Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9401 7770
www.lgacoustics.com.au

Transportation Noise Assessment

Woolstores Place, My Elphinstone, Albany

Reference: 21127004-01

Prepared for:
Rowe Group

Reference: 21127004-01

Lloyd George Acoustics Pty Ltd
ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923
www.lgacoustics.com.au

Contacts	General	Daniel Lloyd	Terry George	Matt Moyle
E:	info@lgacoustics.com.au	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	matt@lgacoustics.com.au
P:	9401 7770	0439 032 844	0400 414 197	0412 611 330
Contacts	Rob Connolly	Daryl Thompson	Hao Tran	Matt Nolan
E:	rob@lgacoustics.com.au	daryl@lgacoustics.com.au	hao@lgacoustics.com.au	matt.nolan@lgacoustics.com.au
P:	0410 107 440	0420 364 650	0438 481 207	0448 912 604

Date	Rev	Description	Author	Verified
08-03-23	0	Issued to Client	Daniel Lloyd	

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1. INTRODUCTION

It is proposed to subdivide land at Woolstores Place, My Elphinstone, Albany (refer *Figure 1-1*) with the proposed Structure Plan shown in *Figure 1-2*. The site adjoins Princess Royal Drive, which is considered a 'Strategic Freight Route', as well as the freight railway into the Port of Albany. As such, a noise assessment is required against *State Planning Policy No. 5.4 Road and Rail Noise*, being the subject of this report.

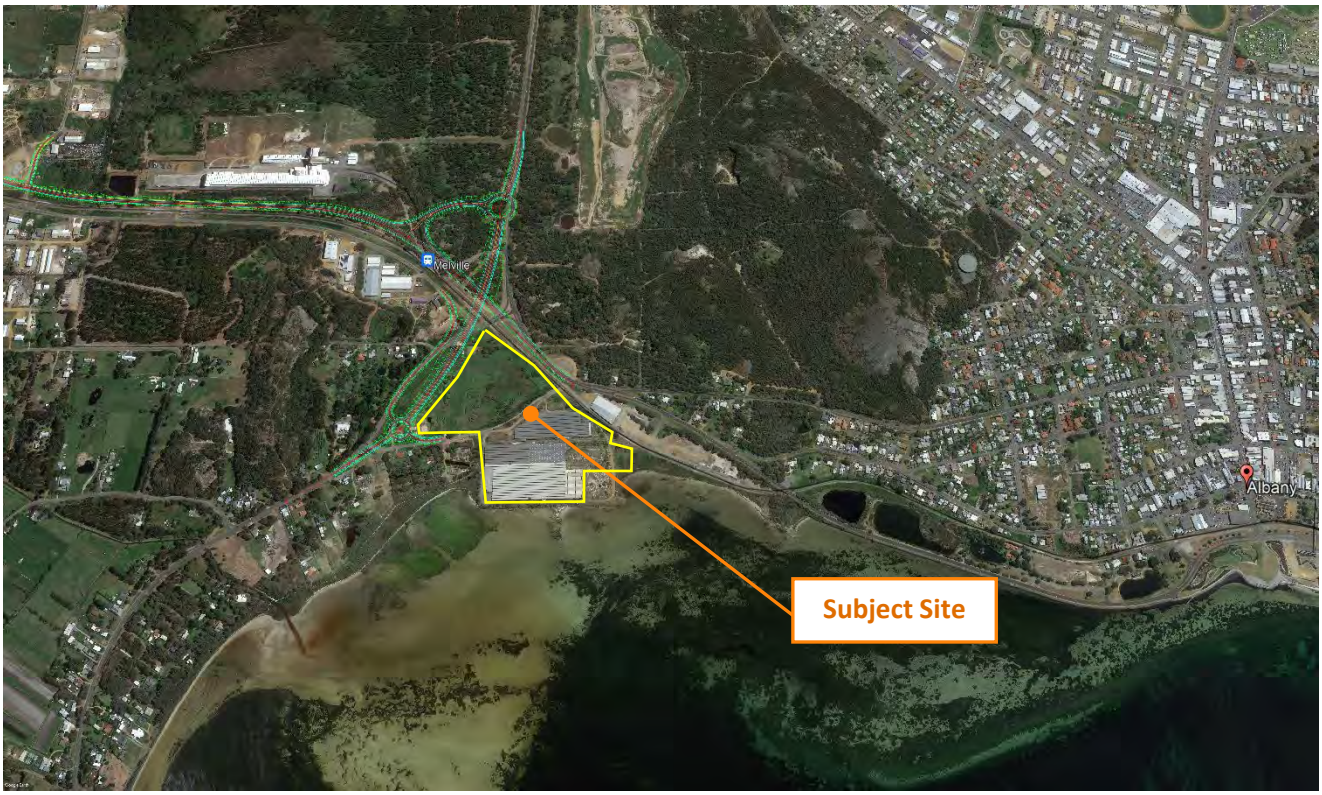


Figure 1-1: Structure Plan Location (Source: Google Earth)

Appendix B contains a description of some of the terminology used throughout this report.

Figure 1-2: Structure Plan Layout

2. CRITERIA

2.1. Noise

The criteria relevant to this project is provided in *State Planning Policy No. 5.4 Road and Rail Noise* (hereafter referred to as SPP 5.4) produced by the Western Australian Planning Commission (WAPC). SPP 5.4 is supported by the *Road and Rail Noise Guidelines* (the Guidelines) and the Department of Planning, Lands and Heritage mapping. The objectives of SPP 5.4 are to:

- Protect the community from unreasonable levels of transport noise;
- Protect strategic and other significant freight transport corridors from incompatible urban encroachment;
- Ensure transport infrastructure and land-use can mutually exist within urban corridors;
- Ensure that noise impacts are addressed as early as possible in the planning process; and
- Encourage best practice noise mitigation design and construction standards.

Table 2-1 sets out noise targets that are to be achieved by proposals under which SPP 5.4 applies. Where the targets are exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

Table 2-1: Noise Targets for Noise Sensitive Land-Use

Scenario	Outdoor Noise Target		Indoor Noise Target	
Noise-sensitive land-use and/or development	55 dB $L_{Aeq(Day)}$	50 dB $L_{Aeq(Night)}$	40 dB $L_{Aeq(Day)}$ (Living and Work Areas)	35 dB $L_{Aeq(Night)}$ (Bedrooms)

Notes:

- Day period is from 6am to 10pm and night period from 10pm to 6am.
- The outdoor noise target is to be measured at 1-metre from the most exposed, habitable[1] facade of a noise sensitive building.
- For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 *Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors* (as amended) for each relevant time period.
- Outdoor targets are to be met at all outdoor areas as far as is reasonable and practicable to do so using the various noise mitigation measures outlined in the Guidelines.

The application of SPP 5.4 is to consider anticipated traffic volumes for the next 20 years from when the noise assessment has been undertaken and to assume one train per hour during the night period.

[1] *A habitable room is defined in State Planning Policy 3.1 as a room used for normal domestic activities that includes a bedroom, living room, lounge room, music room, sitting room, television room, kitchen, dining room, sewing room, study, playroom, sunroom, gymnasium, fully enclosed swimming pool or patio.*

2.2. Vibration

SPP 5.4 does not consider vibration, however common criteria used in Western Australia for annoyance are the vibration curves 1.4 and 2 (Annex A) of Australian Standard 2670.2-1990 *Evaluation of human exposure to whole-body vibration Part 2: Continuous and shock induced vibration in buildings (1 to 80 Hz)*. These criteria are compared against the R.M.S vibration levels.

For structural damage to buildings, the criterion of 5 mm/s, taken from the German standard DIN 4150, is generally accepted as the threshold above which superficial damage, such as cracking plaster, can occur. These criteria are compared against the Peak vibration levels.

3. METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of SPP 5.4 and associated Guidelines, as described in *Section 3.1* and *Section 3.2*. Vibration measurements adjacent to the freight railway have been undertaken in accordance with relevant standards.

3.1. Site Measurements

Noise monitoring was undertaken on site using a Ngara Noise Data Logger (S/N: 87803A) (refer *Figure 3-1*). The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. The logger complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within ± 1 dB. Lloyd George Acoustics holds current laboratory calibration certificate for the logger.

The microphone was approximately 1.4 metres above existing ground level and approximately 40 metres from the edge of Princess Royal Drive main carriageway and 20m from the freight railway. The measurements were recorded between 22nd and 29th June 2022.

Figure 3-1: Photograph of a Typical Noise Logger on Site

In addition to the above measurements, results from noise measurements undertaken adjacent to Frenchman Bay Road, as part of the Albany Ring Road Project (ref: Lloyd George Acoustics; 21016036-02; 1/9/22), were also used as part of the noise model calibration.

Vibration monitoring was undertaken using a Texcel ground vibration monitor (S/N: M7278) connected to a geophone that was fixed to the ground using metal spikes. The geophone was positioned next to the noise logger, which was considered as a reasonable representation of the first building envelope.

3.2. Noise Modelling

The computer program *SoundPLAN 8.2* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms (modified to reflect Australian conditions) for road noise and the *Nordic Prediction Method for Train Noise* (NMT) algorithms were used to predict the noise from the railway.

The modifications to the CoRTN algorithms included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Class 1 and 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two source heights at 1.5 metres and 3.6 metres above road level;
- A -0.8 dB correction has been applied to the lower level heavy vehicle noise source and -8.0 dB to the higher level noise source based on the *Transportation Noise Reference Book*; Paul Nelson (1987), so as to provide consistent results with the CoRTN algorithms;
- Adjustments of -0.8 dB and -1.7 dB have been applied to the predicted levels for the 'free-field' and 'at façade' cases respectively, based on the findings of *An Evaluation of the U.K. DoE Traffic Noise Prediction*; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group (March 1983).

Predictions are made at heights of 1.4 metres above ground floor level for single storey buildings and 4.2 metres above ground floor level for possible first floors of double storey buildings. The noise is predicted at 1-metre from an assumed building façade, resulting in a + 2.5 dB correction due to reflected noise.

Various input data are included in the modelling and these are discussed in *Section 3.2.1* to *Section 3.2.6.*

3.2.1. Ground Topography

Topographical data for the site was provided by the design team and the ground levels for the surrounding areas was provided by Landgate.

3.2.2. Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the roads, 0.6 (60%) within the proposed subdivision, noting that 0.0 represents hard reflective surfaces such as water and 1.0 represents absorptive surfaces such as grass.

3.2.3. Vehicle Speed

The existing posted speed on both roads is 70 km/hr and it is assumed to remain unchanged into the future.

3.2.4. Road Surface

The corrections applied for different road surface finishes are provided in *Table 3-1*.

Table 3-1: Noise Relationship between Different Road Surfaces

Chip Seal				Asphalt			
14mm	10mm	5mm	Slurry	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	+1.0 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The road surface is assumed to be 10mm Chip Seal for the Princess Royal Drive and Frenchman Bay Road and dense graded asphalt for the intersections.

3.2.5. Traffic Volumes

Existing traffic volumes were obtained from Main Roads WA Traffic Map. For consistency, the forecast 2021 and 2031 traffic volumes and percentage of heavy vehicles that were used for the Albany Ring Road project was used to for this project and extrapolate to 2041.

Table 3-2: Traffic Information Used in Noise Modelling

Road	Parameter	Scenario			
		Existing – 2022		Future – 2041	
		Northbound	Southbound	Northbound	Southbound
Princess Royal Dve	24-hour Volume	4,593	5,473	7,415	6,176
	% Heavy	30	30	30	30
Frenchman Bay Rd/Hanrahan Rd	24-hour Volume	3,970	3,970	7,823	9,874
	% Heavy	5	5	5	5

3.2.6. Rail Data

Existing train movements were obtained from the measurement data, with future train movements in-line with the requirements under the Policy. *Table 3-3* provides the train numbers over a 24 hour period that were used in the model.

Table 3-3: Traffic Information Used in Noise Modelling

Parameter	Scenario Trains/24hrs	
	Existing	Future
Freight Train	8	24

4. RESULTS

4.1. Noise Monitoring

The results of the noise monitoring are summarised in *Table 4-1* and shown graphically in *Figure 4-1*.

Table 4-1: Measured Average Noise Levels at Logger Adjacent to Princess Royal Dve

Date	Parameter			
	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
Wednesday, 22 June 2022	58.0	55.3	56.7	49.7
Thursday, 23 June 2022	57.1	54.4	55.7	49.5
Friday, 24 June 2022	56.7	54.0	55.2	49.5
Monday, 27 June 2022	54.6	52.9	54.4	45.5
Tuesday, 28 June 2022	53.9	52.0	53.2	47.5
Wednesday, 29 June 2022	55.9	53.7	55.3	44.2
Average	**56.0**	**53.7**	**55.1**	**47.7**

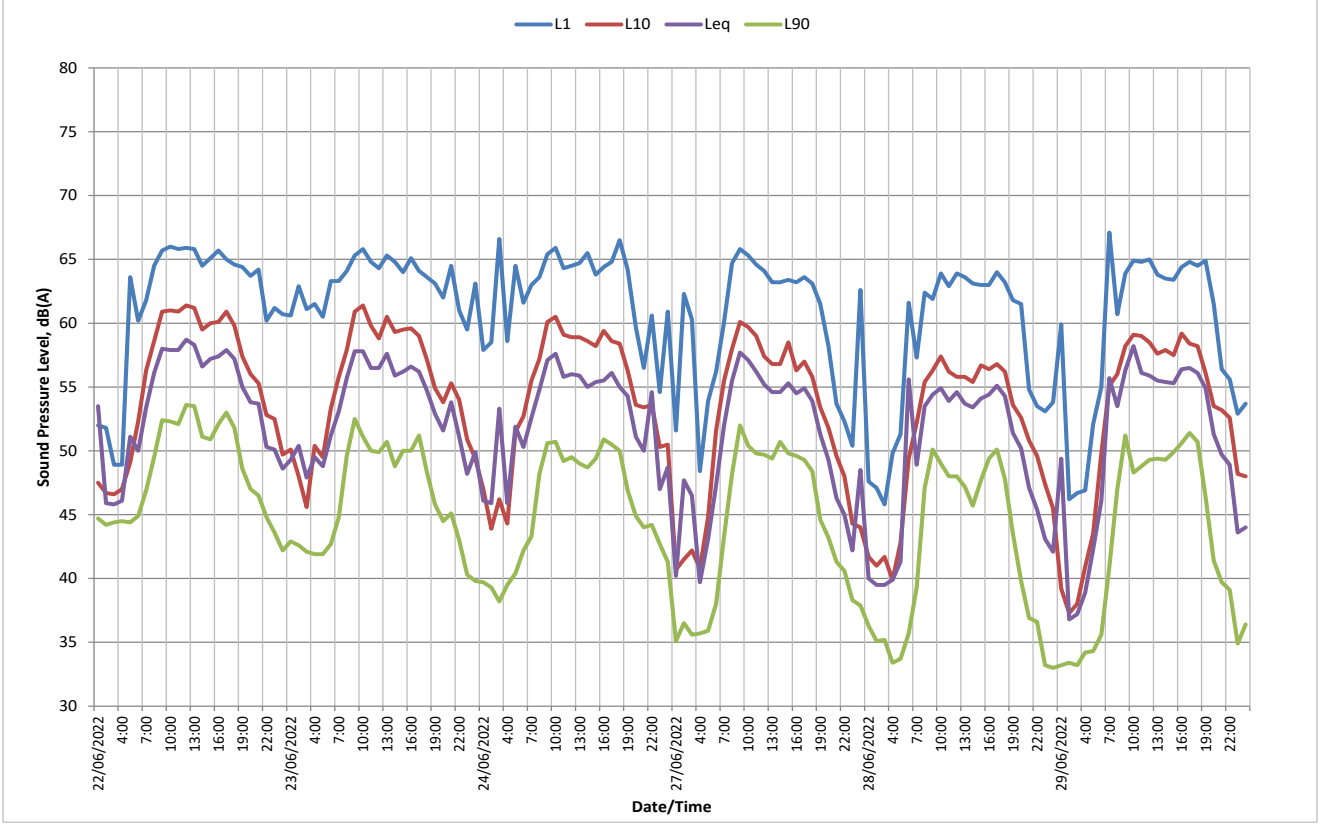


Figure 4-1: Hourly Noise Measurement Results at Noise Logger

For road traffic noise, the average difference between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 7.4 dB and this same difference has been assumed to exist in future years.

The data obtained adjacent to Frenchman Bay Road (as part of the Albany Ring Road) is summarised below in *Table 4-2.* It can be seen that average difference between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 10.5 dB

Table 4-2: Measured Average Noise Levels at Logger Adjacent to Princess Royal Dve

Date	Parameter			
	$L_{A10,18hour}$, dB	$L_{Aeq,24hour}$, dB	$L_{Aeq(Day)}$, dB	$L_{Aeq(Night)}$, dB
Average	**61.2**	**58.3**	**59.9**	**49.4**

As the difference between these two parameters (in both cases) is more than 5 dB, it is the daytime road traffic noise that will dictate compliance or otherwise (refer *Section 2*).

When considering the noise from the freight railway, because we are required to assume one movement per hour for future noise impacts, then it is the night period noise that will dictate compliance or otherwise with the Policy.

4.2. Vibration Monitoring

The results of the vibration measurements are presented in *Figure 4-2 and Figure 4-3,* being for R.M.S. and Peak vibration velocity levels respectively.

The results show that the existing R.M.S. vibration velocity levels at 20m from the railway are generally under 0.2mm/s, with Peak vibration velocity levels below 1.0mm/s.

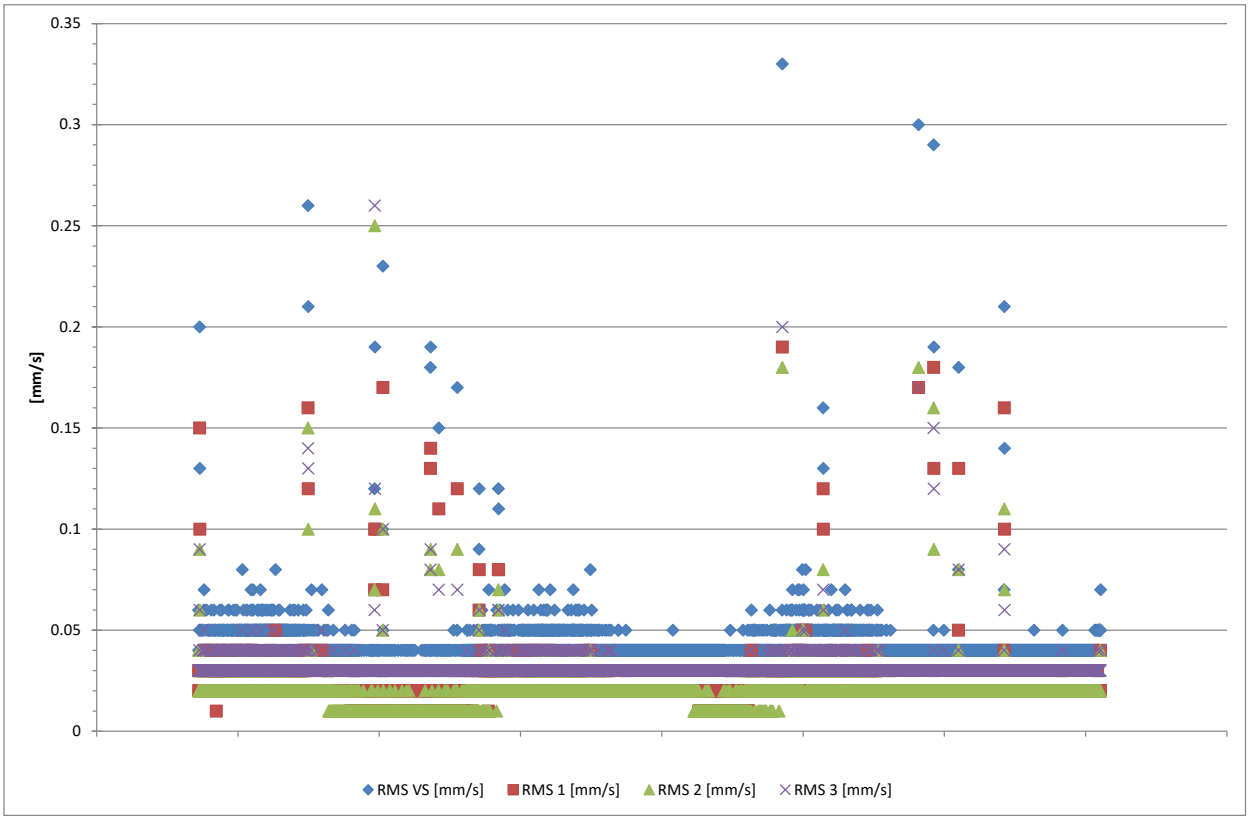


Figure 4-2 Existing R.M.S. Vibration Levels

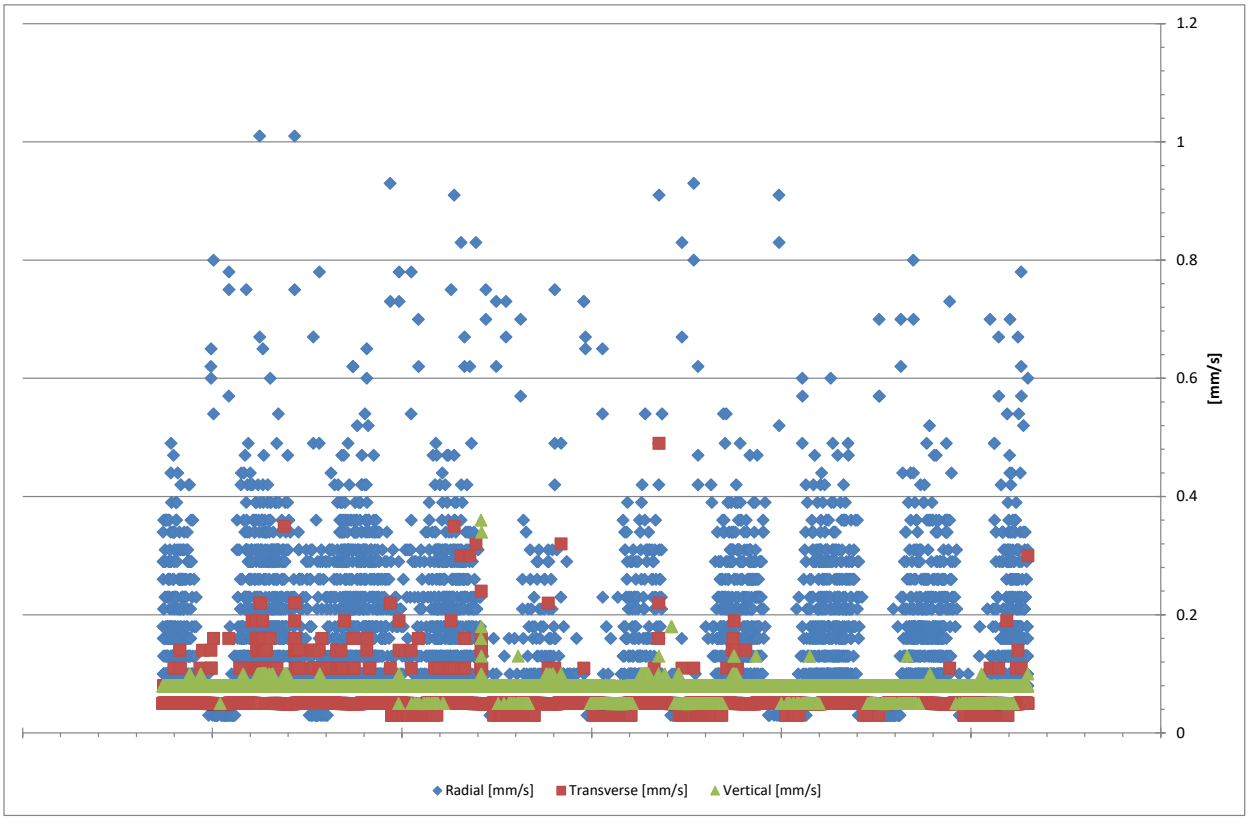


Figure 4-3 Existing Peak Vibration Levels

4.3. Noise Modelling

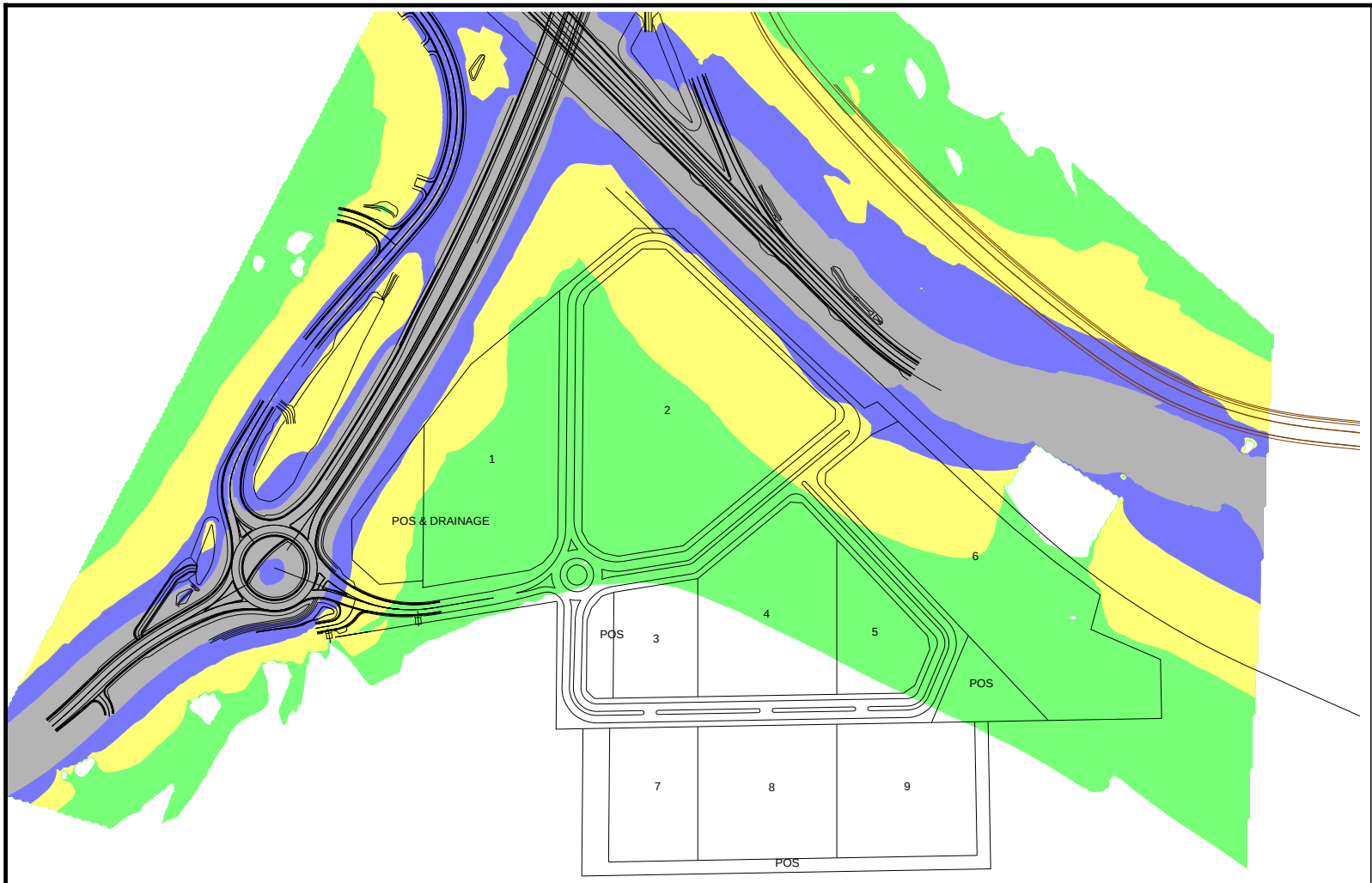
The noise model was initially set-up for existing conditions (road/rail design and traffic volumes) and calibrated to the noise measurement location. The model is then updated to include the future road/rail design and traffic volumes, maintaining the same model calibration.

The results of the noise modelling are provided as noise contour plots representing the noise at various building heights.

Figure 4-4 to Figure 4-11 shows the predicted road and rail noise level at ground, first, fifth and eighth floor level respectively. The noise zones shown in the figures coincide with the "deemed to comply" facade protection packages A to D, as detailed in the Guidelines and reproduced at *Appendix A.*

It should be noted that the contours, particularly for ground floor level, may contract as the buildings close to the noise source would provide a barrier effect to the buildings behind. However, as this project is at Structure Plan phase and the lot layout has yet to be designed, the barrier effect from buildings in not considered.

Figure 4-4



Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale
0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Road Noise Level Contours - Single-Storey Dwellings - 1.4m AGL

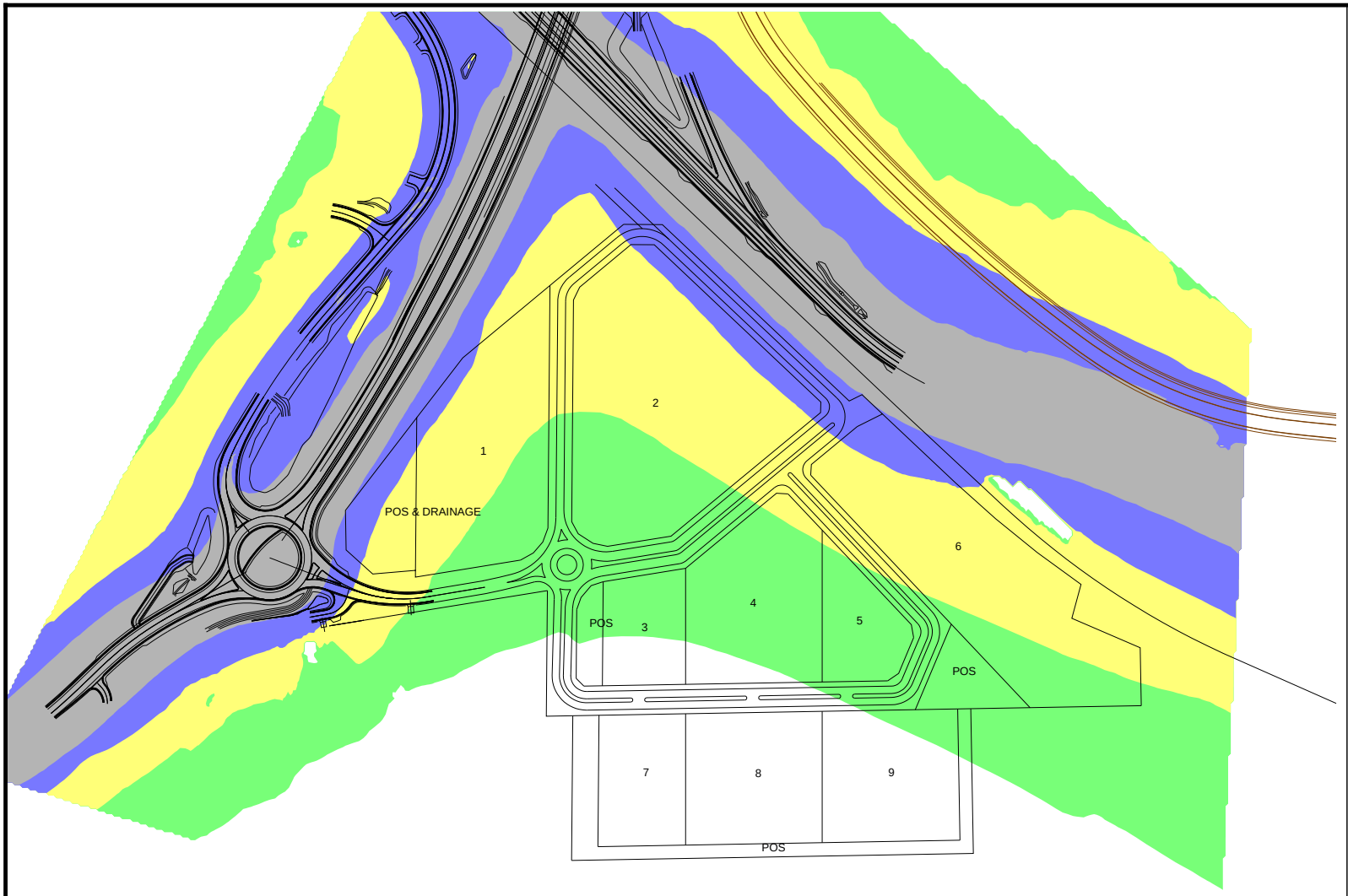
$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
CoRTN Algorithms

27 February 2023

Lloyd George Acoustics
PO Box 717
HILLARYS WA 6923
(08) 9401 7770

Figure 4-5



Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale

0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Road Noise Level Contours - Two-Storey Dwellings - 4.4m AGL

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
CoRTN Algorithms

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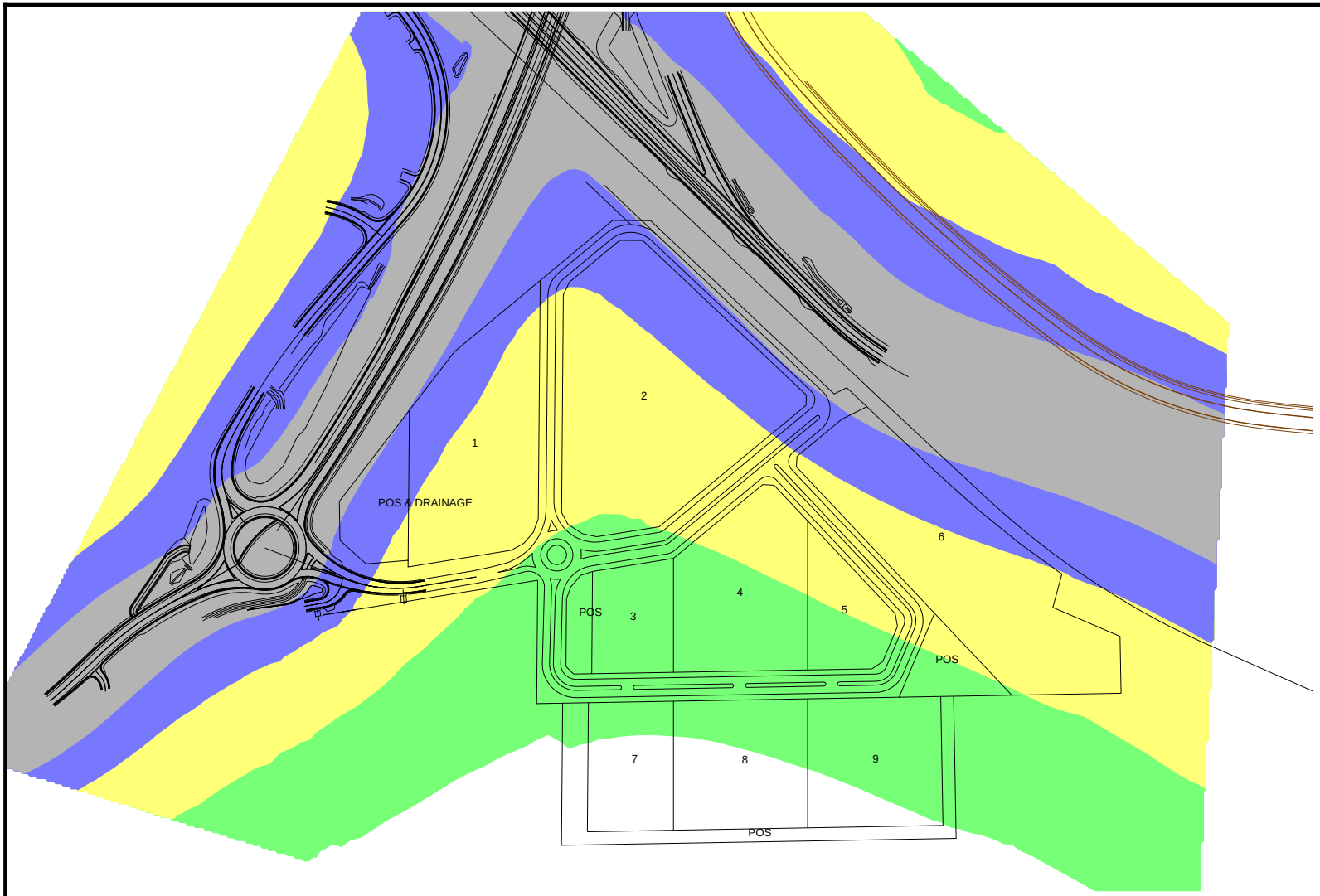
HILLARYS WA 6923
(08) 9401 7770

Figure 4-6



Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale

0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Road Noise Level Contours - Five-Storey Dwellings - 13.4m AGL

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
CoRTN Algorithms

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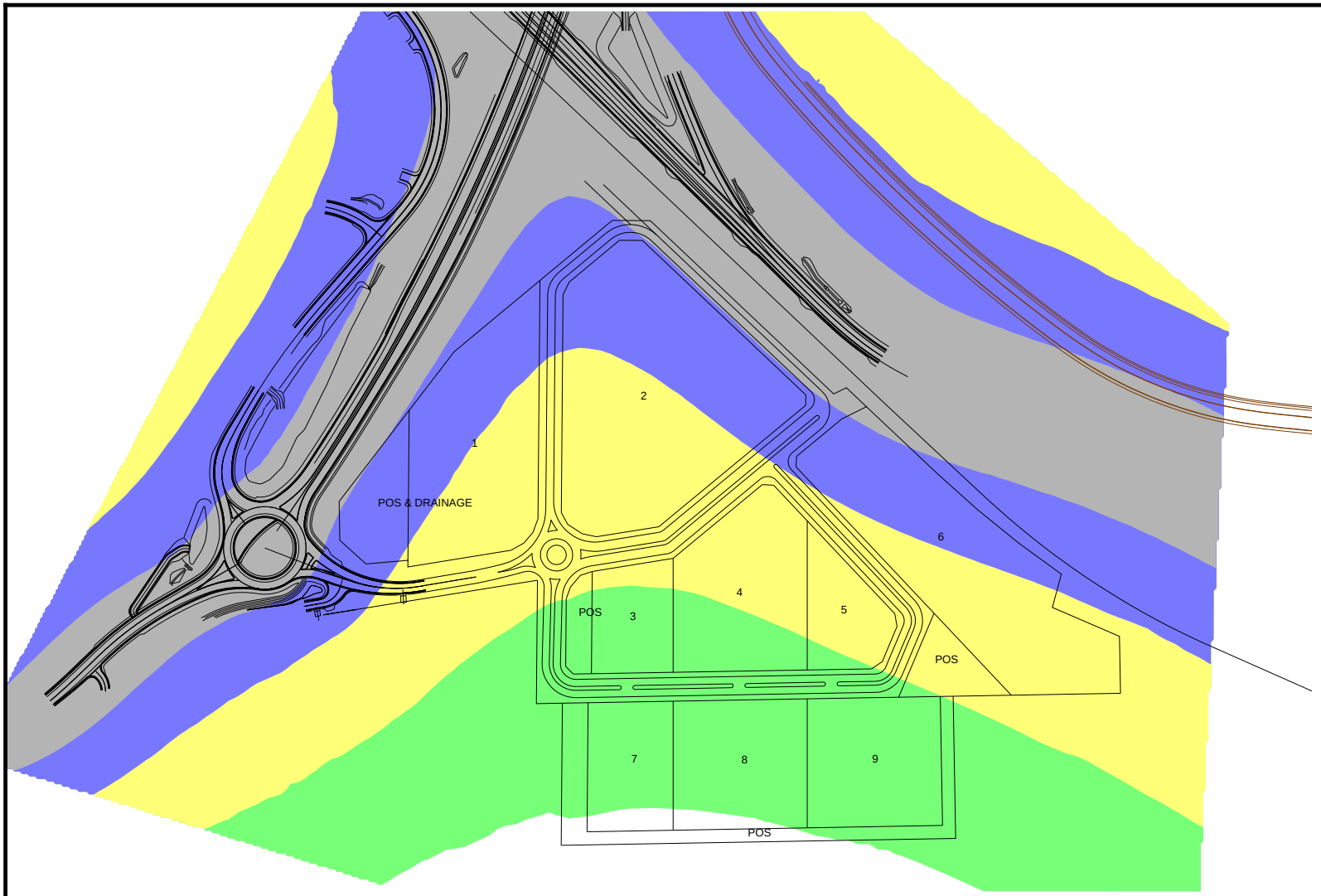
(08) 9401 7770

Figure 4-7



Noise levels
$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	Exposure B
<= 60	
<= 61	
<= 62	
<= 63	Exposure C
<= 64	
<= 65	
<= 66	
> 66	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale

0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Road Noise Level Contours - Eight-Storey Dwellings and Above - 22.4m AGL

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
CoRTN Algorithms

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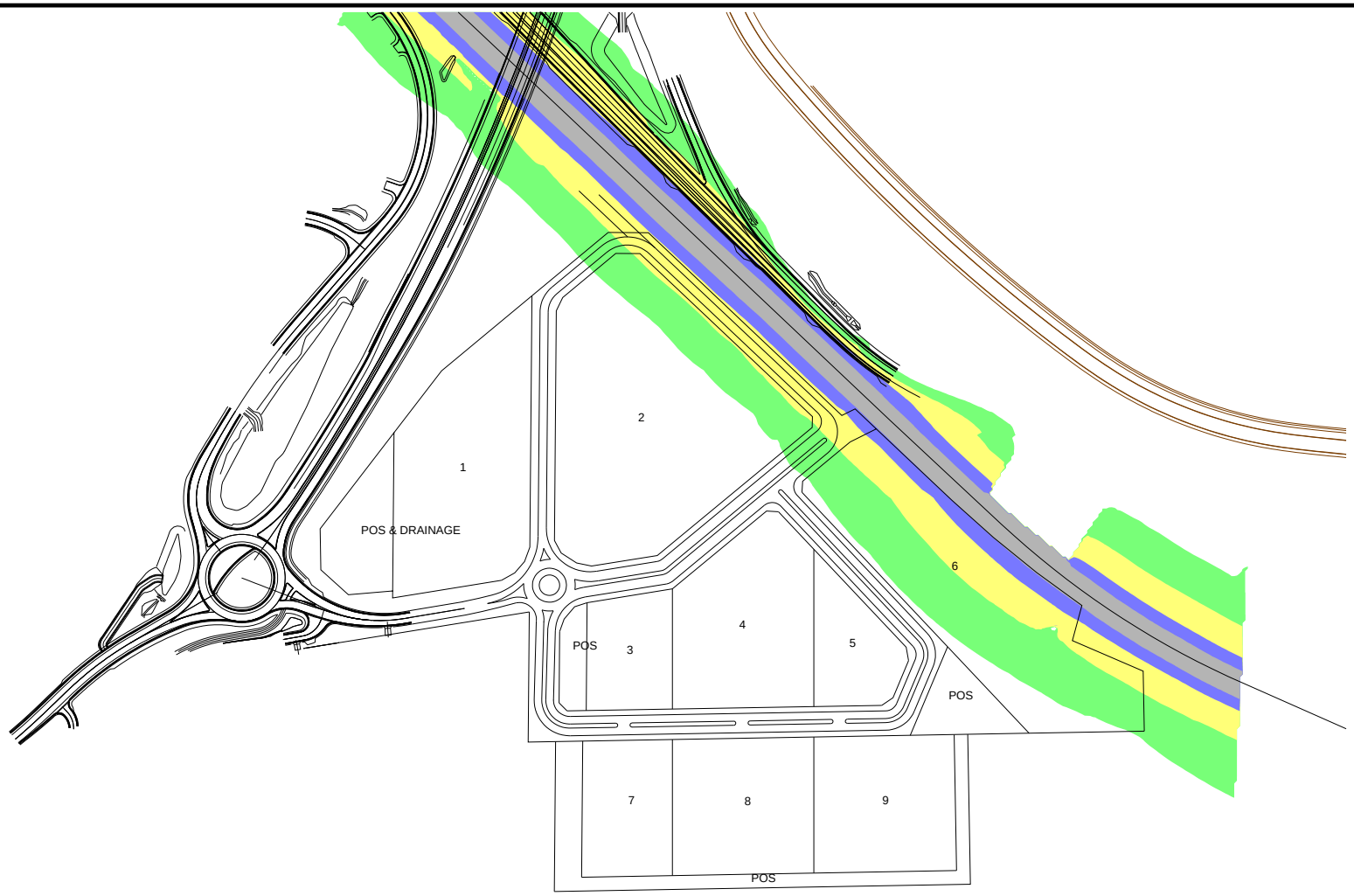
(08) 9401 7770

Figure 4-8



Noise levels
$L_{Aeq,Night}$ dB

<= 50	
<= 51	Exposure A
<= 52	
<= 53	
<= 54	Exposure B
<= 55	
<= 56	
<= 57	
<= 58	Exposure C
<= 59	
<= 60	
<= 61	
> 61	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale

0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Rail Noise Level Contours - Single-Storey Dwellings - 1.4m AGL

$L_{Aeq(Night}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
NMT Algorithms

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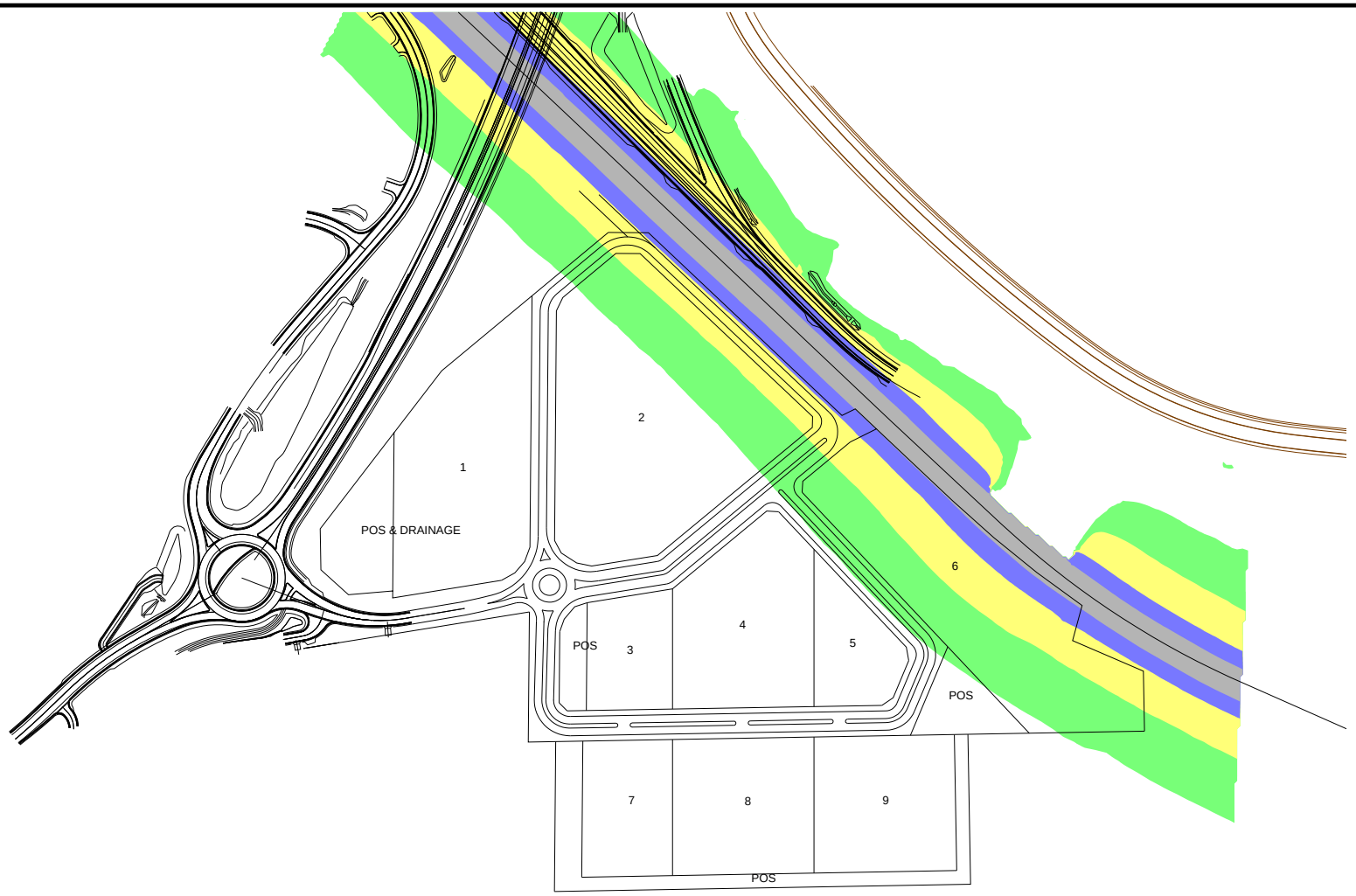
HILLARYS WA 6923
(08) 9401 7770

Figure 4-9



Noise levels
$L_{Aeq,Night}$ dB

<= 50	
<= 51	Exposure A
<= 52	
<= 53	
<= 54	Exposure B
<= 55	
<= 56	
<= 57	
<= 58	Exposure C
<= 59	
<= 60	
<= 61	
> 61	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale

0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Rail Noise Level Contours - Two-Storey Dwellings - 4.4m AGL

$L_{Aeq(Night}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
NMT Algorithms

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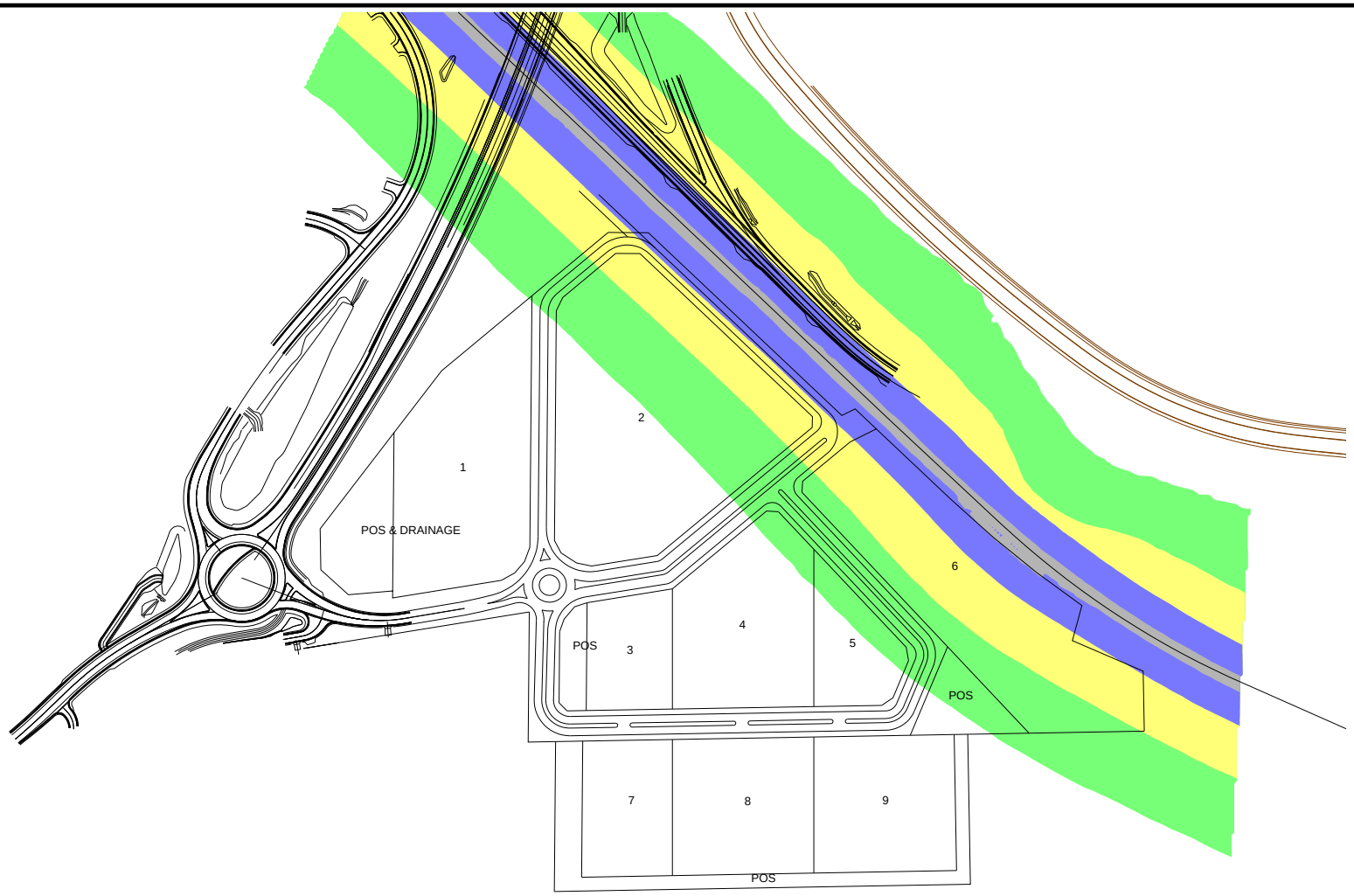
Figure 4-10



Noise levels
$L_{Aeq,Night}$ dB

<= 50		
<= 51	Exposure A	
<= 52		
<= 53		
<= 54	Exposure B	
<= 55		
<= 56		
<= 57		
<= 58	Exposure C	
<= 59		
<= 60		
<= 61		
> 61	Exposure D	

SPP 5.4 (Sep 2019)

N

Length Scale

0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Rail Noise Level Contours - Five-Storey Dwellings - 13.4m AGL

$L_{Aeq(Night}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
NMT Algorithms

27 February 2023

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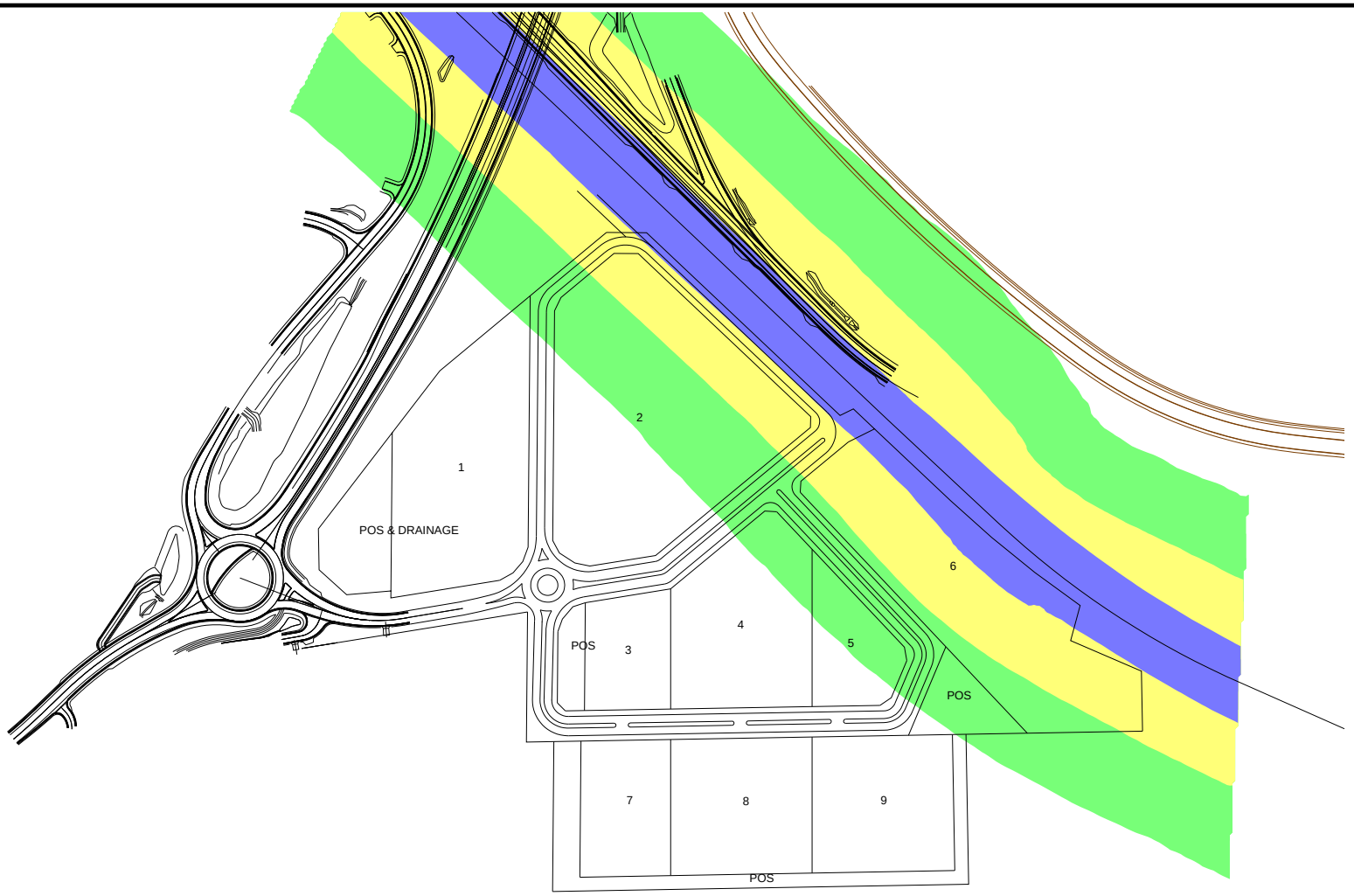
Figure 4-11



Noise levels
$L_{Aeq,Night}$ dB

<= 50	
<= 51	Exposure A
<= 52	
<= 53	
<= 54	Exposure B
<= 55	
<= 56	
<= 57	
<= 58	Exposure C
<= 59	
<= 60	
<= 61	
> 61	Exposure D

SPP 5.4 (Sep 2019)

N

Length Scale
0 25 50 100 150 200 m

Woolstores Place, Mt Elphinstone, Albany - Structure Plan
Rail Noise Level Contours - Eight-Storey Dwellings and Above - 22.4m AGL

$L_{Aeq(Night}$ Noise Level Contours Based on Future Conditions

SoundPlan v8.2
NMT Algorithms

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PO Box 717
HILLARYS WA 6923
(08) 9401 7770

5. ASSESSMENT

5.1. Transportation Noise Levels

The objectives of SPP 5.4 are to achieve:

- Indoor noise levels specified in *Table 2-1* in noise-sensitive areas (e.g. bedrooms and living rooms or houses); and
- A reasonable degree of acoustic amenity for outdoor living areas on each residential lot.

Where the outdoor noise targets of *Table 2-1* are achieved, no further noise controls are necessary.

From the results presented in *Section 4.3*, it is evident the outdoor noise target will be exceeded at a number of lots and that noise mitigation must be considered. In addition, it can be seen that the road noise is significantly higher than the rail noise and will therefore dictate the extent of mitigation required. However, the low frequency component of locomotives does require consideration and that would be factored into the facade design.

Due to the geometry of the road, in that it is significantly higher than the subdivision ground levels with limited space for noise walls, using barriers is not considered to be reasonable or practicable for this subdivision and noise mitigation would generally be limited to facade protection only.

With reference to the various 'deemed to comply' facade protection packages, these are based on typical single house designs and are inherently conservative. For multi-storey apartment buildings, the appropriate facade protection would be determined and controlled through the building design process and would be tailored to reflect the apartment layout, window and wall areas etc., to achieve the desired internal noise levels. This process is typical for apartment style buildings close to transportation corridors and high quality design outcomes are easily achieved.

Commercial buildings are not included within the Policy and do not require specific noise mitigation.

5.2. Vibration Levels

The results of the R.M.S. vibration levels presented in *Figure 4-2,* are generally below the threshold that would result in annoyance for residential uses, particularly as the vibration source is intermittent and not continuous.

The Peak vibration levels presented in *Figure 4-3*, are well below levels that are likely to result in structural damage to buildings.

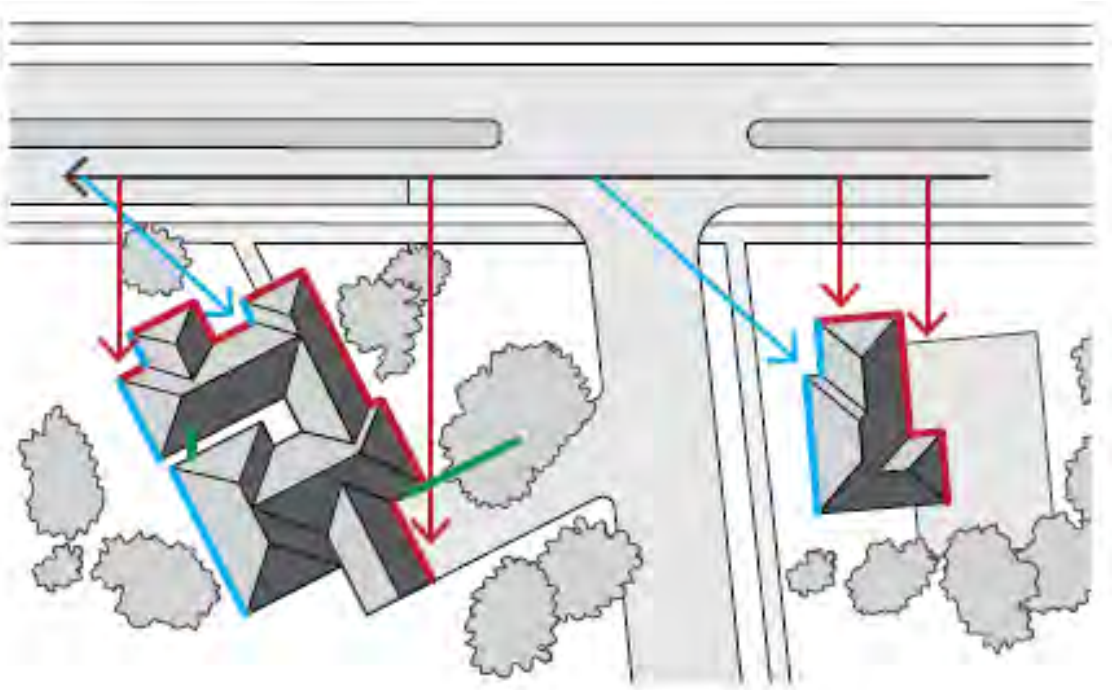
Appendix A – Quiet House Packages

The packages and information provided on the following pages are taken from *Road and Rail Noise Guidelines* (September 2019).

Where outdoor and indoor noise levels received by a noise-sensitive land-use and/or development exceed the policy's noise target, implementation of quiet house requirements is an acceptable solution.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor (red): Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular (at a 90 degree angle) to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).
- **Side-on** to transport corridor (blue): Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line, at any angle, can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).
- **Opposite** to transport corridor (green): Neither 'side on' nor 'facing', as defined above.



Quiet House Package A

56-58 dB $L_{Aeq(Day)}$ & 51-53 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with minimum 10mm single or 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$): – Sealed awning or casement windows with minimum 6mm glass.	• Up to 40% floor area ($R_w + C_{tr} \geq 25$): – Sliding or double hung with minimum 6mm single or 6mm-12mm-6mm double insulated glazing; • Up to 60% floor area ($R_w + C_{tr} \geq 28$); • Up to 80% floor area ($R_w + C_{tr} \geq 31$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	No specific requirements	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.	• Doors to achieve $R_w + C_{tr} \geq 25$: – 35mm Solid timber core hinged door and frame system certified to R_w 28 including seals; – Glazed sliding door with 10mm glass and weather seals.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less.	
	Opposite	No specific requirements	
External Walls	All	• $R_w + C_{tr} \geq 45$: – Two leaves of 90mm thick clay brick masonry with minimum 20mm cavity; or – Single leaf of 150mm brick masonry with 13mm cement render on each face; or – One row of 92mm studs at 600mm centres with: ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm hardboard or fibre cement sheeting or 11mm fibre cement weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: • Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2 metres height above ground level.	

Quiet House Package B

59-62 dB $L_{Aeq(Day)}$ & 54-57 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 28$): – Sliding or double hung with 6mm-12mm-10mm double insulated glazing; – Sealed awning or casement windows with minimum 6mm glass. • Up to 60% floor area ($R_w + C_{tr} \geq 31$); • Up to 80% floor area ($R_w + C_{tr} \geq 34$).
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass.	• Doors to achieve $R_w + C_{tr} \geq 28$: – 40mm Solid timber core hinged door and frame system certified to R_w 32 including seals; – Fully glazed hinged door with certified $R_w + C_{tr} \geq 28$ rated door and frame including seals and 6mm glass.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester (24kg/m^3). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m^3) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 35$: – Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling with R3.0+ fibrous insulation.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Quiet House Package C

63-66 dB $L_{Aeq(Day)}$ & 58-61 dB $L_{Aeq(Night)}$

Element	Orientation	Room	
		Bedroom	Indoor Living and Work Areas
External Windows	Facing	• Up to 20% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 40% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.	• Up to 40% floor area ($R_w + C_{tr} \geq 31$): – Fixed sash, awning or casement with minimum 6mm glass or 6mm-12mm-6mm double insulated glazing. • Up to 60% floor area ($R_w + C_{tr} \geq 34$): – Fixed sash, awning or casement with minimum 10mm glass or 6mm-12mm-10mm double insulated glazing.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Doors	Facing	• Not recommended.	• Doors to achieve $R_w + C_{tr} \geq 30$: – Fully glazed hinged door with certified $R_w + C_{tr} \geq 31$ rated door and frame including seals and 10mm glass; – 40mm Solid timber core side hinged door, frame and seal system certified to R_w 32 including seals. Any glass inserts to be minimum 6mm.
	Side On	As above, except $R_w + C_{tr}$ values may be 3 dB less or max % area increased by 20%.	
	Opposite	As above, except $R_w + C_{tr}$ values may be 6 dB less or max % area increased by 20%.	
External Walls	All	• $R_w + C_{tr} \geq 50$: – Two leaves of 90mm thick clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). Resilient ties used where required to connect leaves. – Two leaves of 110mm clay brick masonry with minimum 50mm cavity between leaves and 25mm glasswool or polyester insulation (24kg/m^3). – Single leaf of 220mm brick masonry with 13mm cement render on each face. – 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face. – Single leaf of 90mm clay brick masonry with: ▪ A row of 70mm x 35mm timber studs or 64mm steel studs at 600mm centres; ▪ A cavity of 25mm between leaves; ▪ 50mm glasswool or polyester insulation (11kg/m^3) between studs; and ▪ One layer of 10mm plasterboard fixed to the inside face.	
Roofs and Ceilings	All	• $R_w + C_{tr} \geq 40$: – Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibrous insulation between steel sheeting and roof battens; – R3.0+ insulation batts above ceiling; – 2 x 10mm plasterboard ceiling or 1 x 13mm sound-rated plasterboard affixed using steel furring channel to ceiling rafters.	
Outdoor Living Areas		At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum 2.4 metres height above ground level.	

Mechanical Ventilation requirements

In implementing the acceptable treatment packages, the following mechanical ventilation / air-conditioning considerations are required:

- Acoustically rated openings and ductwork to provide a minimum sound reduction performance of R_w 40 dB into sensitive spaces;
- Evaporative systems require attenuated ceiling air vents to allow closed windows;
- Refrigerant based systems need to be designed to achieve National Construction Code fresh air ventilation requirements;
- Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable.

Notification

Notifications on title advise prospective purchasers of the potential for noise impacts from major transport corridors and help with managing expectations.

The Notification is to state as follows:

This lot is in the vicinity of a transport corridor and is affected, or may in the future be affected, by road and rail transport noise. Road and rail transport noise levels may rise or fall over time depending on the type and volume of traffic.

Appendix B – Terminology

The following is an explanation of the terminology used throughout this report:

- **Decibel (dB)**

The decibel is the unit that describes the sound pressure levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

- **A-Weighting**

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A, dB.

- **L_{eq}**

The L_{eq} level represents the average noise energy during a measurement period.

- **L_1**

The L_1 level represents the noise level exceeded for 1 percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

- **L_{10}**

The L_{10} level represents the noise level exceeded for 10 percent of the measurement period and is considered to represent the "intrusive" noise level.

- **L_{90}**

The L_{90} level represents the noise level exceeded for 90 percent of the measurement period and is considered to represent the "background" noise level.

- **$L_{Aeq(Day)}$**

The $L_{Aeq(Day)}$ level is the logarithmic average of the L_{Aeq} levels from 6.00am to 10.00pm.

- **$L_{Aeq(Night)}$**

The $L_{Aeq(Night)}$ level is the logarithmic average of the L_{Aeq} levels from 10.00pm to 6.00am.

- **$L_{A10,18hour}$**

The $L_{A10,18hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00am and midnight.

- **$L_{Aeq,24hour}$**

The $L_{Aeq,24hour}$ level is the logarithmic average of the L_{Aeq} levels from over an entire day.

- **Noise-sensitive land use and/or development**

Land-uses or development occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan park, camping ground, educational establishment, child care premises, hospital, nursing home, corrective institution or place of worship.

- **R_w**

This is the weighted sound reduction index. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

- **C_{tr}**

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of – 4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -12 dB.

- **About the Term 'Reasonable'**

An assessment of reasonableness should demonstrate that efforts have been made to resolve conflicts without comprising on the need to protect noise-sensitive land-use activities. For example, have reasonable efforts been made to design, relocate or vegetate a proposed noise barrier to address community concerns about the noise barrier height? Whether a noise mitigation measure is reasonable might include consideration of:

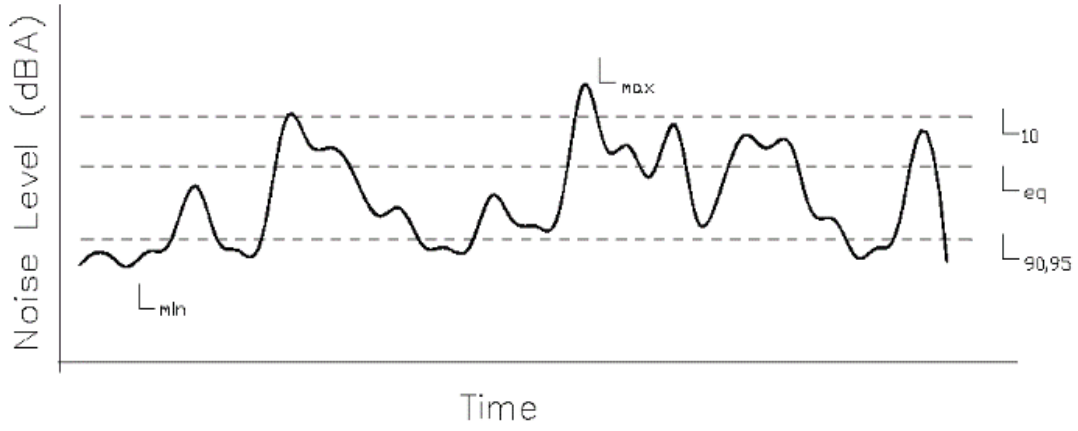
- The noise reduction benefit provided;
- The number of people protected;
- The relative cost vs benefit of mitigation;
- Road conditions (speed and road surface) significantly differ from noise forecast table assumptions;
- Existing and future noise levels, including changes in noise levels;
- Aesthetic amenity and visual impacts;
- Compatibility with other planning policies;
- Differences between metropolitan and regional situations and whether noise modelling requirements reflect the true nature of transport movements;
- Ability and cost for mobilisation and retrieval of noise monitoring equipment in regional areas;
- Differences between Greenfield and infill development;
- Differences between freight routes and public transport routes and urban corridors;
- The impact on the operational capacity of freight routes;
- The benefits arising from the proposed development;
- Existing or planned strategies to mitigate the noise at source.

- **About the Term 'Practicable'**

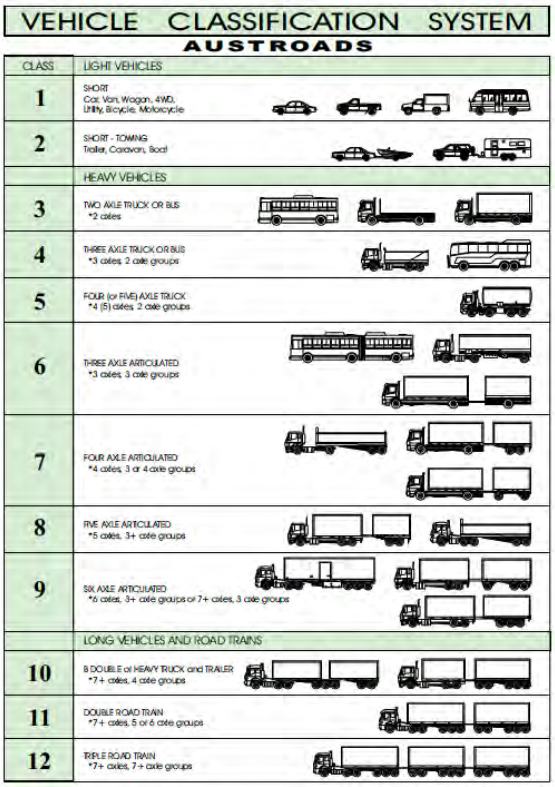
'Practicable' considerations for the purposes of the policy normally relate to the engineering aspects of the noise mitigation measures under evaluation. It is defined as "reasonably practicable having regard to, among other things, local conditions and circumstances (including costs) and to the current state of technical knowledge" (*Environmental Protection Act 1986*). These may include:

- Limitations of the different mitigation measures to reduce transport noise;
- Competing planning policies and strategies;
- Safety issues (such as impact on crash zones or restrictions on road vision);
- Topography and site constraints (such as space limitations);
- Engineering and drainage requirements;
- Access requirements (for driveways, pedestrian access and the like);
- Maintenance requirements;
- Bushfire resistance or BAL ratings;
- Suitability of the building for acoustic treatments.

- **Chart of Noise Level Descriptors**



- **Austroads Vehicle Class**



- **Typical Noise Levels**