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STATION STREET MENANGLE, STAGE 1 DEVELOPMENT APPLICATION

DA Acoustic Report

21 December 2018

Mirvac Homes (NSW) Pty Limited c/o Calibre Group

TK439-01F02 DA Acoustic Report (r4)

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1 Introduction

Renzo Tonin & Associates was engaged to conduct an environmental noise assessment of rail and industrial noise onto Stage 1 of the proposed residential subdivision located at Station Street, Menangle.

This report quantifies the noise impact from an industrial site to the north of the development; noise impact from the Southern Highlands rail line, which runs through the development between Stage 1, and Stages 2, 3 and 4, and road noise generated by Menangle Road, located to the west of the development Noise impacts for rail traffic have been assessed in accordance with Wollondilly Shire Council ('Council') DCP 2016, New South Wales ('NSW') State Environmental Planning Policy (Infrastructure) 2007 ('ISEPP') and NSW Department of Planning document Development near Rail Corridors and Busy Roads - Interim Guideline.

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

2.1 Site description and development overview

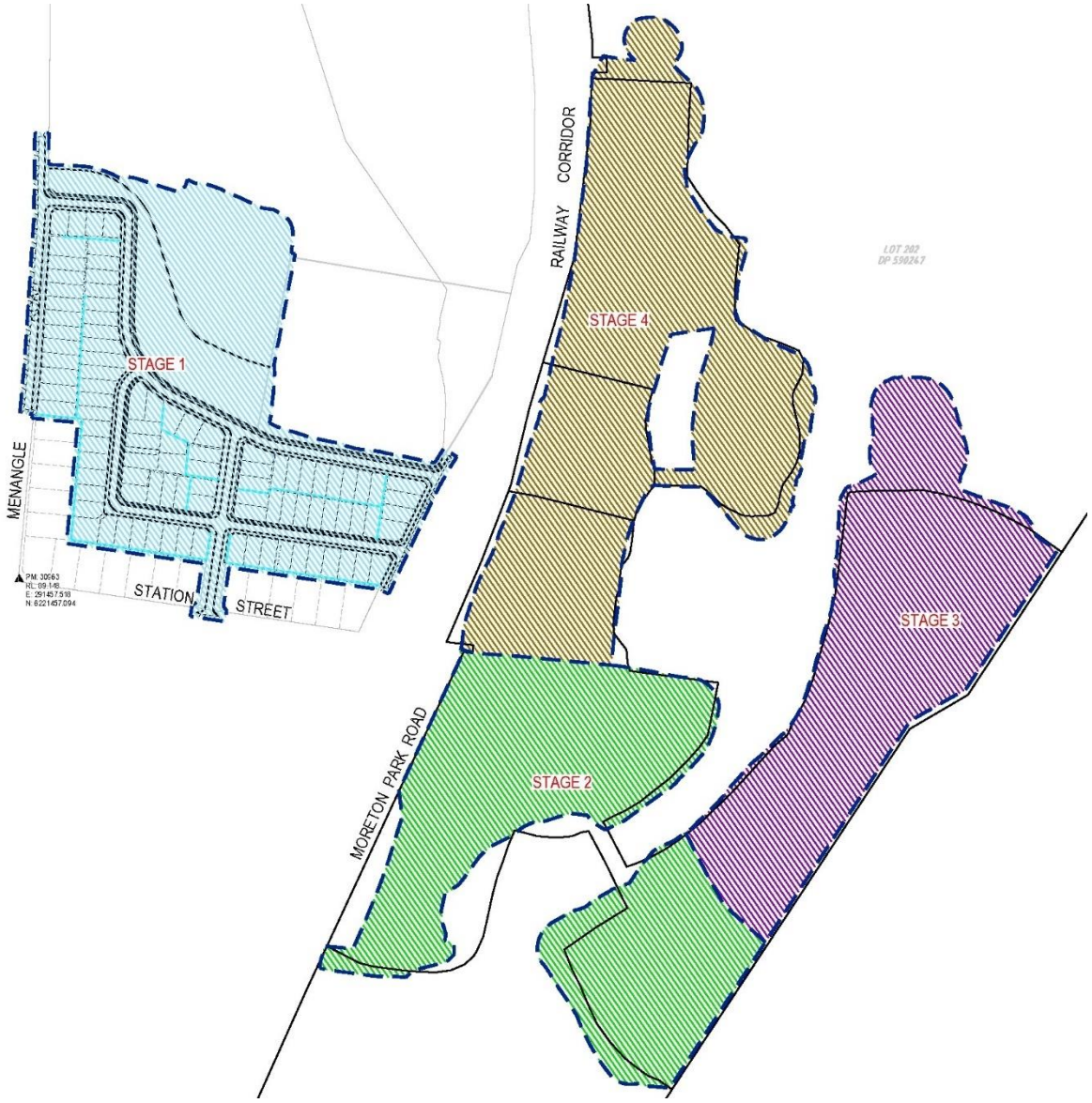
The site is situated some 50km from the Sydney CBD in the south-western suburb of Menangle.

The Stage 1 residential subdivision includes the development of 97 residential lots and is bound by an industrial premises (quarry) approximately 220m to the north, Menangle Road immediately to the west, Station Street immediately to the south and the Southern Highlands Rail Line immediately to the east.

Figure 1 presents the subject site and surrounds. Figure 2 presents the staging plan for the current Stage 1 and future Stages 2-4.

Figure 1: Subject Site

Figure 2: Draft staging plan



2.2 Assessment methodology

In order to assess the potential industrial, road and rail traffic noise impact on the subdivision site, the following methodology was used:

- Conduct noise monitoring on site to establish existing noise levels
- Using predictive noise modelling and the results of noise measurements for validation, , determine the extent of noise impact at each residential lot;
- Identify where industrial noise and rail traffic noise emission onto the site may exceed the relevant criteria;

- Where external noise levels are predicted to exceed the noise criteria, in-principle recommendations are provided for building envelope design in order to achieve internal noise criteria.

3 Existing noise environment

Long-term noise monitoring was conducted at the subject site between Wednesday 1 and Friday 10 August, 2018 in order to determine existing background noise conditions and to quantify the current noise impacting the site generated by existing road and rail. Noise monitoring methodology is presented in APPENDIX D.

Short-term attended noise and vibration measurements were conducted on Friday 10 August to quantify noise from the surrounding industrial sources and vibration impacting on the site by the Southern Highlands Rail Line. Vibration measurement locations were off site and were used to establish existing vibration levels as the basis for on-site predictions.

3.1 Noise and vibration measurement locations

Long-term noise monitoring, short-term noise measurement and vibration monitoring locations are outlined in Table 1 and presented in Figure 3.

Table 1: Noise and vibration measurement locations

ID	Location	Description
Long-term noise monitoring		
L1	Cnr Unnamed Road and Menangle Road	The logger was located approximately 15m to the east of Menangle Road. The noise environment was dominated by distant traffic noise from the Hume Highway to the east, with occasional noise from passing traffic on Menangle Road.
L2	Stevens Road	The logger was located approximately 60m to the west of the Southern Highlands Rail Line. The noise environment was dominated by distant traffic from the Hume Highway to the east, with occasional noise from passing passenger and freight trains.
S1	Northern property boundary	Short-term measurement was conducted at the northern extent of the property, towards an access road servicing two portions of Benedict Sands industrial site. The noise environment was dominated by the Hume Highway to the east, and truck activity was occasionally audible from the north.
S2	Northern property boundary	Short-term measurement was conducted at the northern extent of the property, towards an access road servicing two portions of Benedict Sands industrial site. Clear line-of-sight was provided to heavy vehicles utilising the access road during measurement. The noise environment was dominated by the Hume Highway to the east, and truck activity was occasionally audible from the north.
S3	Northern property boundary	Short-term measurement was conducted at the northern extent of the property, towards an access road servicing two portions of Benedict Sands industrial site. The noise environment was dominated by the Hume Highway to the east, and truck activity was occasionally audible from the north,
S4	Northern property boundary	Short-term measurement was conducted at the northern extent of the property, towards an access road servicing two portions of Benedict Sands industrial site. The noise environment was dominated by the Hume Highway to the east, and truck activity was occasionally audible from the north,

ID	Location	Description
V1	Eastern property boundary	Operator attended rail vibration survey approximately 30m west of the Southern Highlands Rail Corridor.
V2	Eastern property boundary	Operator attended rail vibration survey approximately 45m west of the Southern Highlands Rail Corridor

Figure 3: Noise and vibration measurement locations

3.2 Noise and vibration measurement results

Results from long-term noise monitoring and short-term noise measurements are presented in Table 2 and Table 3 below. Vibration measurement results are presented in Figure 5 to Figure 8 in Section 9.4.

Table 2: Road/Rail noise monitoring results

	L_{Aeq} noise levels		$L_{Aeq\ 1hr}$ noise levels			
	Day[1]	Night[2]	Day - up[3]	Day - low[4]	Night - up[3]	Night - low[4]
L1 - Cnr Unnamed Road and Menangle Road	58	56	63	54	60	49
L2 - Stevens Road	60	59	64	53	63	53

Notes
1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Upper 10th percentile $L_{Aeq\ 1hr}$
4. Lower 10th percentile $L_{Aeq\ 1hr}$

Table 3: Short-term noise measurement results

ID	Time of measurement	$L_{Aeq,\ 15min}$
S1	11:16-11:31	51
S2	11:37-11:52	49
S3	11:56-11:11	50
S4	12:18-12:33	49

4 Noise criteria

4.1 State Environmental Planning Policy (Infrastructure) 2007 noise limits

In NSW the SEPP (Infrastructure) 2007, also known at the Infrastructure SEPP ('ISEPP'), commenced 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.

4.1.1 ISEPP Guideline

To support the infrastructure SEPP, 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.

The Guideline clarifies the time period of measurement and assessment. As stated in the Guideline in Section 3.4 'What Noise and Vibration Concepts are Relevant' and Table 3.1 of Section 3.6.1, noise measurements are determined over the following relevant time periods:

- Daytime 7am - 10pm $L_{Aeq(15hr)}$
- Night-time 10pm - 7am $L_{Aeq(9hr)}$

L_{Aeq} is the Equivalent Continuous Noise Level and accounts for both the level of fluctuating noise and also the number of noise events over the time period. The noise criteria nominated in the ISEPP are internal noise levels with windows and doors closed and the requirements are stated in the following table.

Table 4: ISEPP internal road and rail traffic noise criteria

Internal space	Time period	Noise metric	Internal criteria^
Bedrooms	7am - 10pm	$L_{Aeq(15hrs)}$	40*
	10pm - 7am	$L_{Aeq(9hrs)}$	35
Other Habitable Rooms	Any Time	$L_{Aeq(15hrs)}$ and $L_{Aeq(9hrs)}$	40

Notes: ^ With windows and doors closed.

* Whilst not specified in the ISEPP, daytime criteria for bedrooms are set to 40dB(A), as per the other habitable rooms.

The Guideline in Section 3.6.1 'Airborne Noise' states as follows:

> *"If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, 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."*

As noise modelling is undertaken for external locations, the above criteria and guidelines have been used to establish equivalent external noise criteria. This external noise criterion is used to determine which building facades may require specific acoustic treatment to meet the requirements of the ISEPP. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA 2011 requirements.

Table 5: ISEPP road and rail traffic noise criteria for new residential development

Room	Location	$L_{Aeq,\ 15hr}$ Day 7am - 10pm	$L_{Aeq\ 9hr}$ Night 10pm - 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: * Requisite for 40,000AADT Roads only under ISEPP 2007.

^ ISEPP Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA 2011 requirements.

4.2 Wollondilly Shire Council DCP 2016

4.2.1 Industrial noise

Section 2.9 of the Wollondilly Shire Council DCP 2016 states the following:

> *Controls*
>
> 1. *When the subdivision of land is proposed in an area where an existing nearby non-residential use may impact on future residents, the consent authority must be satisfied that the new development would not restrict the ability of the existing development to meet amenity requirements in relation to issues such as noise, odour and the like in accordance with the principles established in the case of Inghams Enterprises vs Kira Holdings.*

The DCP does not describe specific criteria for determining whether a new residential development is likely to restrict the ability of existing developments to meet amenity requirements in relation to noise issues, and therefore this report relies on the guidelines described in Australian/New Zealand Standard AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors".

4.2.2 AS/NZS 2107:2016

Australian/New Zealand Standard AS/NZS 2107:2016 "Acoustics - Recommended design sound levels and reverberation times for building interiors" recommends design criteria for conditions affecting the

acoustic environment within building interiors to ensure a healthy, comfortable and productive environment for the occupants and the users. The background sound levels recommended take into account the function of the area(s) and apply to the sound level measured within the space unoccupied but ready for occupancy. The Standard is applicable to steady-state or quasi-steady-state sounds such as mechanical services equipment and road traffic noise intrusion, but not intended for transient or variable sources such as aircraft noise, railways and construction noise.

The sound levels given in this Standard are for the design of spaces in buildings and are provided as a range with a recommended lower level and upper level. Sound levels within the given ranges have been found to be acceptable by most people for the space under consideration. When the sound level is greater than the upper level of the range most people occupying the space will become dissatisfied with the level of sound.

Recommended internal noise levels for residential premises in suburban areas or near minor roads are reproduced in Table 6 below.

Table 6: Design sound levels for residential premises

Item	Type of occupancy/activity	Design sound level ($L_{Aeq,t}$) range
7	**RESIDENTIAL BUILDINGS**	
	Houses and apartments in suburban areas or near minor roads -	
	Apartment common areas (e.g. foyer, lift lobby)	45 to 50
	Living areas	30 to 40
	Sleeping areas (night time)	30 to 35
	Work areas	35 to 40

5 Road traffic noise assessment

Based on long-term noise monitoring results presented in Table 2, noise impact from Menangle Road is predicted to comply with the ISEPP noise limits. No noise mitigation is required for the lots in the western part of the subdivision adjacent to Menangle Road.

6 Rail traffic noise assessment

6.1 Rail noise predictions

Rail noise sound power levels were determined from the noise monitoring results. The following $L_{Aeq9hour}$ sound power levels were used and are based on noise data measured at L2.

Table 7: Rail noise 9-hour equivalent sound power levels PWL/metre (re 1 Picowatt)

Noise source component	Overall dB(A)	Octave band centre frequency - Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Wheel and track noise component	89					88	82	82	76	71
Train engine component	81	97	90	88	89					

Noise modelling was then conducted to quantify rail noise impacts across the site. The noise model used a line source for rail traffic split into two heights, namely, 0.55m for wheel and track noise, and 2.8m for locomotive engine noise.

The model chosen for noise propagation calculations is ISO9613, as implemented by CadnaA computer software program. ISO9613 is a world-wide recognized standard for noise prediction.

Noise contours over the subject site were calculated at 1.5m above ground (ground floor receiver) and 4.5m above ground (first floor receiver). Modelling was conducted assuming single storey dwellings to allow a conservative amount of shielding.

Noise predictions were assessed to night-time criteria as compliance with the more stringent night-time criteria will results in compliance during the day.

6.2 Rail noise impacts

The rail noise prediction results are set out as noise contour maps in APPENDIX B of this report. The contour maps in APPENDIX B show that noise levels at some facades at the east of Stage 1 do not comply with the ISEPP noise limits. Table 8 lists the noise affected lots.

Noise control treatments to mitigate rail noise are discussed in 7.

Table 8: Noise affected residential lots

Stage 1				
Lot 110	Lot 111	Lot 112	Lot 113	Lot 145

7 Noise control treatment recommendations

The noise modelling identified areas where the external noise goals were not met. Therefore, the affected areas of residential dwellings are to be designed to meet the relevant internal noise criteria.

The following provides in-principle noise control recommendations to reduce rail noise intrusion for residential premises. The recommendations are based on a number of assumptions relating to the built form. The advice provided here is in respect of acoustics only. Supplementary professional advice should be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

7.1 Building setbacks and layout.

Dwellings constructed in rail noise affected areas can be designed so that their layouts minimise noise in living and sleeping areas. Less sensitive rooms (such as kitchens, laundries and bathrooms) are recommended to be placed on the side of the building fronting the nearest noise source (being the road or rail line).

7.2 Indicative building construction

On the basis of the noise modelling, and in accordance with internal noise criteria set out in Section 4.1, recommendations for building element constructions are presented for the following room types. It is assumed that non-habitable rooms are separated from habitable spaces by doors (i.e. doors to studies, laundries, and ensuites/bathrooms etc.).

Table 9: Room parameters

Room	Item	Description
Bedroom	Dimensions (L x W x H)	4m x 4m x 2.7m
	Surface finishes	Carpeted floors with underlay, plasterboard walls and ceiling, and bed
Living room	Dimensions (L x W x H)	7m x 5m x 2.7m
	Surface finishes	Timber or tiled floors, plasterboard walls and ceiling
Lounge	Dimensions (L x W x H)	6m x 4m x 2.7m
	Surface finishes	Carpeted floors with underlay, plasterboard and ceiling

The required acoustic treatment categories are presented graphically in APPENDIX C .The acoustic treatment corresponding to each category is specified in Table 10.

Table 10: Acoustic constructions for treatment categories (ISEPP)

Category	Room	Construction element	Indicative treatment	
Category A (Alternative ventilation not required)	Bedrooms and adjoining ensuites	Windows/glazed doors*	Less than $4m^2$ = R_W 24	No specific glass thickness required
			$4m^2$ – $8m^2$ = R_W 27	6mm float glass with acoustic seals
		Walls/roof/ceiling	Standard constructions	
	Lounge/living rooms	Windows/glazed doors*	Less than $8m^2$ = R_W 29	6mm float glass with acoustic seals
			$8m^2$ – $16m^2$ = R_W 32	6.38mm laminated glass with acoustic seals
		Timber doors	35mm solid core timber - acoustic seals	
		Walls/roof/ceiling	Standard constructions	

Notes: * Area of windows and doors shall be the total of all glazing for the given room.

The acoustic requirements for windows and doors have been provided on an R_W basis so as to allow flexibility with the developer and variations in design due to other design requirements such as thermal performance. The R_W rating sets the basis of the recommended acoustic performance and the constructions are provided for guidance only. The acoustic performance of specific building components should be confirmed by manufactures or suitably qualified professional prior to installation.

Unless otherwise specified, the base building envelope of dwellings is considered to be of standard constructions which are assumed to consist of the following:

- Walls of brick veneer construction, double brick, or light weight clad construction which could consist of fibre-cement cladding on the outside of timber stud walls and internal plasterboard lining. All walls are assumed to have minimum R1.5 insulation in the cavity. It is noted that both brick veneer and cavity double brick construction are of significantly higher acoustic performance than light weight cladding systems. In higher traffic noise areas, there may be a requirement to upgrade light weight systems. These instances will be noted in the acoustic recommendations.
- Roof to be pitched, with concrete or terracotta tile or sheet metal roof with sarking, R3.0 insulation in the roof space (combination of below roof and above ceiling), and one layer of 10mm thick standard plasterboard fixed to ceiling joists.
- External doors to be solid core timber or glazed, fitted with acoustic seals around the perimeter. Pivot style doors are not recommended as full perimeter acoustic seals are not readily incorporated. The performance of any external doors should have the same acoustic performance as that required for general glazing.

7.3 Scope of acoustic recommendations

The recommended mitigation measures for rail noise cannot take into account the specific design of each dwelling as those details are not available at this stage of development. The recommendations have been developed in order for the approvals process and cost planning, and to provide the indicative measures required for each dwelling. Whilst it is the intent for the recommendations and this report to minimise the need for detailed acoustic assessment of each dwelling, it is recommended that an individual acoustic review of the 'Construction' drawings be carried out for each noise affected lot to ensure correct interpretation and application of the recommendations.

8 Industrial noise

The site is in located nearby industrial developments, namely Benedict Sands located approximately 260m to the north of the subject site and Hi Quality Group located approximately 1800m to the north east of the subject site, separated from the proposed development by Hume Highway.

Attended measurements were conducted to determine the noise impact from these industrial premises. The following observations were made:

- Activity occurring at Hi Quality group was inaudible over road traffic noise from the Hume Highway from the north east extent of the site.
- Sources of noise associated with Benedict Sands included noise from heavy vehicles traversing the site, and noise associated with filling the vehicles with soil and rocks.

Operator attended measurements were conducted at the northern extend of the Stage 1 development whilst the industrial site was in operation. Table 11 presents the measured noise levels at the boundary measurement locations ('S' locations), and the predicted nosie levels at the nearest future development lots ('A' locations) .

Table 11: Measured and predicted industrial noise levels , dB(A)

ID	Distance to source	$L_{Aeq, 15min}$, external
S1	55	51
A1, Lot 107	670	40
S2	85	49
A2, Lot 104	630	40
S3	30	50
A3, Lot 193	300	40
S4	30	49
A4, Lot 194	270	39

Based on a nominal 10dB(A) reduction through an open window for a residence of standard construction, the following predicted internal noise levels from the measured industrial noise apply:

Table 12: Internal noise levels, $L_{Aeq, 15min}$

ID	Internal noise level, dB(A)	Noise goals, dB(A)	
		Day (living areas)	Night (sleeping areas)
A1, Lot 107	30	40	35
A2, Lot 104	30		
A3, Lot 193	30		
A4, Lot 194	29		

Internal noise levels from industrial noise associated with the development are predicted to be at least 5dB(A) below the most stringent (night) internal noise goals per AS/NZS 2107:2016 and therefore the proposal does not pose a threat to the ability of the nearest identified industrial developments to meet amenity requirements in relation to noise.

9 Rail vibration assessment

9.1 Vibration Criteria

9.1.1 Regenerated noise

The Department of Planning's "Development near Rail Corridors & Busy Roads – Interim Guideline" 2008 (DoP Guideline) provides recommended criteria for ground-borne or regenerated rail noise. Table 13 below provides a summary of the noise limits for sleeping and living spaces.

Table 13: Recommended Internal Noise Criteria for Regenerated Rail Noise

Occupancy	Period	L_{Amax} Noise Limit [1]
Sleeping areas (Bedrooms)	10pm – 7am	35 dB(A)
Other habitable rooms (excluding garages, kitchens, bathrooms and hallways)	At any time	40 dB(A)

Notes:

1. L_{Amax} – is the-weighted maximum sound pressure level measures using a "slow" response time

9.1.2 Rail tactile vibration

Section 3.6.3 of the DoP Guideline provides recommended vibration criteria in accordance with the following documents:

1. Department of Environment and Conservation 2006 publication "Assessing Vibration: a technical guideline" (DEC Guideline)
2. German Standard DIN 4150 Part 3 1992
3. British Standard BS 7385 Part 2 1993
4. Australian Standard AS 2670.2 1990

The above documents have been reviewed and the criteria for assessment tactile vibration from train pass-bys affecting the proposed development is quantified in accordance with:

- Assessing Vibration: A technical guideline (Department of Environment and Conservation, 2006)
- British Standard BS6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)"

The criteria curves presented in BS6472:1992 are identical to those in Australian Standard AS2670.2 1990 and the International Standard 2631-2:1989.

Criteria for continuous vibration from the British Standard BS6472:1992 for residential spaces are shown in Figure 4 below.

Figure 4: Tactile Vibration Criteria for Residential Buildings

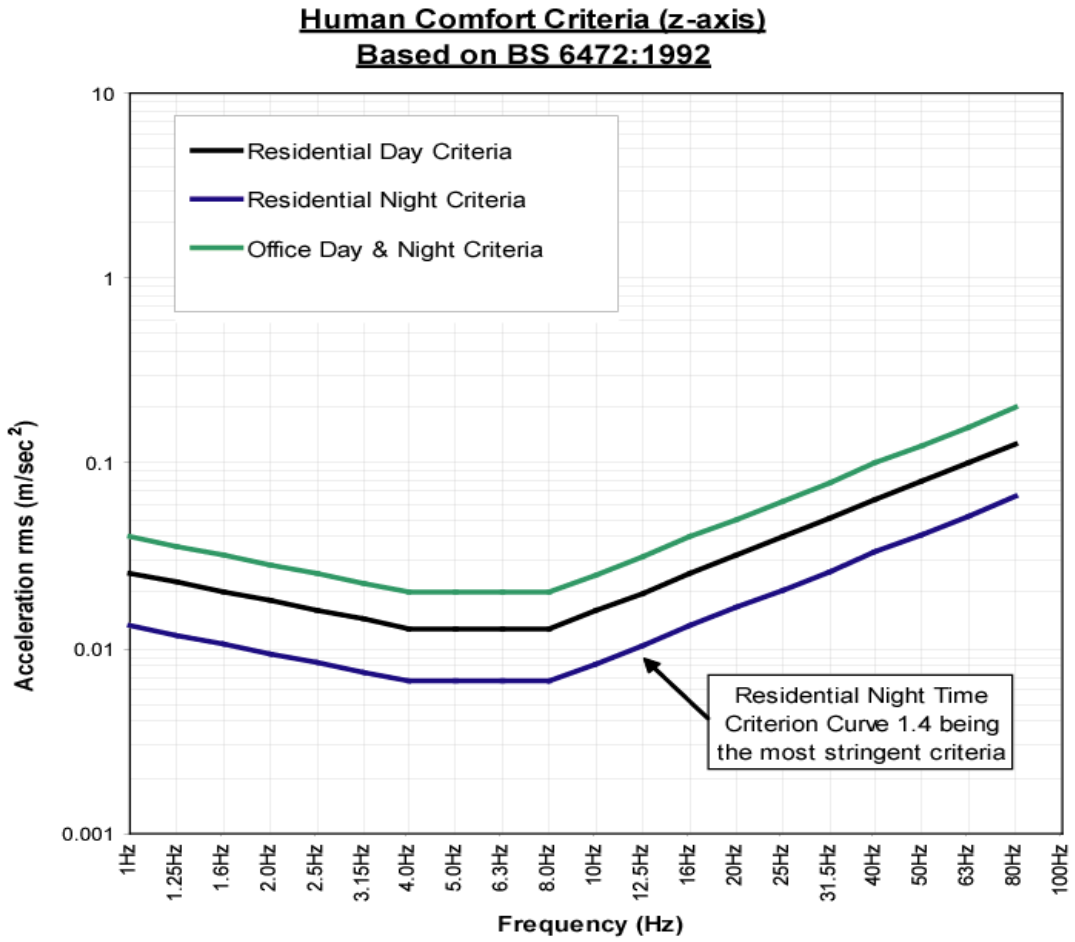


Table 2.4 of the DEC Guideline presents acceptable vibration dose values for intermittent vibration. Table 14 below outlines DEC's requirements.

Table 14: Acceptable VDVs for intermittent vibration in residential buildings m/s$^{1.75}$

Location	Period	Preferred VDV m/s$^{1.75}$
Residence	Day time (7am – 10pm)	0.20
	Night time (10pm – 7am)	0.13

9.2 Rail vibration monitoring location

An operator attended rail vibration survey was undertaken on site on 10th August 2018 from 12pm to 4pm. Vibration measurements were undertaken at two locations approximately 30m and 45m west of the Southern Highlands Rail Corridor. Results from the two measurement locations were analysed and predicted to the worst affected residential dwelling located 60m west of the rail corridor.

9.3 Instrumentation

Train vibration levels were measured using the Sinus SoundBook multi-channel analyser and PCB accelerometers at the location shown in Figure 3 in Section 3.1. Three accelerometers (x, y & z) were fixed to a steel bracket that is fixed to a metal spike impaled into the soil ground on site.

Weather conditions were fine during the operator-attended survey. All instruments were calibrated before and after measurement. No significant drift in calibration was observed.

The recorded ground vibration levels of train pass-bys are shown in Section 9.4 below together with the vibration criteria from British Standard BS6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80 Hz)" and DECC intermittent vibration dosage criterion.

9.4 Measured tactile train vibration and assessment to BS6472 and DEC

Results of the train vibration survey were plotted against night and day criterion of British Standard BS6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)" as shown in Figure 5 to Figure 8 below. In addition, the measured train vibration levels were used to calculate the vibration dosage values (VDV) and then compared to the acceptable levels from the Table 2.4 of DEC Guideline 2006.

Results from the measurements demonstrate that the floor induced vibration within the proposed worst-affected dwelling from each of the measured train pass-bys are predicted to be compliant with the British Standard BS6472:1997 for human comfort in a residential environment during the day and night. Similarly, the calculated vibration dosage values (VDV) complied with the preferred day and night VDV criterion as defined in the DEC guideline 2006.

Figure 5: Vibration Assessment for Human Annoyance BS6472 in Horizontal X&Y-Axis (Passenger Trains)

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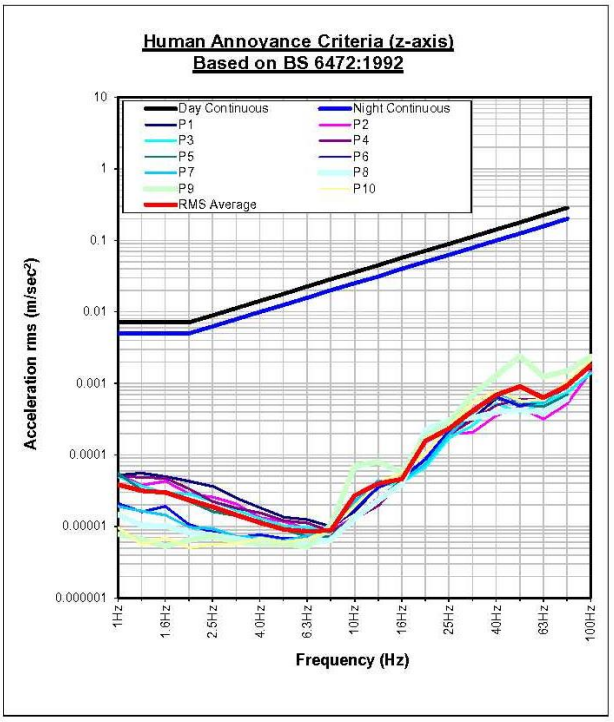
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TK439-01
Location:	Menangle, NSW
Source:	Passenger Trains

Assessment Location:	Residential	Axis	X&Y	Total secs of Vib per Day (t):	1,050
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	300



Legend														
Measurement		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	RMS Ave	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.25Hz	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	5.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	6.3Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	8.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	10Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000		
	12.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000		
	16Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	20Hz	0.0001	0.0002	0.0001	0.0002	0.0002	0.0001	0.0001	0.0002	0.0002	0.0001	0.0002		
	25Hz	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0003	0.0003	0.0002	0.0002		
	31.5Hz	0.0003	0.0002	0.0003	0.0003	0.0004	0.0004	0.0004	0.0003	0.0007	0.0005	0.0004		
	40Hz	0.0006	0.0004	0.0005	0.0005	0.0006	0.0007	0.0007	0.0004	0.0013	0.0008	0.0007		
	50Hz	0.0005	0.0005	0.0004	0.0006	0.0005	0.0005	0.0006	0.0004	0.0024	0.0006	0.0009		
	63Hz	0.0006	0.0003	0.0005	0.0006	0.0005	0.0006	0.0005	0.0004	0.0012	0.0006	0.0006		
	80Hz	0.0009	0.0005	0.0007	0.0009	0.0007	0.0010	0.0010	0.0006	0.0015	0.0011	0.0009		
	100Hz	0.0018	0.0015	0.0014	0.0016	0.0015	0.0020	0.0021	0.0011	0.0024	0.0021	0.0018		
Weighted rms	Day	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0071	0.0140
	Night	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0050	0.0100
eVDV	Day	**0.0010**	**0.0008**	**0.0007**	**0.0009**	**0.0008**	**0.0006**	**0.0005**	**0.0005**	**0.0011**	**0.0006**	**0.0008**	**0.20**	**0.40**
	Night	**0.0007**	**0.0006**	**0.0005**	**0.0006**	**0.0006**	**0.0004**	**0.0004**	**0.0003**	**0.0008**	**0.0004**	**0.0006**	**0.13**	**0.26**

NOTE: Red indicates exceedence of Preferred DECCW Criterion
NOTE: Gray indicates continous vibration levels and criteria if intermittent criteria is selected

QTS-01 (rev 12) Human Annoyance Vibration Assessment BS6472-DEC - z axis

Figure 6: Vibration Assessment for Human Annoyance BS6472 in Horizontal X&Y-Axis (Freight Trains)

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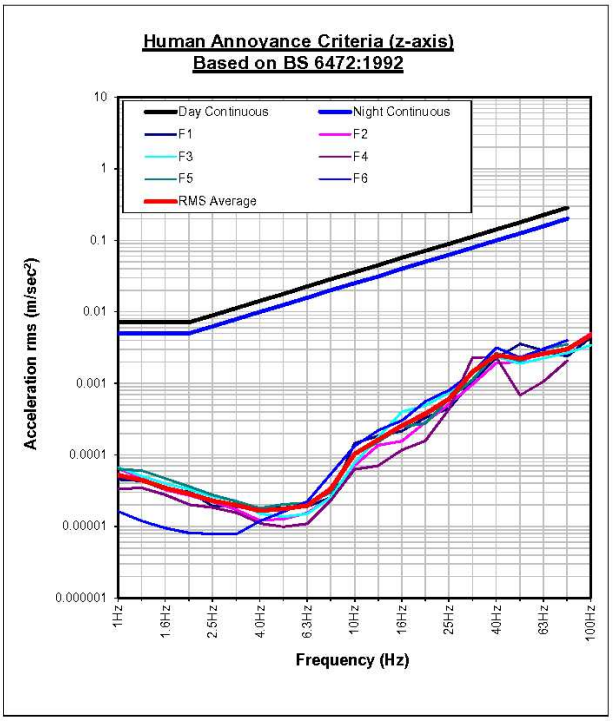
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TK439-01
Location:	Menangle, NSW
Source:	Freight Trains

Assessment Location:	Residential	Axis	X&Y	Total secs of Vib per Day (t):	1,260
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	1,080



Legend														
Measurement		F1	F2	F3	F4	F5	F6	0	0	0	0	RMS Ave	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0000	0.0001	0.0001	0.0000	0.0001	0.0000					0.0001		
	1.25Hz	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000					0.0000		
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	5.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	6.3Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	8.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001					0.0000		
	10Hz	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001					0.0001		
	12.5Hz	0.0002	0.0001	0.0002	0.0001	0.0002	0.0002					0.0002		
	16Hz	0.0002	0.0002	0.0004	0.0001	0.0002	0.0003					0.0003		
	20Hz	0.0003	0.0003	0.0005	0.0002	0.0003	0.0006					0.0004		
	25Hz	0.0004	0.0005	0.0007	0.0004	0.0006	0.0008					0.0006		
	31.5Hz	0.0011	0.0010	0.0014	0.0023	0.0011	0.0014					0.0015		
	40Hz	0.0023	0.0019	0.0024	0.0023	0.0026	0.0032					0.0025		
	50Hz	0.0036	0.0020	0.0019	0.0007	0.0020	0.0023					0.0022		
	63Hz	0.0029	0.0027	0.0022	0.0011	0.0030	0.0030					0.0026		
	80Hz	0.0024	0.0031	0.0027	0.0021	0.0035	0.0040					0.0030		
	100Hz	0.0044	0.0050	0.0034	0.0044	0.0059	0.0048					0.0047		
Weighted rms	Day	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003					0.0002	0.0071	0.0140
	Night	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003					0.0002	0.0050	0.0100
eVDV	Day	0.0021	0.0018	0.0020	0.0018	0.0021	0.0022					0.0020	0.20	0.40
	Night	0.0020	0.0017	0.0019	0.0017	0.0020	0.0022					0.0019	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion
NOTE: Gray indicates continous vibration levels and criteria if intermittent criteria is selected

QTS-01 (rev 12) Human Annoyance Vibration Assessment BS6472-DEC - z axis

Figure 7: Vibration Assessment for Human Annoyance BS6472 in Vertical Z-axis Plane (Passenger Trains)

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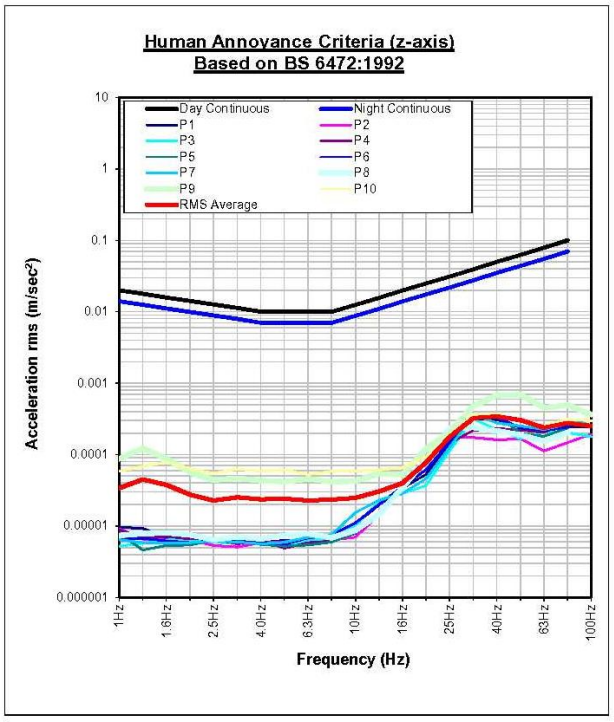
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TK439-01
Location:	Menangle, NSW
Source:	Passenger Trains

Assessment Location:	Residential	Axis	Z	Total secs of Vib per Day (t):	1,050
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	300



Legend														
Measurement		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	RMS Ave	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	1.25Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	5.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	6.3Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	8.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	10Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
	12.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	16Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000		
	20Hz	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001		
	25Hz	0.0001	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002		
	31.5Hz	0.0003	0.0002	0.0003	0.0002	0.0003	0.0003	0.0004	0.0002	0.0005	0.0004	0.0003		
	40Hz	0.0003	0.0002	0.0002	0.0002	0.0004	0.0003	0.0003	0.0002	0.0007	0.0004	0.0003		
	50Hz	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0007	0.0003	0.0003		
	63Hz	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0003	0.0002		
	80Hz	0.0002	0.0001	0.0002	0.0003	0.0002	0.0002	0.0003	0.0002	0.0005	0.0003	0.0003		
	100Hz	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003	0.0001	0.0004	0.0003	0.0003		
Weighted rms	Day	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002	0.0002	0.0100	0.0200
	Night	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002	0.0002	0.0070	0.0140
eVDV	Day	0.0010	0.0008	0.0009	0.0009	0.0012	0.0011	0.0011	0.0010	0.0023	0.0018	0.0013	0.20	0.40
	Night	0.0007	0.0006	0.0007	0.0006	0.0009	0.0008	0.0008	0.0007	0.0017	0.0013	0.0009	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion
NOTE: Gray indicates continous vibration levels and criteria if intermittent criteria is selected

QTS-01 (rev 12) Human Annoyance Vibration Assessment BS6472-DEC - z axis

Figure 8: Vibration Assessment for Human Annoyance BS6472 in Vertical Z-Axis Plane (Freight Trains)

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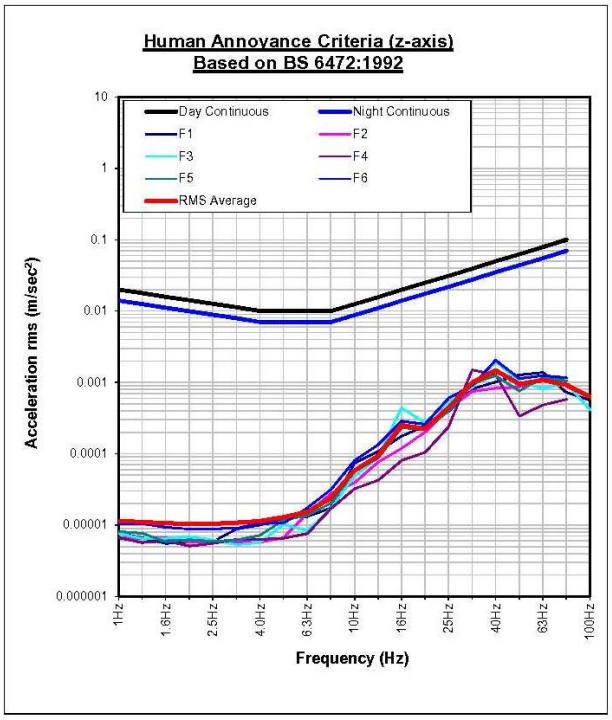
Vibration Survey Results

Vibration Assessment for Human Annoyance BS6472-1992 & DECCW

Project No.:	TK439-01
Location:	Menangle, NSW
Source:	Freight Trains

Assessment Location:	Residential	Axis	Z	Total secs of Vib per Day (t):	1,260
Type of Vibration:	Intermittent			Total secs of Vib per Night (t):	1,080



Legend														
Measurement		F1	F2	F3	F4	F5	F6	0	0	0	0	RMS Ave	Preferred DECCW Criterion	Maximum DECCW Criterion
Acceleration rms (m/sec²)	1Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	1.25Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	1.6Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	2.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	2.5Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	3.15Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	4.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	5.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	6.3Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	8.0Hz	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					0.0000		
	10Hz	0.0001	0.0000	0.0000	0.0000	0.0001	0.0001					0.0001		
	12.5Hz	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001					0.0001		
	16Hz	0.0002	0.0001	0.0004	0.0001	0.0002	0.0003					0.0003		
	20Hz	0.0002	0.0002	0.0003	0.0001	0.0002	0.0003					0.0002		
	25Hz	0.0004	0.0004	0.0005	0.0002	0.0004	0.0006					0.0004		
	31.5Hz	0.0008	0.0007	0.0008	0.0015	0.0010	0.0009					0.0010		
	40Hz	0.0010	0.0008	0.0020	0.0013	0.0012	0.0020					0.0015		
	50Hz	0.0013	0.0009	0.0010	0.0003	0.0008	0.0011					0.0009		
	63Hz	0.0014	0.0011	0.0008	0.0005	0.0012	0.0012					0.0011		
	80Hz	0.0007	0.0009	0.0010	0.0006	0.0010	0.0012					0.0009		
	100Hz	0.0006	0.0006	0.0004	0.0005	0.0008	0.0007					0.0006		
Weighted rms	Day	0.0005	0.0004	0.0006	0.0005	0.0005	0.0006					0.0005	0.0100	0.0200
	Night	0.0005	0.0004	0.0006	0.0005	0.0005	0.0006					0.0005	0.0070	0.0140
eVDV	Day	0.0038	0.0031	0.0049	0.0040	0.0038	0.0051					0.0042	0.20	0.40
	Night	0.0036	0.0030	0.0047	0.0038	0.0037	0.0049					0.0040	0.13	0.26

NOTE: Red indicates exceedence of Preferred DECCW Criterion
NOTE: Gray indicates continous vibration levels and criteria if intermittent criteria is selected

QTS-01 (rev 12) Human Annoyance Vibration Assessment BS6472-DEC - z axis

9.5 Calculated ground-borne rail noise inside proposed development

Regenerated or ground-borne rail noise is the low rumble heard inside buildings with vicinity of railway lines due to ground vibration generated by passing trains which propagate through soil and rock up into building elements such as foundation, wall and floors which re-radiates as audible sound.

Train vibration levels measured on site were used to predict the regenerated rail noise inside the proposed dwelling nearest to the rail corridor. These calculated noise levels inside apartments are summarised in Table 15 below and compared to ground-borne noise criteria defined in Table 13.

Table 15: Calculated Regenerated Rail Noise Levels Inside Apartment

Floor Level	Proposed Occupancy/Space	Calculated1 Ground-borne Rail Noise inside development	DoP Guideline 2008 Criteria[1] for Ground-borne Rail Noise inside Dwellings	Comply? (Yes/No)
Ground	Residential – sleeping areas	19 dB(A)	35 dB(A)	Yes
Level 1	Residential – sleeping areas	20 dB(A)	35 dB(A)	Yes

Notes:

1. Ground-borne noise calculations were based upon the measured $L_{Max\ (Slow)}$ of 95% of train pass-events as per DOP Guideline 2008.

The above assessment predicts ground-borne rail noise levels inside proposed residential spaces of the development due to train pass-bys on the Southern Highlands Rail to be in compliance with the L_{Amax} (Slow) criteria stipulated in the DoP Guideline 2008.

10 Conclusion

Renzo Tonin & Associates has conducted an environmental noise assessment of rail noise and vibration and industrial noise onto Stage 1 of the proposed residential subdivision located at Station Street, Menangle. The assessment has been undertaken in accordance with Wollondilly Shire Council requirements, NSW State Environment Planning Policy (Infrastructure) 2007, and relevant NSW noise and vibration guidelines.

The findings of this study are:

- The ISEPP criteria are predicted to be exceeded at the ground floor and first floor of dwellings exposed to the Southern Highlands Rail Line. For facades that are exposed to noise levels above the ISEPP (listed in Table 8), indicative building envelope design has been provided in accordance with the internal noise level criteria and described in Table 10.

- Road traffic noise levels from surrounding roads are predicted to be compliant at the worst affected residential lots.

- The proposed residential development is predicted not to impact the ability of the nearest identified industrial developments to meet amenity requirements in relation to noise issues.

- Vibration impacts from the Southern Highlands Rail Line have been found to be compliant with human comfort vibration criteria and regenerated noise criteria.

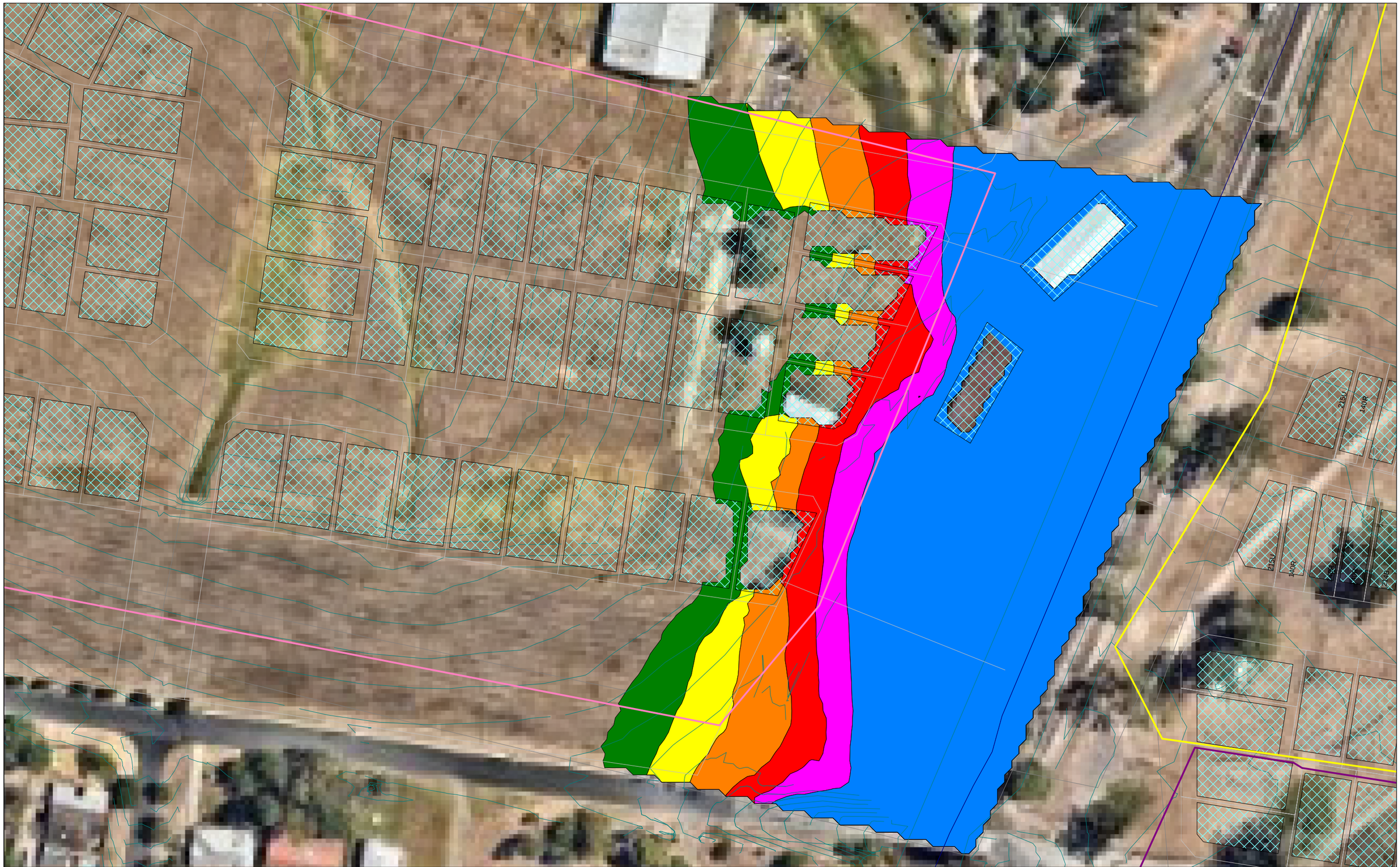
APPENDIX A Glossary of terminology

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

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
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.
Assessment period	The period in a day over which assessments are made.
Assessment point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
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, when extraneous noise is removed. 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 L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. 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 switched on 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.
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.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	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).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
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 pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
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.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Noise modelling results



Legend:

- Line Source
- Road
- Building
- Contour Line
- Receiver
- Calculation Area

Noise Level - dB(A)

- = 55
- = 56
- = 57
- = 58
- = 59
- = 60

Consultant:

RENZO TONIN & ASSOCIATES

inspired to achieve

Acoustics, Vibration & Structural Dynamics

Sydney Melbourne Brisbane Gold Coast Kuwait

1/418A Elizabeth Street, SURRY HILLS NSW 2010
P: 02 8218 0500 F: 02 8218 0501

Client: MIRVAC

Project:

STATION STREET,
MENANGLE
STAGE 1

Description:

RAIL NOISE
4.5m GRID

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TK439-01	Created by:	MW
Fig Ref:	tK349-01 F01 (r0)	Grid:	F01
Date:	2018.09.05	Scale:	1: 1000 A3

Legend:

- Line Source
- Road
- Building
- Contour Line
- Receiver
- Calculation Area

Noise Level - dB(A)

- = 55
- = 56
- = 57
- = 58
- = 59
- = 60

Consultant:

RENZO TONIN & ASSOCIATES

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Acoustics, Vibration & Structural Dynamics

Sydney Melbourne Brisbane Gold Coast Kuwait

1/418A Elizabeth Street, SURRY HILLS NSW 2010

P: 02 8218 0500 F: 02 8218 0501

Client: MIRVAC

Project:

STATION STREET,
MENANGLE
STAGE 1

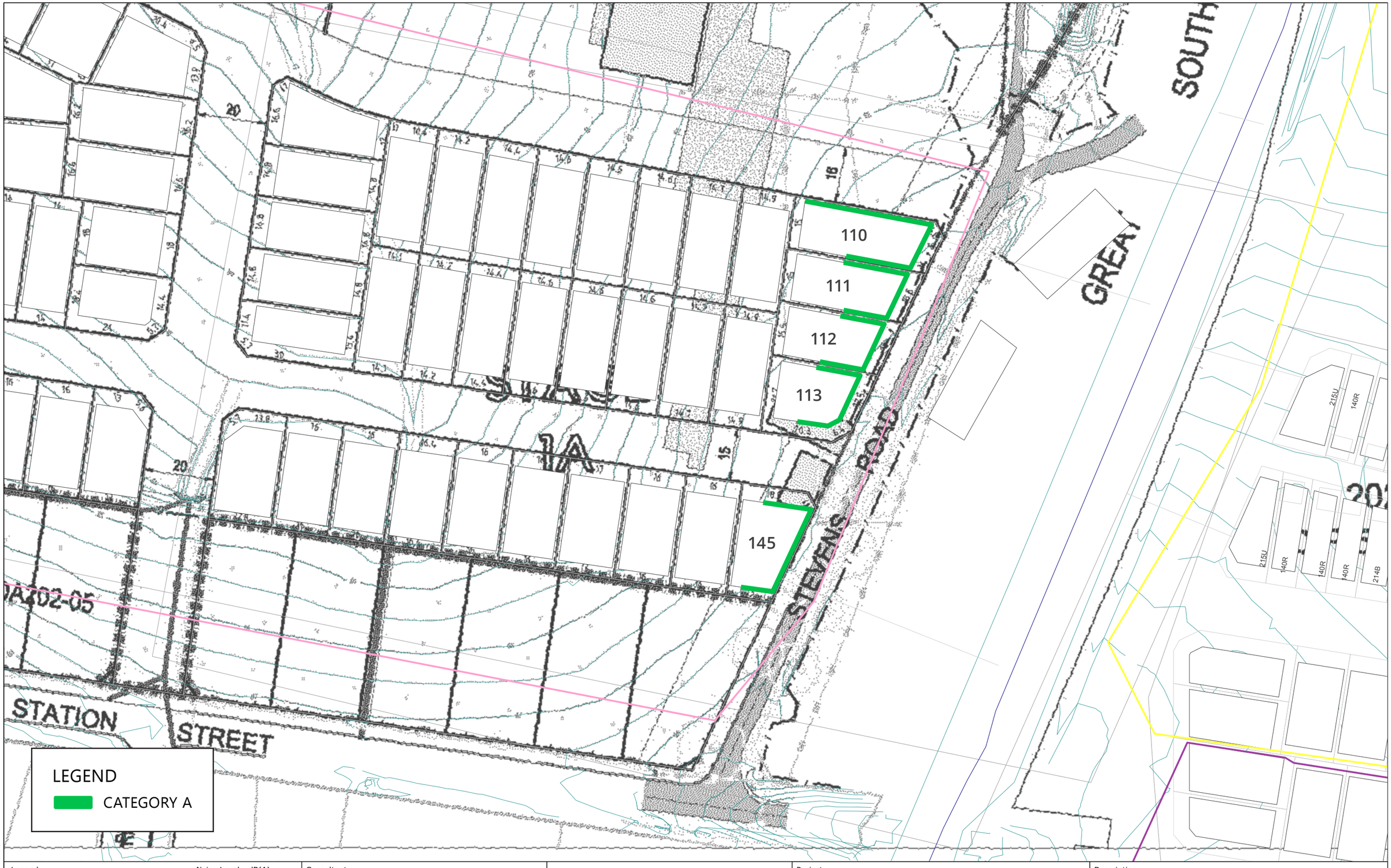
Description:

RAIL NOISE
1.5m GRID

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TK439-01	Created by:	MW
Fig Ref:	TK439-01 F02 (r0)	Grid:	F02
Date:	2018.09.05	Scale:	1: 1000 A3

APPENDIX C Acoustic treatment categories



Legend:

- Line Source
- Road
- Building
- Contour Line
- Receiver
- Calculation Area

Noise Level - dB(A)

- = 55
- = 56
- = 57
- = 58
- = 59
- = 60

Consultant:

RENZO TONIN & ASSOCIATES

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Acoustics, Vibration & Structural Dynamics

Sydney Melbourne Brisbane Gold Coast Kuwait

1/418A Elizabeth Street, SURRY HILLS NSW 2010

P: 02 8218 0500 F: 02 8218 0501

Client: MIRVAC

Project:

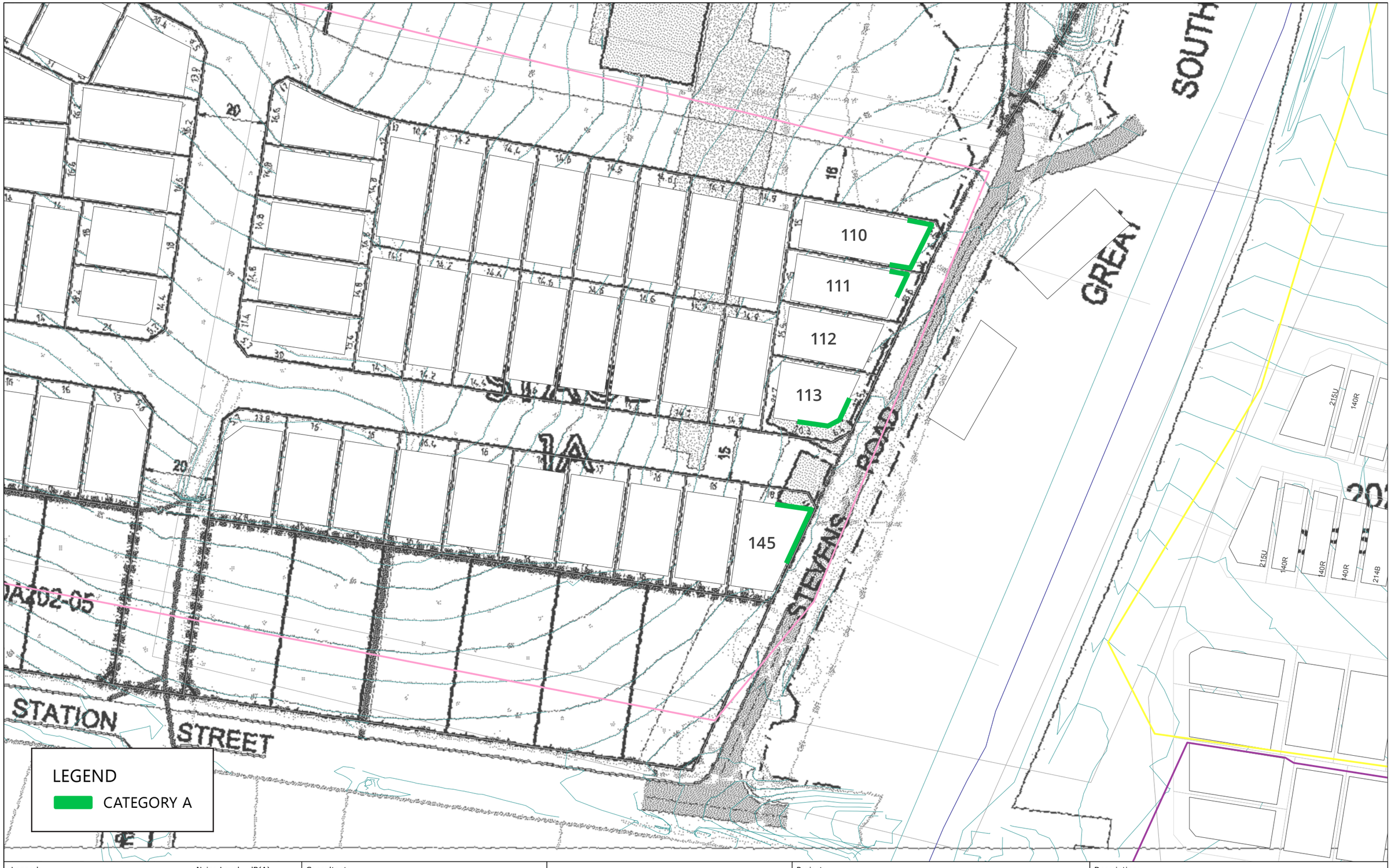
STATION STREET,
MENANGLE
STAGE 1

Description:

ARCHITECTURAL ACOUSTIC RAIL NOISE TREATMENT CATEGORIES
First Floor

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TK439-01	Created by:	MW
Fig Ref:	tK349-01 F03 (r0)	Grid:	F03
Date:	2018.09.05	Scale:	1: 1000 A3



Legend:

- Line Source
- Road
- Building
- Contour Line
- Receiver
- Calculation Area

Noise Level - dB(A)

- = 55
- = 56
- = 57
- = 58
- = 59
- = 60

Consultant:

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1/418A Elizabeth Street, SURRY HILLS NSW 2010

P: 02 8218 0500 F: 02 8218 0501

Client: MIRVAC

Project:

STATION STREET,
MENANGLE
STAGE 1

Description:

ARCHITECTURAL ACOUSTIC RAIL NOISE TREATMENT CATEGORIES
Ground Floor

Noise levels are approximate due to interpolation of contours and should be used for reference only.
For information only and not for construction.

Project No.:	TK439-01	Created by:	MW
Fig Ref:	tK349-01 F04 (r0)	Grid:	F04
Date:	2018.09.05	Scale:	1: 1000 A3

APPENDIX D Long-term noise monitoring methodology

D.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
RTA06 (NTi Audio XL2, with low noise microphone)	Type 1	1/1	L1, L2

Note: 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 4230 calibrator. No significant drift in calibration was observed.

D.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 INP. 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 is typically 1.5m above ground level (and less than 3m). The correction factor applied to the data is based on Table C.1 of ISO 4354:2009 '*Wind actions on structures*'.

D.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 E Long-term noise monitoring results

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Cnr Menangle and Unnamed Road, Northeast of Subject Site

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Wednesday-01-August-2018	-	44.6	38.4	-	53.7	53.1
Thursday-02-August-2018	43.7	45.5	-	54.8	56.0	-
Friday-03-August-2018	44.8	39.1	30.3	55.6	53.6	48.5
Saturday-04-August-2018	43.8	39.7	36.6	54.1	54.9	50.7
Sunday-05-August-2018	40.3	42.9	41.8	54.4	53.9	53.9
Monday-06-August-2018	47.9	34.9	-	57.1	54.0	-
Tuesday-07-August-2018	45.8	34.2	33.4	56.9	55.1	53.5
Wednesday-08-August-2018	43.5	37.6	-	60.2	54.6	-
Thursday-09-August-2018	41.5	50.8	42.7	55.6	56.0	54.1
Friday-10-August-2018	-	-	-	-	-	-
Representative Weekday[5]	**44.3**	**39.1**	**35.9**	**57.1**	**54.8**	**52.8**
Representative Weekend[5]	**42.1**	**41.3**	**39.2**	**54.2**	**54.4**	**52.6**
Representative Week[5]	**43.8**	**39.7**	**37.5**	**56.6**	**54.7**	**52.7**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at facade

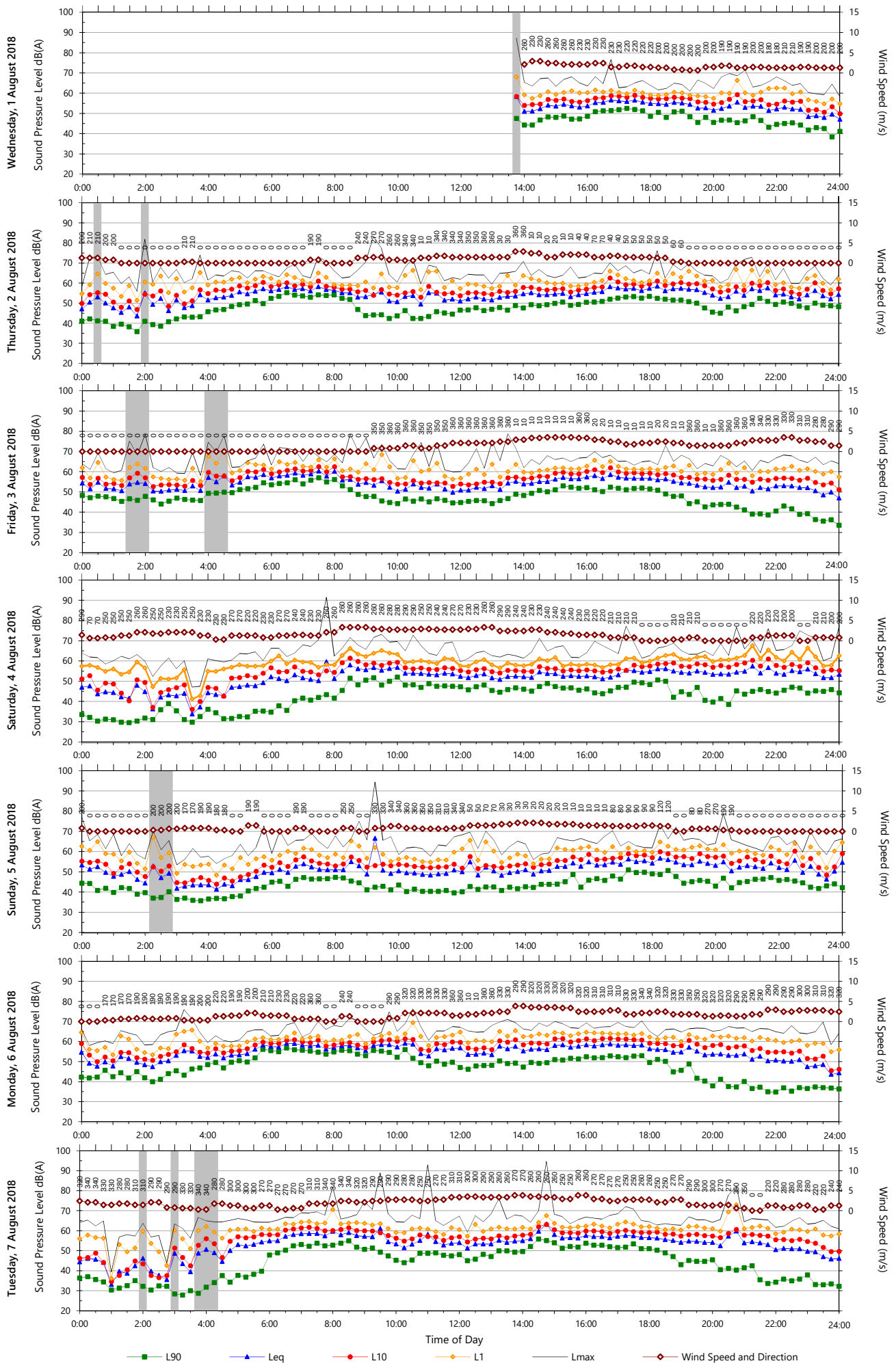
Cnr Menangle and Unnamed Road, Northeast of Subject Site

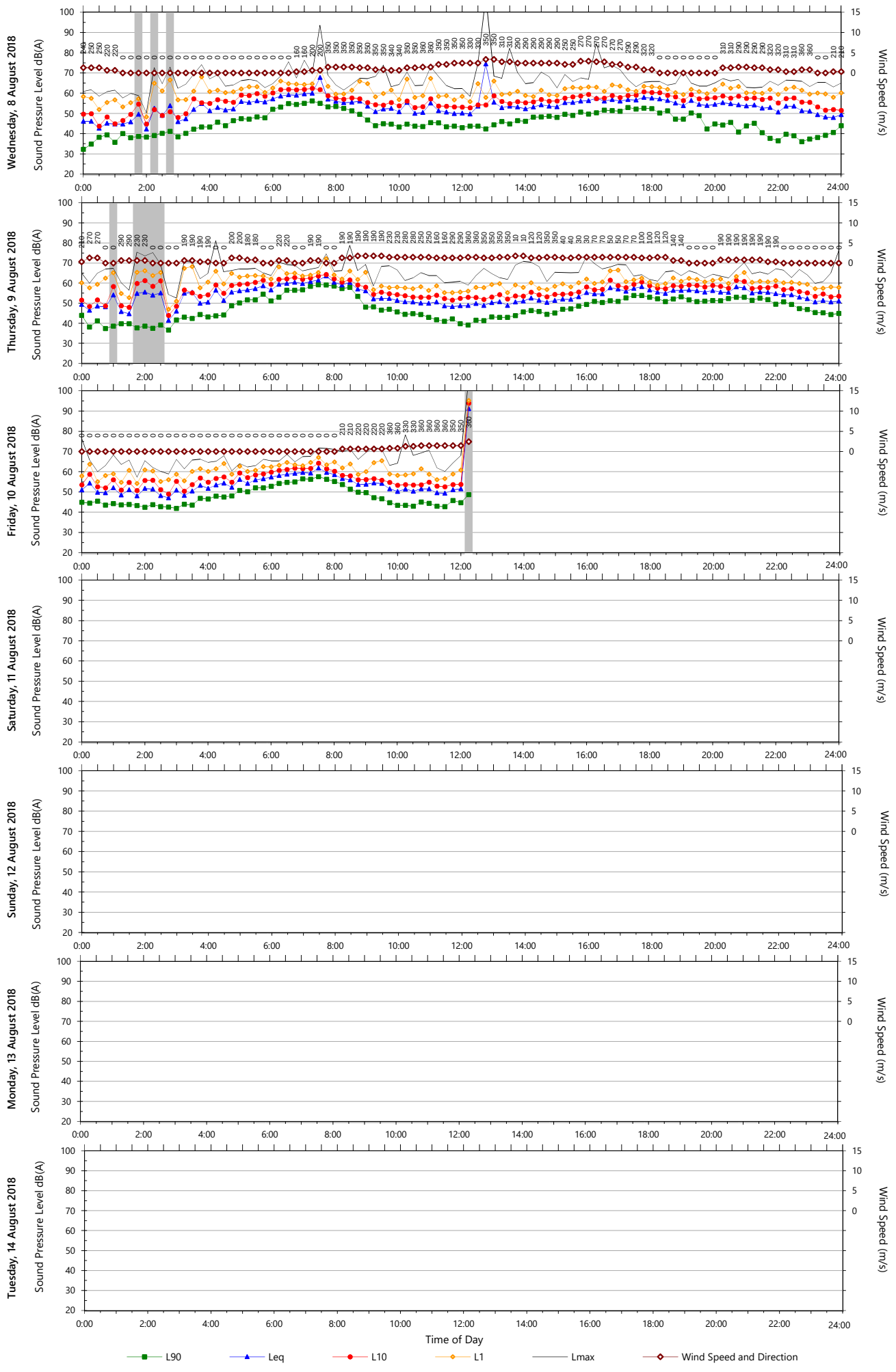
Road / Rail Noise Monitoring Results (at one metre from façade)

	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	**Day[1]**	**Night[2]**	**Day - Up[4]**	**Day - Low[5]**	**Night - Up[4]**	**Night - Low[5]**
Wednesday-01-August-2018	56.7	55.6	58.4	53.5	59.8	48.5
Thursday-02-August-2018	57.6	57.4	59.6	54.9	60.9	53.0
Friday-03-August-2018	57.7	51.0	61.1	54.3	55.0	44.1
Saturday-04-August-2018	56.9	53.1	58.9	54.6	57.4	44.3
Sunday-05-August-2018	56.6	56.4	61.4	51.9	60.9	51.2
Monday-06-August-2018	59.0	53.8	60.6	54.9	59.8	40.4
Tuesday-07-August-2018	59.0	56.0	61.9	55.5	61.6	47.0
Wednesday-08-August-2018	61.8	57.4	69.0	53.6	62.3	46.8
Thursday-09-August-2018	58.2	56.6	62.9	51.8	61.5	52.2
Friday-10-August-2018	58.0	-	62.5	53.0	-	-
Representative Weekday[3]	**58.8**	**55.8**	**63.4**	**54.1**	**60.6**	**49.1**
Representative Weekend[3]	**56.7**	**55.1**	**60.3**	**53.4**	**59.4**	**49.0**
Representative Week[3]	**58.4**	**55.7**	**62.9**	**54.0**	**60.4**	**49.1**

Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Logarithmic average of daily L_{Aeq}
4. Upper 10th percentile $L_{Aeq\ 1hr}$
5. Lower 10th percentile $L_{Aeq\ 1hr}$
6. Values are calculated at the facade. 2.dB is added to results if logger is placed in the free field


Wednesday, 1 August 2018
Thursday, 2 August 2018
Friday, 3 August 2018
Saturday, 4 August 2018
Sunday, 5 August 2018
Monday, 6 August 2018
Tuesday, 7 August 2018
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of Day
L90
Leq
L10
L1
Lmax
Wind Speed and Direction


Wednesday, 8 August 2018
Thursday, 9 August 2018
Friday, 10 August 2018
Saturday, 11 August 2018
Sunday, 12 August 2018
Monday, 13 August 2018
Tuesday, 14 August 2018
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of Day
L90
Leq
L10
L1
Lmax
Wind Speed and Direction

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Stevens Road - Rail

Background & Ambient Noise Monitoring Results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Wednesday-01-August-2018	-	46.8	42.0	-	57.2	57.0
Thursday-02-August-2018	40.0	44.2	47.0	56.7	59.8	58.6
Friday-03-August-2018	41.3	40.8	34.8	56.2	53.8	52.4
Saturday-04-August-2018	42.6	42.7	36.7	57.6	58.1	53.6
Sunday-05-August-2018	38.0	45.6	44.0	53.3	56.6	58.3
Monday-06-August-2018	44.1	39.0	32.9	57.9	54.0	53.9
Tuesday-07-August-2018	46.1	37.8	35.0	60.9	54.0	55.0
Wednesday-08-August-2018	40.1	39.7	39.7	57.5	54.6	58.3
Thursday-09-August-2018	40.7	49.8	44.3	57.7	58.4	58.1
Friday-10-August-2018	-	-	-	-	-	-
Representative Weekday[5]	**41.0**	**40.8**	**39.7**	**58.1**	**56.6**	**56.7**
Representative Weekend[5]	**40.3**	**44.2**	**40.4**	**56.0**	**57.4**	**56.6**
Representative Week[5]	**41.0**	**42.7**	**39.7**	**57.7**	**56.8**	**56.7**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at facade

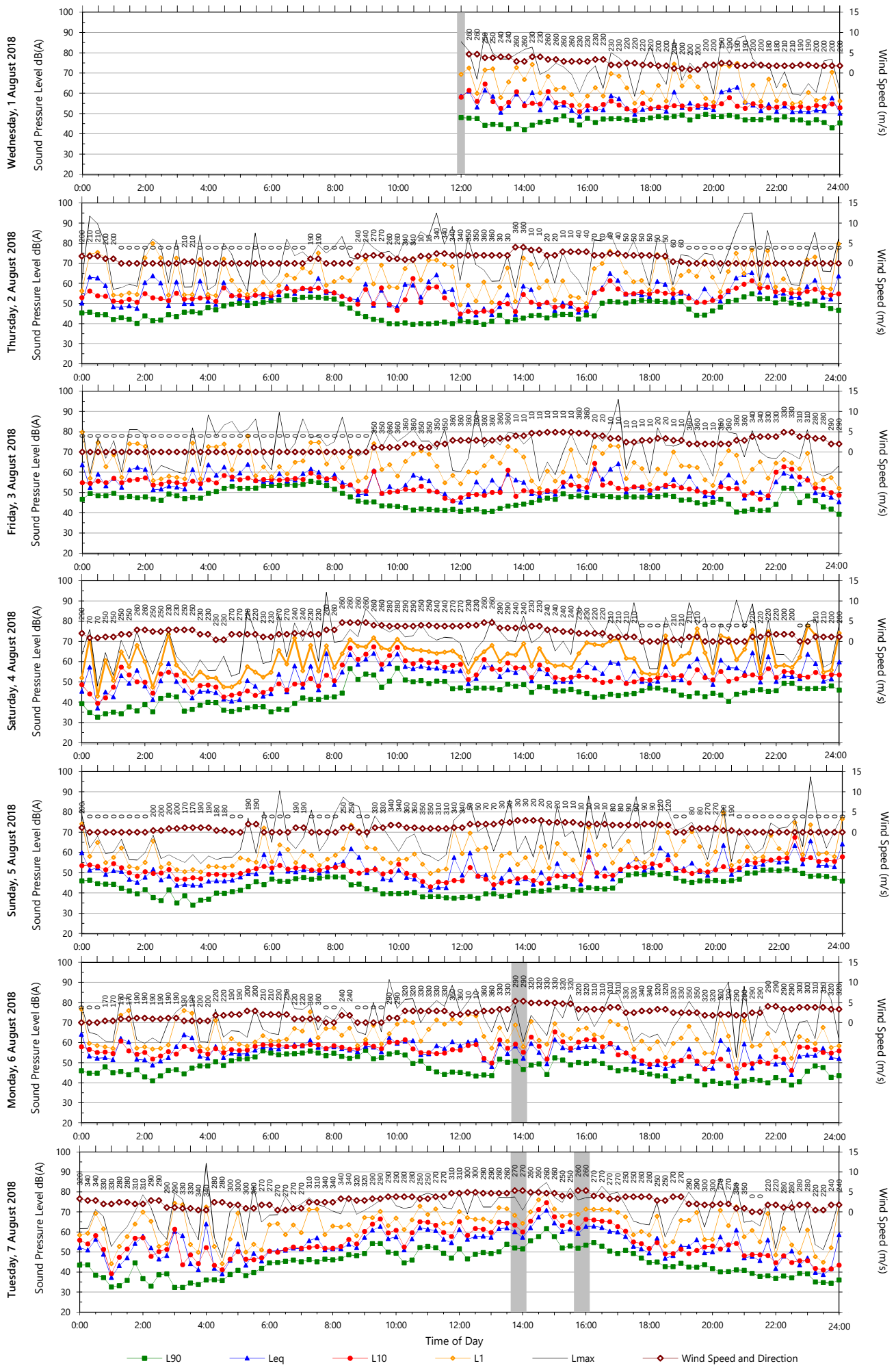
Stevens Road - Rail

Road / Rail Noise Monitoring Results (at one metre from façade)

	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	**Day[1]**	**Night[2]**	**Day - Up[4]**	**Day - Low[5]**	**Night - Up[4]**	**Night - Low[5]**
Wednesday-01-August-2018	59.1	59.5	63.5	54.4	63.2	54.3
Thursday-02-August-2018	60.3	61.1	64.3	50.0	63.0	54.7
Friday-03-August-2018	58.2	54.9	63.3	51.3	60.0	44.8
Saturday-04-August-2018	60.3	56.2	63.8	55.3	61.0	46.9
Sunday-05-August-2018	56.8	60.8	60.8	49.7	64.6	54.9
Monday-06-August-2018	59.6	56.4	61.6	52.3	61.4	50.5
Tuesday-07-August-2018	62.3	57.5	67.9	54.5	61.3	47.5
Wednesday-08-August-2018	59.4	60.8	63.2	53.5	63.3	51.1
Thursday-09-August-2018	60.4	60.6	63.4	55.0	63.1	56.5
Friday-10-August-2018	59.8	-	61.0	51.6	-	-
Representative Weekday[3]	**60.0**	**59.2**	**64.0**	**53.1**	**62.4**	**52.8**
Representative Weekend[3]	**58.9**	**59.1**	**62.6**	**53.3**	**63.2**	**52.5**
Representative Week[3]	**60**	**59**	**64**	**53**	**63**	**53**

Notes:

1. Day is 7:00am to 10:00pm
2. Night is 10:00pm to 7:00am
3. Logarithmic average of daily L_{Aeq}
4. Upper 10th percentile $L_{Aeq\ 1hr}$
5. Lower 10th percentile $L_{Aeq\ 1hr}$
6. Values are calculated at the facade. 2.dB is added to results if logger is placed in the free field


Wednesday, 1 August 2018
Thursday, 2 August 2018
Friday, 3 August 2018
Saturday, 4 August 2018
Sunday, 5 August 2018
Monday, 6 August 2018
Tuesday, 7 August 2018
Sound Pressure Level dB(A)
Wind Speed (m/s)
Time of Day
L90
Leq
L10
L1
Lmax
Wind Speed and Direction

Unattended Monitoring Results

Location: Stevens Road - Rail