography of the site.

- If Stage 1 and Stage 2 are developed prior to Stage 3 - Stage 2 dwellings will be more affected if the section of the noise wall in Stage 3 is not yet constructed. Therefore, a temporary 3m noise wall would need to be provided along the boundary between Stages 2 and 3 (as shown in Figure 3) to avoid increased property treatments to the Stage 2 dwellings.

- Stage 3 will not be affected by the staging process as long as the Stage 3 section of the noise wall is completed prior to the Stage 3 dwellings.

- If Stage 4 was developed prior to Stage 3 – no additional measures as Stage 4 is not reliant on the Stage 3 noise wall.

Figure 3 Noise wall modification for staging

6 Conclusion

Renzo Tonin & Associates have completed a traffic noise assessment for the proposed residential subdivision at 192 Narellan Road, Campbelltown.

The findings of this assessment are:

- A noise wall of 2.0m to 4.8m height as outlined in APPENDIX D is recommended to provide a reasonable external amenity and to reduce traffic noise levels across the site.
- In-principle building treatments have been recommended in APPENDIX D for each affected residential lot to comply with the required internal noise goals detailed in Section 4.
- ISEPP mechanical ventilation requirements have been discussed in Section 5.6.
- Requirements for staging the development have been discussed and a temporary noise wall arrangement is described in Section 5.7.

References

[1] Renzo Tonin & Associates (2013), 168-192 Narellan Road, Campbelltown Preliminary Noise Assessment for Rezoning Application, TG505-01F02 (rev 2) Noise Assessment.

[2] Renzo Tonin & Associates (2015), 168-192 Narellan Road, Campbelltown Noise Barrier Feasibility Study, TG505-02F02 (r1) Noise Barrier Feasibility Study.

[3] Renzo Tonin & Associates (2013), Narellan Road Upgrade (Camden Valley Way to Baxland Road) Noise and Vibration Assessment, TF888-01F03 (rev 4) Noise and Vibration Assessment.

[4] Renzo Tonin & Associates (2019), Narellan Road Post Construction Noise Assessment, TK554-01F02 Post Construction Noise Assessment r1.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Absorption Coefficient α	The absorption coefficient of a material, usually measured for each octave or third-octave band and ranging between zero and one. For example, a value of 0.85 for an octave band means that 85% of the sound energy within that octave band is absorbed on coming into contact with the material. Conversely, a low value below about 0.1 means the material is acoustically reflective.
Adverse weather	Weather effects that enhance noise (particularly wind and temperature inversions) occurring at a site for a significant period of time. In the NSW INP this occurs when wind occurs for more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of nights in winter.
Air-borne noise	Noise which is fundamentally transmitted by way of the air and can be attenuated by the use of barriers and walls placed physically between the noise source and receiver.
Ambient noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Amenity	A desirable or useful feature or facility of a building or place.
AS	Australian Standard
Assessment period	The time period in which an assessment is made. e.g. Day 7am-10pm & Night 10pm-7am.
Assessment Point	A location at which a noise or vibration measurement is taken or estimated.
Attenuation	The reduction in the level of sound or vibration.
Audible Range	The limits of frequency which are audible or heard as sound. The normal hearing in young adults detects ranges from 20 Hz to 20 kHz, although some people can detect sound with frequencies outside these limits.
A-weighting	A filter applied to the sound recording made by a microphone to approximate the response of the human ear.
Background noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level if measured as an overall level or an L90 noise level when measured in octave or third-octave bands.
Barrier (Noise)	A natural or constructed physical barrier which impedes the propagation of sound and includes fences, walls, earth mounds or berms and buildings.
BS	British Standard
CoRTN	United Kingdom Department of Environment entitled "Calculation of Road Traffic Noise (1988)"
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our environment:

threshold of hearing	0 dB	The faintest sound we can hear, defined as 20 micro Pascal
	10 dB	Human breathing
almost silent	20 dB	
	30 dB	Quiet bedroom or in a quiet national park location
generally quiet	40 dB	Library
	50 dB	Typical office space or ambience in the city at night

	moderately loud	60 dB	CBD mall at lunch time
		70 dB	The sound of a car passing on the street
	loud	80 dB	Loud music played at home
		90 dB	The sound of a truck passing on the street
	very loud	100 dB	Indoor rock band concert
		110 dB	Operating a chainsaw or jackhammer
	extremely loud	120 dB	Jet plane take-off at 100m away
	threshold of pain	130 dB	
		140 dB	Military jet take-off at 25m away

dB(A)	A-weighted decibel. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies. The dB(C) level is not widely used but has some applications.
ECRTN	Environmental Criteria for Road Traffic Noise, NSW, 1999
ENMM	Environmental Noise Management Manual, Roads and Maritime Services (Transport for NSW)
EPA	Environment Protection Authority
Free-field	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.
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.
Heavy Vehicle	A truck, transporter or other vehicle with a gross weight above a specified level (for example: over 8 tonnes).
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 dB(A).
ISEPP	State Environmental Planning Policy (Infrastructure), NSW, 2007
ISEPP Guideline	Development Near Rail Corridors and Busy Roads - Interim Guideline, NSW Department of Planning, December 2008
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.
L10(1hr)	The L10 level measured over a 1 hour period.
L10(18hr)	The arithmetic average of the L10(1hr) levels for the 18 hour period between 6am and 12 midnight on a normal working day.
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 dB(A).
LAeq or Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the LAeq.

LAeq(1hr)	The LAeq noise level for a one-hour period. In the context of the NSW EPA's Road Noise Policy it represents the highest tenth percentile hourly A-weighted Leq during the period 7am to 10pm, or 10pm to 7am (whichever is relevant).
LAeq(8hr)	The LAeq noise level for the period 10pm to 6am.
LAeq(9hr)	The LAeq noise level for the period 10pm to 7am.
LAeq(15hr)	The LAeq noise level for the period 7am to 10pm.
LAeq (24hr)	The LAeq noise level during a 24 hour period, usually from midnight to midnight.
Lmax	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmax.
Lmin	The minimum sound pressure level measured over a given period. When A-weighted, this is usually written as the LAmin.
Laboratory Test	The performance of a building element when measured in a laboratory. The sound insulation performance of a building element installed in a building however can differ from its laboratory performance for many reasons including the quality of workmanship, the size and shape of the space in which the measurement is conducted, flanking paths and the specific characteristics of the material used which may vary from batch to batch.
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. That is, the sound of 85 dB is four times or 400% the loudness of a sound of 65 dB.
Microphone	An electro-acoustic transducer which receives an acoustic signal and delivers a corresponding electric signal.
NCG	Noise Criteria Guideline, Roads and Maritime Services (Transport for NSW)
NMG	Noise Mitigation Guideline, Roads and Maritime Services (Transport for NSW)
Noise	Unwanted sound
Normalised	A method of adjusting the measured noise indices in a laboratory so that they are independent of the measuring space. The noise level in a room is affected by reverberation in the room. For example, the Ln,w impact sound pressure level measured in a laboratory is dependent upon the amount of absorptive material in the receiving room. The value is adjusted to what would be measured if the sound absorption in the receiving room is set at 10m2. This enables all laboratories to report the same value when measured under slightly different conditions. See also 'Standardised'.
NRC	Noise Reduction Coefficient. A measure of the ability of a material to absorb sound. The NRC is generally a number between 0 and 1 but in some circumstances can be slightly greater than 1 because of absorption at the edges of the material. A material with an NRC rating of 1 absorbs 100% of incoming sound, that is, no sound is reflected back from the material. The NRS is the average of the absorption coefficient measured in the octave bands 250Hz, 500Hz, 1kHz & 2kHz which correspond to the predominant frequencies associated with the human voice.
RBL	Rating Background Level is the representative LA90 background noise level for a period, as defined in the NSW EPA's noise ploicies.
Reflection	Sound wave reflected from a solid object obscuring its path.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 pico watt.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone referenced to 20 mico Pascal.

APPENDIX B Noise monitoring methodology

B.1 Noise monitoring equipment

A long-term unattended noise monitor consists of a sound level meter housed inside a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period. Long term noise monitoring was conducted using the following instrumentation:

Description	Type	Octave band data	Logger location(s)
RTA07 (NTi Audio XL2)	Type 1	1/1	All

Notes: All meters comply with AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and designated either Type 1 or Type 2 as per table, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Type 4231 calibrator. No significant drift in calibration was observed.

B.2 Meteorology during monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s) or rain were excluded from the recorded data in accordance with the NSW Noise Policy for Industry (NPfI). Determination of extraneous meteorological conditions was based on data provided by the Bureau of Meteorology (BOM), for a location considered representative of the noise monitoring location(s). However, the data was adjusted to account for the height difference between the BOM weather station, where wind speed and direction is recorded at a height of 10m above ground level, and the microphone location, which was 1.5m above ground level. The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

B.3 Noise vs time graphs

Noise almost always varies with time. Noise environments can be described using various descriptors to show how a noise ranges about a level. In this report, noise values measured or referred to include the L_{10}, L_{90}, and L_{eq} levels. The statistical descriptors L_{10} and L_{90} measure the noise level exceeded for 10% and 90% of the sample measurement time. The L_{eq} level is the equivalent continuous noise level or the level averaged on an equal energy basis. Measurement sample periods are usually ten to fifteen minutes. The Noise -vs- Time graphs representing measured noise levels, as presented in this report, illustrate these concepts for the broadband dB(A) results.

APPENDIX C Noise contour maps

Plot Date: 28/06/21 - 17:58 Layout: TXXXX XX-XX-XX-XX APPB&E-W_O_R_K_A_R_E_A(r25)

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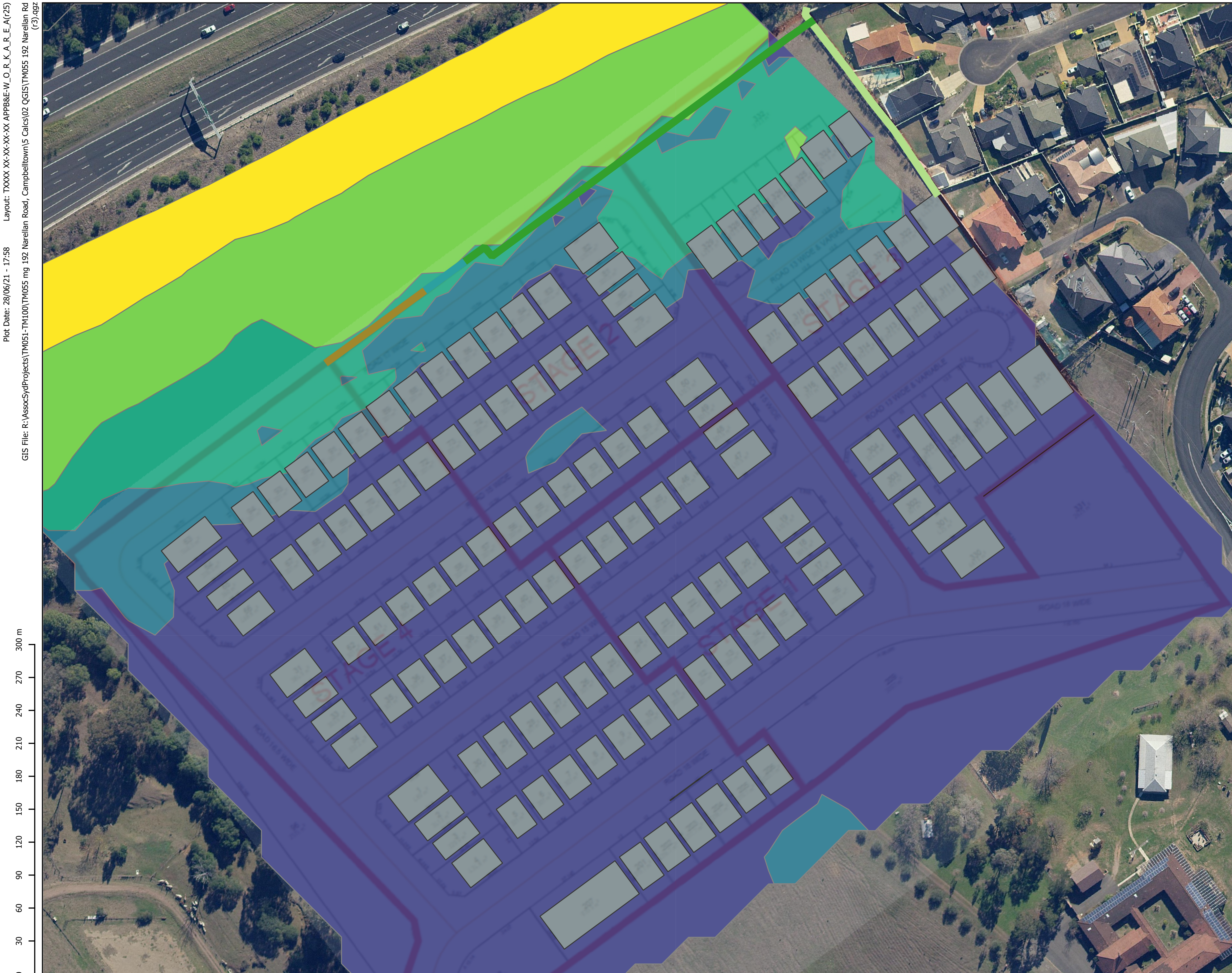

Ground floor noise level Night, 10pm to 7am dB(A) Leq 9 hour

- < 53
- 53 - 55
- 55 - 60
- 60 - 65
- Above 65

- Buildings
- 4.8m noise wall
- 3m noise wall
- 2.8m existing noise wall
- 2m noise wall

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r0	MA	28/06/21	Prepare figures	MG

A3 Original

Co-ordinate System: MGA Zone 56

0 70 140 210 m

1:1

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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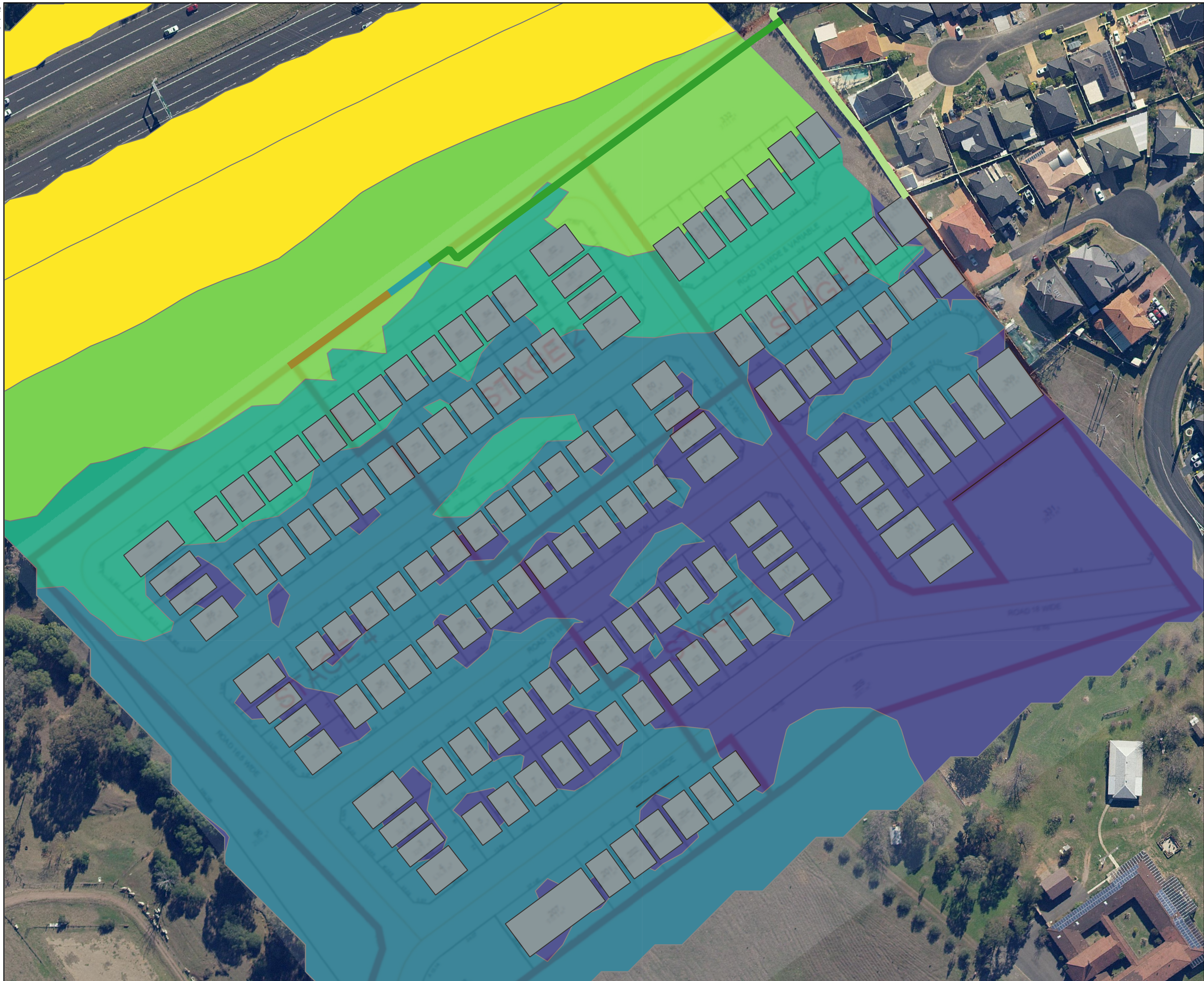
192 Narellan Road

Ground floor noise contours based on night time traffic noise

CadnaA_V02

Sheet 1 of 4



First floor noise level Night, 10pm to 7am dB(A) Leq 9 hour

■	< 53
■	53 - 55
■	55 - 60
■	60 - 65
■	Above 65

- Buildings
- 4.8m noise wall
- 3m noise wall
- 2.8m existing noise wall
- 2m noise wall

Layout: TXXXX XX-XX-XX-XX APPB&E-W_O_R_K_A_R_E_A(r25)

Plot Date: 28/06/21 - 17:30

GIS File: R:\AssocSydProjects\TM051-TM100\TM055 mg 192 Narellan Road, Campbelltown\5 Calcs\02 QGIS\TM055 192 Narellan Rd (r3).qgz

300 m, 270, 240, 210, 180, 150, 120, 90, 60, 30, 0

REV	BY	DATE	DESCRIPTION	APPROVER
r0	MA	28/06/21	Prepare figures	MG

A3 Original | Co-ordinate System: MGA Zone 56

0 70 140 210 m

1:1

FULL SIZE A3

NOTE: Do not scale from this drawing.

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192 Narellan Road

First floor noise contours based on night time traffic noise CadnaA_V04

APPENDIX D Building treatment recommendations

The dwellings in the proposed development will require facade treatment to achieve suitable internal noise levels. The facade treatment recommendations are shown on the following attached figures. Ground floor and first floor recommendations have been provided for living rooms and bedrooms.

APPENDIX E details the facade treatment categories and recommended constructions. The facade recommendations assume room volumes and areas as per Table B1 of the ISEPP Guideline.

Ground floor facade treatments

- Category 1
- Category 2
- Category 3
- Category 4

- Buildings
- 4.8m noise wall
- 3m noise wall
- 2.8m existing noise wall
- 2m noise wall

REV	BY	DATE	DESCRIPTION	APPROVER
r0	MA	28/06/21	Prepare figures	MG

A3 Original

Co-ordinate System: MGA Zone 56

0 70 140 210 m

1:1

FULL SIZE A3

NOTE: Do not scale from this drawing.

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192 Narellan Road

Ground floor facade treatments based on night time traffic noise

CadnaA_V02

Plot Date: 28/06/21 - 18:07

Layout: TXXXX XX-XX-XX-XX APPB&E-W_O_R_K_A_R_E_A(r25)

GIS File: R:\AssocSydProjects\TM051-TM100\TM055 mg 192 Narellan Road, Campbelltown\5 Calcs\02 QGIS\TM055 192 Narellan Rd (r3).qgz

Plot Date: 28/06/21 - 18:08 Layout: TXXXX XX-XX-XX-XX APPB&E-W_O_R_K_A_R_E_A(r25)

GIS File: R:\AssocSydProjects\TM051-TM100\TM055 mg 192 Narellan Road, Campbelltown\5 Calcs\02 QGIS\TM055 192 Narellan Rd (r3).qgz

First floor facade treatments

- Category 1
- Category 2
- Category 3
- Category 4
- Buildings
- 4.8m noise wall
- 3m noise wall
- 2.8m existing noise wall
- 2m noise wall

REV	BY	DATE	DESCRIPTION	APPROVER
r0	MA	28/06/21	Prepare figures	MG

A3 Original

Co-ordinate System: MGA Zone 56

0 70 140 210 m

1:1

FULL SIZE A3

NOTE: Do not scale from this drawing.

CLIENT

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192 Narellan Road

First floor facade treatments based on night time traffic noise

CadnaA_V04

Sheet 3 of 4

APPENDIX E Building treatment categories

Category No.	Building Element	Required Acoustic Rating of Building Element, Rw	Construction Recommendation		
1	Windows / Sliding Doors	24+	Openable with minimum 4mm monolithic glass and standard weather seals		
	Facade	38+	Cladding Construction: 9mm fibre cement sheeting or weatherboards or plank cladding externally, 90mm timber stud, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	40+	Pitched concrete or terracotta tile or metal sheet roof, 10mm plasterboard ceiling fixed to ceiling joists, bulk insulation in roof cavity.		
	Door	28+	35mm solid core timber door fitted with full perimeter acoustic seals		
2	Windows / Sliding Doors	27+	Openable with minimum 6mm monolithic glass and full perimeter acoustic seals		
	Facade	45+	Cladding Construction: 9mm fibre cement sheeting or weatherboards or plank cladding externally, 90mm timber stud, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	43+	Pitched concrete or terracotta tile or metal sheet roof, 10mm plasterboard ceiling fixed to ceiling joists, bulk insulation in roof cavity.		
	Door	30+	40mm solid core timber door fitted with full perimeter acoustic seals		
3	Windows / Sliding Doors	32+	Openable with minimum 6.38mm laminated glass and full perimeter acoustic seals		
	Facade	52+	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.		Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	48+	Pitched concrete or terracotta tile or sheet metal roof, 1 layer of 13mm sound-rated plasterboard fixed to ceiling joists, bulk insulation in roof cavity.		
	Door	33+	45mm solid core timber door fitted with full perimeter acoustic seals		
4	Windows / Sliding Doors	35+	Openable with minimum 10.38mm laminated glass and full perimeter acoustic seals		

Category No.	Building Element	Required Acoustic Rating of Building Element, Rw	Construction Recommendation	
	Facade	55+	Brick Veneer Construction: 110mm brick, 90mm timber stud, minimum 40mm clearance between masonry and stud frame, R2 insulation batts in wall cavity, 10mm standard plasterboard internally.	Cavity Brick Construction: 2 leaves of 110mm brickwork separated by 50mm gap.
	Roof	52+	Pitched concrete or terracotta tile or sheet metal, 2 layers of 13mm sound-rated plasterboard fixed to ceiling joists, bulk insulation in roof cavity.	
	Door	33+	45mm solid core timber door fitted with full perimeter acoustic seals	

Notes:

- Where a room has different category recommendations on two or more facades, the roof recommendation for the highest category applies.
- Any wall, roof or ceiling penetrations shall be acoustically sealed so as not to reduce the acoustic performance of the element.
- The acoustic performance of glazed doors should be in accordance with the window glazing requirement of the applicable category.
- Development Near Rail Corridors and Busy Roads – Interim Guideline recommends solid core timber doors of 45mm thickness for treatment categories 3 and 4. To align with current industry construction methods, solid core door recommendations have been limited to no more than 40mm thickness.

The required acoustic rating is for the entire system. For example, for windows this includes the glass, frame and seals including the perimeter seal at the wall junction.

By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the glazing assembly, a higher rating implying a higher sound reduction performance.

Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.

The client is advised not to commence detailing or otherwise commit to systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of systems and assemblies is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved. No responsibility is taken for use of or reliance upon untested systems, estimates or opinions. The advice provided here is in respect of acoustics only.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

NOTES FOR GLAZING CONSTRUCTIONS:

All openable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the Rw rating performance of the glazing to not be reduced.

The above glazing thicknesses should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

GENERAL

The sealing of all gaps in acoustic rated glazing assemblies and facades is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.

Check design of all junction details with acoustic consultant prior to construction.

Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.

The information provided in this table is subject to modification and review without notice.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.