northern expressway
environmental report
noise and vibration technical paper

NORTHERN EXPRESSWAY

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Government of South Australia
Department for Transport, Energy and Infrastructure

NOISE AND VIBRATION TECHNICAL PAPER

Northern Expressway

Noise and Vibration Technical Paper

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List of abbreviations

AADT	annual average daily traffic
CoRTN	Calculation of Road Traffic Noise
CV	commercial vehicles
dB	decibel
DGA	dense graded asphalt
DTEI	Department for Transport, Energy and Infrastructure
MNL	measured noise level
PCC	Portland cement concrete
PNL	predicted noise level
QDMR	Queensland Department of Main Roads
RBL	rating background level
SMA	stone mastic asphalt

Glossary

'A' weighted	Frequency filter applied to measured noise levels to represent how humans hear sounds
dB(A)	'A' weighted overall sound pressure level
$L_{eq, T}$	Equivalent continuous noise level measured over a time period T, often referred to as the 'ambient noise level'
$L_{eq, 15h}$	Equivalent continuous noise level measured over the 15 hour day time period (7 a.m. to 10 p.m.)
$L_{eq, 9h}$	Equivalent continuous noise level measured over the 9 hour night time period (10 p.m. to 7 a.m.)
L_{90}	90^{th} percentile noise statistic; the noise level at which 90% of ambient noise over a period is below; often referred to as 'background noise level'
rating background level	calculated by assessing the lower tenth percentile of the dB(A)L_{90} noise level, or in other terms 'the L_{90} of the L_{90}'s' (term taken from NSW Environment Protection Authority, NSW Industrial Noise Policy, 2000)

1 Introduction

1.1 Background

This technical paper assesses the environmental noise due to road traffic before and after construction of the proposed Northern Expressway. Traffic noise has been modelled for two situations: the existing road network and the road network incorporating the Northern Expressway.

The paper outlines reasonable and practicable noise mitigation measures to achieve either the adopted noise level criteria or an agreed satisfactory level of noise amenity for affected residents.

This assessment is based upon traffic volume information, plan and longitudinal section drawings provided by the Department of Transport, Energy and Infrastructure (DTEI).

1.2 Legislative and policy requirements

Environment Protection Act 1993

Section 25 of the South Australian Environment Protection Act 1993 states that: ‘A person must not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practical measures to prevent or minimise any resulting environmental harm.’ Section 25(2) of the Act also specifies that regard must be given, amongst other things, to the nature of pollution or potential pollution, the sensitivity of the receiving environment, the financial implications of various measures, and the current state of technical knowledge in considering the application of the various devices.

DTEI Road Traffic Noise Guidelines

The DTEI Road Traffic Noise Guidelines (2007) provide a framework for assessing and treating road traffic noise from infrastructure projects for new roads or major upgrading of existing roads.

2 Existing environment

2.1 Environmental noise measurements

Existing environmental noise levels were measured by loggers at 30 locations around the project area from Monday 27 November 2006 to Friday 8 December 2006 (Table 2.1) for at least 24 hours at each location under typical ambient conditions (i.e. no unusual traffic or meteorological conditions).

Table 2.1 Summary of logger locations

Location	Ref no.	Measurement period	Property no.
1 Parkers Court, Willaston	1	27.11.06 to 29.11.06	5021
Lot 1 Atyeo Road, Gawler Belt	2	29.11.06 to 1.12.06	1951
Lot 100 Gawler Bypass Road, Reid	3	4.12.06 to 6.12.06	4639
4 Andrews Court, Reid	4	4.12.06 to 6.12.06	4648
Lot 101 Weaver Road, Buchfelde	5	4.12.06 to 6.12.06	5225
Lot 440 Govt Road, Buchfelde	6	29.11.06 to 1.12.06	2126
Lot 100 Two Wells Road, Buchfelde	7	29.11.06 to 1.12.06	5173
Lot 2 Ward Belt Road, Buchfelde	8	6.12.06 to 8.12.06	2107
Lot 200 Two Wells Road, Buchfelde	9	27.11.06 to 29.11.06	2136
Lot 210 Hillier Road, Hillier	10	4.12.06 to 6.12.06	1572
Lot 12 Hillier Road, Hillier	11	27.11.06 to 29.11.06	1576
Lot 207 Hillier Road, Hillier	12	4.12.06 to 6.12.06	1590
Lot 1 Angle Vale Road, Munno Para Downs	13	6.12.06 to 8.12.06	1616
Lot 6 Bain Road, Munno Para Downs	14	6.12.06 to 8.12.06	1612
Lot 201 Frisby Road, Munno Para Downs	15	29.11.06 to 1.12.06	1621
18 Andrews Road, MacDonald Park	16	27.11.06 to 29.11.06	5140
Lot 20 McIntyre Road, MacDonald Park	17	27.11.06 to 29.11.06	1814
13 Spencer Street, MacDonald Park	18	29.11.06 to 1.12.06	1815
Lot 32 Argent Road, Penfield	19	29.11.06 to 1.12.06	1856
Lot 330 Womma Road, Penfield	20	29.11.06 to 1.12.06	1917
Lot 467 Heaslip Road, Penfield	21	6.12.06 to 8.12.06	647
Lot B Section 4111 Womma Road, Penfield Gardens	22	27.11.06 to 29.11.06	631
Lot 81 Pellew Road, Penfield	23	6.12.06 to 8.12.06	593
Lot 42 Taylors Road, Virginia	24	4.12.06 to 6.12.06	406
Lot 76 Taylors Road, Virginia	25	27.11.06 to 29.11.06	554
Lot 13 Stanley Road, Waterloo Corner	26	29.11.06 to 1.12.06	502
Lot 51 Port Wakefield Road, Waterloo Corner	27	6.12.06 to 8.12.06	57
Lot 1 Port Wakefield Road, Waterloo Corner	28	27.11.06 to 29.11.06	4053
34 General Drive, Paralowie	29	27.11.06 to 29.11.06	2535
Port Wakefield Road, Globe Derby Park	30	4.12.06 to 6.12.06	3972

In cases where the microphone of the noise logger was positioned in free field conditions, a façade correction of +2.5 dB was added to the equivalent continuous noise level (L_{Aeq}) results to ensure direct comparison of ambient noise levels at all logging locations. The measurements were unaffected by periods of excessive wind and there was no rainfall during the measurement periods and thus are indicative of existing environmental noise levels at each monitoring location. Weather data was collected from the Bureau of Meteorology weather station at Edinburgh.

Measurement results at each location are summarised in Table 2.2.

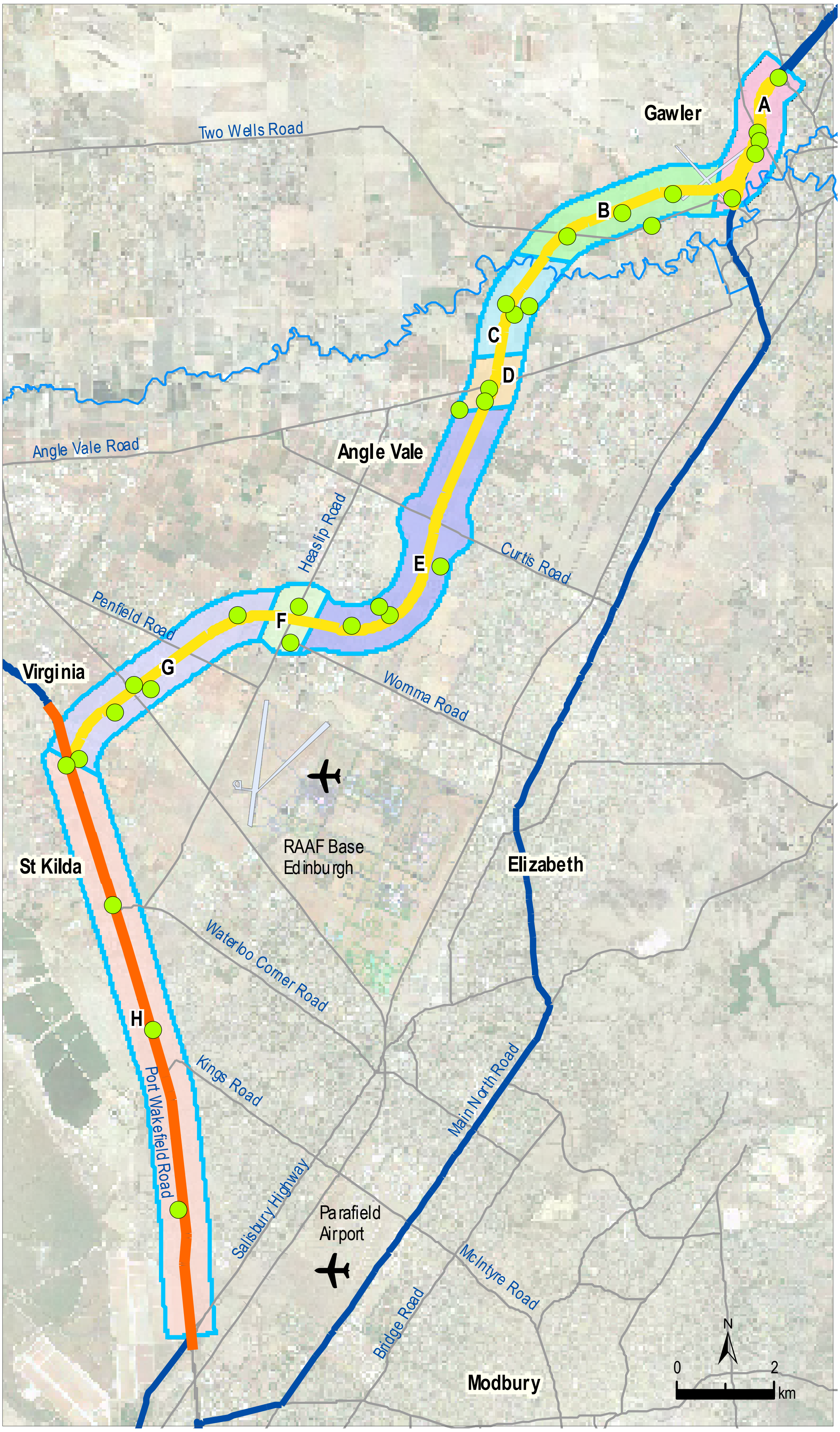
Table 2.2 Environmental noise logging results summary

Ref. no.	15 h day RBL	9 h night RBL	15 h day L_{Aeq}	9 h night L_{Aeq}	24 h L_{Aeq}	Day peak $L_{Aeq, 1h}$	Night peak $L_{Aeq, 1h}$
1	46	25	66	63	65	69	67
2	46	33	58	57	57	63	60
3	46	28	60	54	58	62	58
4	45	26	60	55	58	71	60
5	45	28	67	63	65	70	67
6	39	31	58	58	58	63	63
7	48	29	64	59	62	67	64
8	29	30	48	45	46	64	50
9	42	27	57	53	55	60	60
10	40	25	59	45	56	64	54
11	38	27	54	44	51	61	51
12	36	29	50	47	49	59	58
13	49	30	65	61	63	68	66
14	35	31	52	52	52	67	59
15	43	34	53	51	52	65	56
16	33	26	51	45	49	58	53
17	37	29	50	48	49	54	54
18	34	31	52	49	50	65	54
19	35	33	54	50	53	65	56
20	49	35	59	56	58	63	61
21	47	33	76	74	75	79	79
22	46	26	56	52	55	62	59
23	31	30	62	49	59	73	59
24	38	29	66	59	64	69	65
25	44	29	55	55	55	63	64
26	49	32	61	60	60	66	66
27	41	31	60	60	60	66	65
28	51	38	68	66	67	71	70
29	53	31	64	61	63	66	66
30	48	39	62	60	61	67	63

In summary:

- most residents affected by the Northern Expressway Project currently experience very quiet background noise levels typical of a rural area
- 14 of the 30 receptor locations currently have existing night time rating background levels (RBLs) of less than 30 dB(A)
- 11 of the 30 receptor locations currently have existing day time RBLs of less that 40 dB(A)
- residents closer to the existing road network experience higher background noise levels with significant traffic volume
- the highest traffic noise exposure noted was at Port Wakefield Road where two logging locations recorded day time RBLs of greater than 50 dB(A).

All noise logger results, and correlated weather data, for each logging location are included in Attachment A. Figure 2.1 shows all noise logging locations relative to the Northern Expressway alignment.



Noise logging site

Noise catchments boundary

Refer Section 14 for catchment areas idenitification

Figure 2.1 **Noise catchment areas and monitoring sites**

3 Effects of project upon existing conditions

3.1 Traffic noise criteria

3.1.1 Community response to changes in noise levels

The average ability of an individual to perceived changes in noise levels is well documented. Generally, changes in noise levels of less than 3 dB(A) are barely perceptible to most listeners, whereas 10 dB(A) changes are normally perceived as a doubling (or halving) of noise levels.

Table 3.1 lists the logarithmic relationship to perceived changes in noise levels.

Table 3.1 Average ability to perceived changes in noise levels

Change dB(A)	Human perception of sound
2–3	Barely perceptible
5	Readily noticeable
10	A doubling or halving of the loudness of sound
20	A dramatic change
40	Difference between a faintly audible sound and a very loud sound

Source: Bolt Beranek and Neuman, Inc. 1973.

3.1.2 Road Traffic Noise Guidelines

DTEI recommends that traffic noise impacts be assessed according to its recently improved *Road Traffic Noise Guidelines* (2007), which now adequately assess new road infrastructure affecting rural areas.

Residents who experience little or no traffic noise are likely to be more affected by traffic noise on a new road alignment than those already experiencing some road traffic noise where noise from traffic on a realigned or upgraded road may make little or no change.

To determine which criteria – 'new exposure' or 'existing exposure' – apply to the Northern Expressway and Port Wakefield Road Upgrade, the following key guideline points were considered:

- A site is defined as having an 'existing road traffic noise exposure' if the prevailing noise level from the existing road alignment(s) is equal to or greater than 55 dB(A) $L_{eq,15h}$ (day) or 50 dB(A) $L_{eq,9h}$ (night).
- A 'significant contribution to road traffic noise exposure' from a road development or upgrading proposal is defined as an increase in road traffic noise at any exposed facade of more than 2 dB over the road traffic noise level from the existing road.

- An alignment or realignment producing noise at a receptor from a different direction can make a ‘significant contribution to road traffic noise exposure’ (as defined above) on top of any increase in traffic noise from the same direction as present. If the new noise emission direction contributes more than 2 dB at any exposed facade, it is ‘significant’, and this means the new alignment or realignment is a ‘new road traffic noise source’.

Therefore the adopted noise level criteria for the Northern Expressway project are:

- for areas presently exposed to road traffic noise of less than day time 53 dB(A) $L_{eq,15h}$ and night time 48 dB(A) $L_{eq,9h}$ the external target criteria for 2026 will be:
  - day time 55 dB(A) $L_{eq,15h}$ and night time 50 dB(A) $L_{eq,9h}$
- for areas presently exposed to road traffic noise greater than day time 53 dB(A) $L_{eq,15h}$ and night time 48 dB(A) $L_{eq,9h}$, the external target criteria for 2026 will be the lower of:
  - the existing noise level plus 2 dB(A)
  - a day time 65 dB(A) $L_{eq,15h}$ and night time 60 dB(A) $L_{eq,9h}$.

Assessment times are:

- day time – the 15 hour period between 7 a.m. and 10 p.m.
- night time – the 9 hour period between 10 p.m. and 7 a.m.

Noise levels are to be predicted or measured at a location 1 metre from the most exposed window at a height of 1.5 metres above floor level. Noise levels at this location are affected by reflections from the building façade, in which case all predictions are to include a façade reflection factor of +2.5 dB. If noise levels for individual properties are measured at locations not subject to reflections from the building façade, they are also subject to an adjustment factor of +2.5 dB to ensure that the comparison of noise levels against the noise level criteria are consistent.

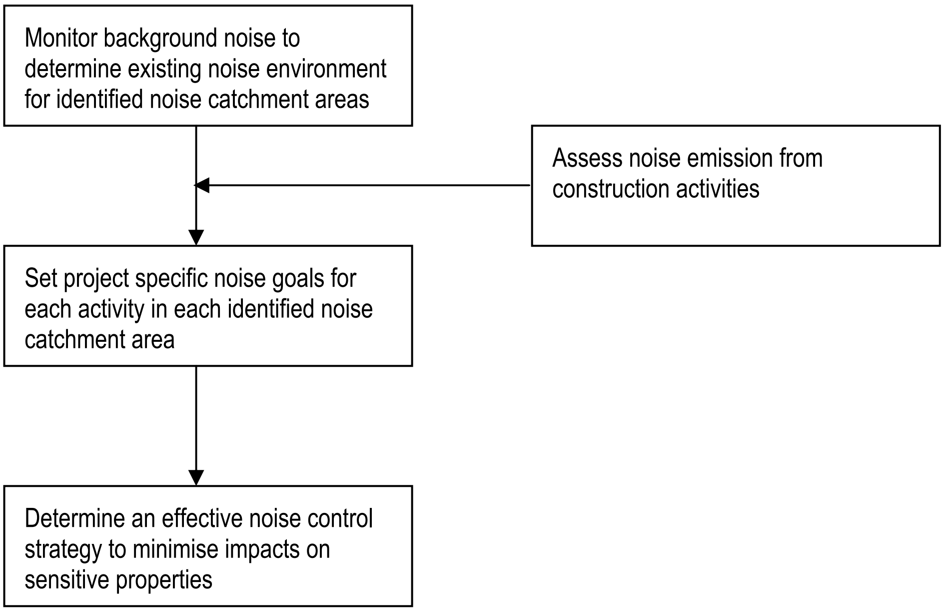
Where predicted future road traffic noise levels exceed the external target criteria, all reasonable and practicable noise mitigation measures will be considered.

A flow chart outlining the applicable criteria and the extent of reasonable and practicable noise mitigation measures is included in Attachment C.

3.2 Construction noise goals

DTEI will develop a project specific framework for managing construction noise to ensure adverse construction noise impacts are minimised where possible. The management framework will be based upon the recent work done for the Bakewell Underpass Project (2006), which is the current standard procedure for management of construction noise impacts.

The following flow chart summarises the role of a construction noise assessment in arriving at an appropriate noise control strategy for the project.



The construction time periods set down by DTEI, which are also consistent with the Environment Protection Authority guidelines, are as follows:

- day time is defined as the hours between 7 a.m. and 7 p.m.
- night is defined as the hours between 7 p.m. and 7 a.m.

In order to determine appropriate construction noise goals, sensitive properties are distributed into catchment areas of similar existing environmental noise levels. This recognises that construction noise may be more intrusive for residences living in quieter areas. For example, residents living adjacent the Northern Expressway alignment who are not currently exposed to significant traffic noise would be in one group, and those living nearby Port Wakefield Road where existing traffic noise provides some masking of construction noise would be in another group.

Table 3.2 summarises the method for determining construction noise criteria and whether mitigation must be considered for minimising the noise impact upon the local community to a reasonable level.

Table 3.3 lists the derived construction noise criteria based upon the summarised noise catchment area RBLs.

Table 3.2 Construction noise goals versus mitigation requirement

Impact	Day time[1]		Night time[1]	
	Noise criteria RBL[2] + dB(A)	Mitigation mandatory	Noise criteria RBL[2] + dB(A)	Mitigation mandatory
Low	5–20	×	< 5	×
Moderate	> 20	✓	5–10	✓ 3 nights then 4 day respite 11 p.m. curfew
High	> 20	✓	10–15	✓ 1 night then 5 day respite 11 p.m. curfew
Very high	Hearing risk at levels > 85 dB(A)L_{eq}		>15	✓ avoid night operation[3]

Notes:

1. *Day and night are the periods from 7 a.m. to 7 p.m. and 7 p.m. to 7 a.m. respectively.*
2. *RBL = rating background level for each period determined by using the tenth percentile method ('L90 of the L90s' over each period)*
3. *Avoid night operation unless absolutely necessary. Community consultation must be rigorous to minimise annoyance.*

Table 3.3 Construction noise goals derived for each noise catchment area in dB(A)[1]

Catchment area	Description	RBL[2] day + 20 dB(A)	Low RBL night + 5 dB(A)	Moderate RBL night + 10 dB(A)	High RBL night + 15 dB(A)
A	< 500 m Main North Road	66	33	38	43
B	< 500 m Two Wells Road	60	34	39	44
C	Hillier–Gawler River	58	32	37	42
D	< 500 m Angle Vale Road	63	36	41	46
E	MacDonald Park–Andrews Farm–Munno Para	55	35	40	45
F	< 500 m Heaslip Road	68	39	44	49
G	Virginia–Penfield	61	34	39	44
H	< 500 m Port Wakefield Highway	69	37	42	47

Notes:

1. *Compliance against noise goals are assessed as the worst case LAeq, 15minute during either the period from 7 a.m. to 7 p.m. (day) or 7 p.m. to 7 a.m. (night)*
2. *RBL = rating background level for each period determined by using the tenth percentile method ('L90 of the L90s' over each period).*

3.3 Vibration criteria

Vibration impacts may cause concern to some residents, primarily during the construction phase of the project. DTEI is committed to minimising the potential for vibration impacts on the community.

The effects of ground vibration on buildings resulting may be segregated into the following thee categories:

- human exposure – disturbance to building occupants: vibration which inconveniences or possibly disturbs the occupants or users of the building
- effects on building contents – vibration which may affect the building contents
- effects on building structures – vibration which may prejudice the integrity of the building or structure itself.

In general, vibration criteria for human disturbance are more stringent than vibration criteria for effects on building contents and building structural damage. Hence, compliance with the more stringent limits dictated by human exposure, would ensure compliance for the other two categories.

3.3.1 Human exposure standards

Table 3.4 gives an indication of typical human perception of vibration.

Table 3.4 Vibration and human perception of motion

Approximate vibration level (mm/s)	Degree of perception
0.10	Not felt
0.15	Threshold of perception
0.35	Barely noticeable
1.0	Noticeable
2.2	Easily noticeable
6.0	Strongly noticeable

Note: The approximate vibrations (in floors of buildings) are for vibration having frequency content n the range of 8–80 Hz.

AS 2670.2–1990, *Evaluation of human exposure to whole-body vibration*, *Part 2: Continuous and shock induced vibration in buildings* has been adopted as the relevant standard for nuisance vibration levels. The standard provides a collection of curves that specify acceptable vibration levels, at each frequency, for different circumstances.

Table 3.5 provides guidance on the magnitude of vibration at which adverse comment may begin to arise. Adjustments to the criteria are warranted in some circumstances as undue restriction on vibration levels may prolong operations and result in greater annoyance.

Prior education and warning of any resident exposed to probable vibration perception would ensure that potential annoyance is adequately controlled and managed. Regenerated noise (structure-borne noise) may also increase annoyance when construction activity is close to residential homes.

Table 3.5 indicates that residences are the most sensitive to annoyance from vibration. In most cases the vibration generated by road works activities is continuous or intermittent in character and therefore subject to the lower criteria.

Table 3.5 Building vibration combined direction (x, y, z) vibration criteria, mm/s

Type of building occupancy	Continuous or intermittent vibration	Transient vibration excitation with several occurrences per day
Residential – Night	0.14	2.0
Residential – Day	0.2	6.0
Office	0.4	12.7
Workshop	0.8	12.7

Note: Combined vibration is the vector sum of the 3 vibration axes (root mean squared).

3.3.2 Structural damage standards

Currently no Australian Standard covers assessment of building damage caused by vibrational energy. The DIN 4150 values (maximum levels measured in any direction at the foundation, or, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor) are summarised in Table 3.6.

Levels higher than these minimum figures for low frequencies may be quite safe, depending on the frequency content of the vibration. These levels are ‘safe limits’, up to which no damage due to vibration effects has been observed for the particular class of building. DIN 4150 defines ‘damage’ to include even minor non-structural effects such as superficial cracking in cement render, enlargement of cracks already present, and separation of partitions or intermediate walls from load bearing walls.

A conservative limit (NSW Road and Traffic Authority environmental procedures) is 2 mm/s at the property boundary, which is also a useful guide to annoyance along with building damage. Should such damage be observed without vibration exceeding the ‘safe limits’ then it could be attributed to other causes. DIN 4150 also states that when vibrations higher than the ‘safe limits’ are present, it does not necessarily follow that damage will occur.

Table 3.6 Structural damage 'safe limits' for building vibration

Group	Type of structure	Vibration velocity in mm/s			
		At foundation At a frequency of			Plane of floor of uppermost storey
		< 10 Hz	10–50 Hz	50–100 Hz	All frequencies
1.	Commercial, industrial or similar buildings	20	20–40	40–50	40
2.	Dwellings and buildings of similar design and/or use	5	5–15	15–20	15
3.	Structures that, because of their particular sensitivity to vibration, do not correspond to 1 or 2 and have intrinsic value (e.g. buildings under a preservation order)	3	3–8	8–10	8

Note: For frequencies above 100 Hz, the higher values in the 50–100 Hz column should be used. Where the dynamic loading caused by continuous vibration gives rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in this table may need to be reduced by up to 50%.

Source: German Standard DIN 4150: Part 3-1986.

4 Noise modelling method

4.1 Traffic noise predictions

Traffic noise predictions are carried out in accordance with United Kingdom, Department of Environment (1988), Calculation of Road *Traffic Noise* manual (CoRTN).

The noise predictions are carried out using the latest SoundPlan version 6.4 software, which implements the CoRTN model, produced by Braunstein + Berndt GmbH. SoundPlan has been accepted by DTEI as appropriate modelling software for the purpose of assessing traffic noise impacts and the design of acoustic barriers.

The CoRTN standard is implemented and tested in SoundPlan to ensure that deviations do not exceed 0.2 dB from hand calculations. SoundPlan has also been tested against physical situations using actual noise measurements and the CoRTN model.

CoRTN states that reflections can only occur from the opposite facades. It is difficult for SoundPlan to evaluate the term ‘opposite façade’; it accounts only reflected noise passing over the road where it was emitted. Reflections that did not pass over the road once are not accounted in accordance with the CoRTN model. The same applies for reflections into side roads.

A 500 m search radius has been used within the calculation module. This means that for each receiver, SoundPlan only considers the road traffic noise emission from a section of road within 500 metres of the receiver. Bridges are modelled such that noise can travel beneath the bridge.

Variations to the CoRTN procedure, as implemented in SoundPlan to improve procedures, are noted below. They are not considered to be significant:

- CoRTN requires every step to be rounded to the next 0.1 dB(A). SoundPlan does not do this but performs whole calculations with double precision numbers and only rounds for final results.
- The multiple reflection assessment included in the CoRTN emission calculation for SoundPlan was derived from the German prediction method RLS 90. It is applied as a level addition to the basic LME within the German RLS 90, and it is applied in the same way for the CoRTN emission calculation in SoundPlan.

The CoRTN methodology was verified for Australian conditions in a comprehensive study for the Australian Road Research Board (Sauders et al. 1983) which was later updated (Austroads 2002).

The validation of CoRTN suggested that the method generally over-predicted noise levels but in some cases it does under-predict noise levels.

The implementation of the CoRTN method in SoundPlan has been verified both by the authors of SoundPlan and by Bassett Acoustics.

Modelling predictions were undertaken for significant roads in the existing road network at both 2006 and the Northern Expressway road opening in 2011, at maximum traffic capacity of Port Wakefield Road in 2016 and 15 years after Northern Expressway opening in 2026. Significant roads modelled were:

- Port Wakefield Road
- Heaslip Road
- Angle Vale Road
- Gawler Bypass
- Northern Expressway.

The noise model for this project incorporated the features of:

- traffic volume and/or percentage of cars on the roadway
- traffic volume and/or percentage of heavy vehicles on the roadway
- posted vehicle speeds
- corrections for pavement surface types
- receiver coordinates
- contributed noise from all relevant traffic sources to determine the cumulative noise impact at receiver locations
- +2.5 dB correction for façade reflection factor.

4.1.1 Modelling parameters

The most recent measured traffic volumes for 2005 and 2006 were obtained from DTEI (Table 4.1).

Table 4.1 Measured traffic volumes

Road name	Measurement location	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	47,000	40,050	11.1%	6,950	12.4%
Port Wakefield	North of Summer Road	29,500	25,420	15.2%	4,080	20%
Heaslip	North of Penfield Road	12,300	10,450	12.7%	1,850	13.4%
Heaslip	North of Petherton Road	9,500	8,140	13.6%	1,360	17.5%
Angle Vale	East of Riverbank Road	6,700	5,940	16.6%	760	27.2%
Angle Vale	East of Wingate Road	5,600	4,920	18.4%	680	28.8%
Gawler Bypass	North of Two Wells Road	17,300	15,600	11.9%	1,700	18%

These values were combined with predictions provided by DTEI to produce traffic volumes and compositions along all considered roads for four situations:

- existing road network in 2006
- existing road network in 2011
- proposed road network in 2011
- proposed road network in 2026.

Additionally the following situations were considered for Port Wakefield Road only:

- existing road network in 2016

- proposed road network in 2016

The traffic volumes used in the modelling process are summarised in Attachment D.

The existing roads have been modelled with dense graded asphalt (DGA) surfaces with the Northern Expressway and on/off ramps surfaced with stone mastic asphalt (SMA). Table 4.2 presents the noise level corrections used for SMA relative to DGA, which was the surface used for the model calibration.

Table 4.2 Road surface corrections relative to DGA in dB(A)

Road surface type	Correction
SMA	-2

The correction factor for SMA represents an average of the correction factors from both the Queensland Department of Main Roads (QDMR) and the NSW Roads & Traffic Authority.

The traffic speed modelled along each road was assumed to be the posted speed limit on that road. The speeds used for modelling are summarised in Table 4.3.

Table 4.3 Modelled traffic speeds

Road name	Speed (km/h)
Port Wakefield Road (south of Waterloo Corner)	90
Port Wakefield Road (north of Waterloo Corner)	110
Northern Expressway	110
Gawler Bypass	110
All other roads	80–90

4.1.2 Model calibration

The noise model of the existing road network and the existing traffic volumes (2005, 2006) were used to predict current traffic noise levels at the 30 measurement sites. An analysis on measured day time and night time noise levels found that day time levels generally exceeded night time levels by up to 5 dB(A). At seven out of 30 properties monitored (23%), the day time level exceed the night time level by more than 5 dB(A).

Table 4.4 analyses the predicted (PNL) and measured (MNL) noise level data for receivers located along Port Wakefield Road.

Table 4.4 Comparison of measured and predicted results in dB(A) – Port Wakefield Road

Location	Reference number	Day time $L_{eq, 15h}$			Night time $L_{eq, 9h}$		
		PNL	MNL	PNL – MNL	PNL	MNL	PNL – MNL
34 General Drive, Paralowie	4	66	64	1	61	61	-1
Lot 1 Port Wakefield Road, Waterloo Corner	5	71	68	2	66	66	0
Port Wakefield Road, Globe Derby Park	21	63	62	1	58	60	-1
Lot 51 Port Wakefield Road, Waterloo Corner	25	64	60	4	59	60	-1
Median				1.8			-0.8
Standard deviation				1.3			0.7

Based on the data presented in Table 4.4, a correction factor of -1.8 dB and +0.8 dB has been applied for day time and night time respectively for Port Wakefield Road in the model.

Table 4.5 analyses the PNL and MNL data for receivers located along the Gawler Bypass.

Table 4.5 Comparison of measured and predicted results in dB(A) – Gawler Bypass

Location	Reference number	Day time $L_{eq, 15h}$			Night time $L_{eq, 9h}$		
		PNL	MNL	PNL – MNL	PNL	MNL	PNL – MNL
1 Parkers Court, Willaston	7	66	66	0	62	63	-2
Lot 100 Gawler Bypass Road, Reid	18	60	60	0	56	54	2
4 Andrews Court, Reid	23	62	60	1	58	55	3
Median				0.1			1.8
Standard deviation				0.7			2.2

Based on the data presented in Table 4.5, a correction factor of -0.1 dB and -1.8 dB has been applied for day time and night time respectively, for Main North Road and the Gawler Bypass.

The correction factors derived from the Gawler Bypass data have also been applied to Heaslip Road, Angle Vale Road and Two Wells Road due to the similarity of the type of traffic along these roads. The Port Wakefield Road traffic was considered separately as it is a road train route.

The distribution of the variation of the modelled results from the actual noise levels can be represented by a normal distribution as shown in Figure 4.1.

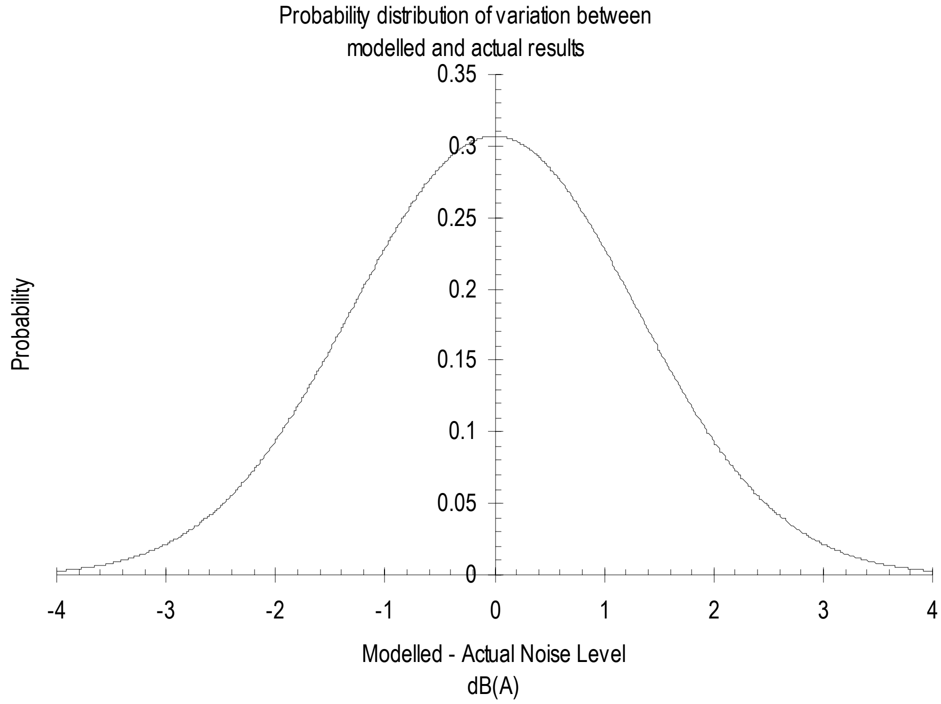


Figure 4.1 Probability distribution function indicating the probability of the difference between the model predicted level, and the actual level for Port Wakefield Road

Table 4.6 provides the expected probability for each section of the difference between the modelled data levels, and actual levels.

Table 4.6 Probability distribution of variation of actual results from modelled results

Location		Probability distribution of actual results from modelled results			
		0	±1 dB(A)	±2 dB(A)	>±3 dB(A)
Port Wakefield Road	$L_{eq,\ 15h}$	55.8%	31.8%	10.3%	2.1%
	$L_{eq,\ 9h}$	84.7%	14.9%	0.4%	<0.1%
Gawler Bypass	$L_{eq,\ 15h}$	84.7%	14.9%	0.4%	<0.1%
	$L_{eq,\ 9h}$	35.1%	28.6%	19.1%	17.3%

There is a larger degree of uncertainty in the results from areas near the Gawler Bypass (Table 4.6) due to the uncertainty of terrain in this area.

4.2 Predicted 2011 traffic noise levels and noise criteria

The model of the existing road network and the predicted 2011 existing road traffic volumes were used to predict the road traffic noise environment at noise sensitive locations without the project. Receivers were only considered if they were within 500 metres of the proposed Northern Expressway, Port Wakefield Road or the Gawler Bypass. In order to summarise the results of a large number of receivers, eight catchment areas were established (Figure 2.1):

- catchment area A: within 500 m of Gawler Bypass.
- catchment area B: within 500 m of Two Wells Road
- catchment area C: Hillier–Gawler River
- catchment area D: within 500 m of Angle Vale Road
- catchment area E: MacDonald Park–Andrews Farm–Munno Para
- catchment area F: within 500 m of Heaslip Road
- catchment area G: Virginia–Penfield
- catchment area H: within 500 m of Port Wakefield Road.

5 Effects of the project on existing environment

5.1 Road traffic noise

5.1.1 Northern Expressway

All identified sensitive receptors at distances of less than 500 metres from the proposed Northern Expressway, Port Wakefield Road or the Gawler Bypass were included in the noise model. The following tables provide an overview of the noise impact by indicating the number (and percentage) of sensitive receptors, for each noise catchment area, which fall within a specific noise level range. Predicted noise impacts are worst case and do not incorporate noise mitigation measures.

Sensitive receptors greater than 500 metres from the road alignment are at a sufficient distance away from road traffic noise to not be adversely affected.

Tables 5.1 and 5.2 summarise existing traffic noise impacts, as well as the 2011 (road opening) and 2026 (15 years after road opening) traffic noise impacts for day and night respectively.

Table 5.3 and 5.4 summarise the differences between the predicted 2026 day time and night time noise levels and the noise criteria in each catchment area. Receivers have been grouped into five classes based on the amount by which the predicted noise levels exceed the noise criteria:

- greater than 8 dB(A) above criteria
- 5–8 dB(A) above criteria
- 3–5 dB(A) above criteria
- 1–2 dB(A) above criteria
- below criteria.

Attachment E provides details of all receivers predicted to be in excess of 2026 noise criteria.

Noise contours in 2026 without mitigation measures

Figures 5.1 to 5.4 indicate the predicted 2026 noise contours in 5 dB(A) intervals for both day time and night time respectively.

Noise level contours provide a visual noise ‘footprint’ indicating the extent of noise impact upon the environment.

The predicted noise level contours do not include specific mitigation measures such as noise walls or additional local shielding for residents, nor the use of SMA as a low noise road surface, and therefore present a base case effect.

Table 5.1 Predicted network day time ($L_{eq,15h}$) noise impact

Catchment area (receptor no.)	Model scenario	> 70 dB(A)	65–70 dB(A)	60–65 dB(A)	55–60 dB(A)	< 55 dB(A)
A (139)	Existing 2011	0%	12%	39%	22%	27%
	NExy 2011	0%	4%	32%	34%	29%
	NExy 2026	0%	23%	24%	37%	15%
B (41)	Existing 2011	0%	0%	0%	7%	93%
	NExy 2011	0%	0%	5%	10%	85%
	NExy 2026	0%	0%	5%	20%	76%
C (16)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	6%	0%	19%	75%
	NExy 2026	0%	6%	6%	38%	50%
D (12)	Existing 2011	0%	0%	33%	25%	42%
	NExy 2011	17%	0%	25%	42%	17%
	NExy 2026	17%	0%	33%	33%	17%
E (56)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	2%	0%	2%	9%	88%
	NExy 2026	2%	0%	7%	13%	79%
F (11)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	0%	0%	9%	91%
	NExy 2026	0%	0%	9%	45%	45%
G (31)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	0%	10%	10%	81%
	NExy 2026	0%	3%	10%	23%	65%
All (306)	Existing 2011	0%	6%	19%	12%	64%
	NExy 2011	1%	2%	18%	22%	57%
	NExy 2026	1%	11%	16%	29%	43%

Notes

1. *Existing 2011 represents the predicted 2011 traffic noise impact with the existing road network i.e. Northern Expressway alignment not present*
2. *NExy 2011 represent the predicted traffic noise impact of the Northern Expressway alignment at road opening in 2011*
3. *NExy 2026 represents predicted traffic noise impact of the Northern Expressway alignment 15 years after opening (2026).*

Table 5.2 Predicted network night time ($L_{eq,9h}$) noise impact

Catchment area (receptor no.)	Model scenario	> 65 dB(A)	60–65 dB(A)	55–60 dB(A)	50–55 dB(A)	< 50 dB(A)
A (139)	Existing 2011	0%	0%	0%	41%	59%
	NExy 2011	0%	0%	1%	37%	63%
	NExy 2026	0%	4%	36%	32%	29%
B (41)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	0%	0%	0%	100%
	NExy 2026	0%	0%	5%	15%	80%
C (16)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	0%	6%	0%	94%
	NExy 2026	0%	6%	0%	25%	69%
D (12)	Existing 2011	0%	0%	0%	33%	67%
	NExy 2011	17%	0%	0%	25%	58%
	NExy 2026	17%	0%	33%	33%	17%
E (56)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	2%	0%	2%	98%
	NExy 2026	2%	0%	2%	13%	84%
F (11)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	0%	0%	0%	100%
	NExy 2026	0%	0%	9%	36%	55%
G (31)	Existing 2011	0%	0%	0%	0%	100%
	NExy 2011	0%	0%	0%	6%	94%
	NExy 2026	0%	3%	10%	16%	71%
All (306)	Existing 2011	0%	0%	0%	20%	80%
	NExy 2011	1%	0%	1%	18%	80%
	NExy 2026	1%	2%	20%	24%	53%

Notes

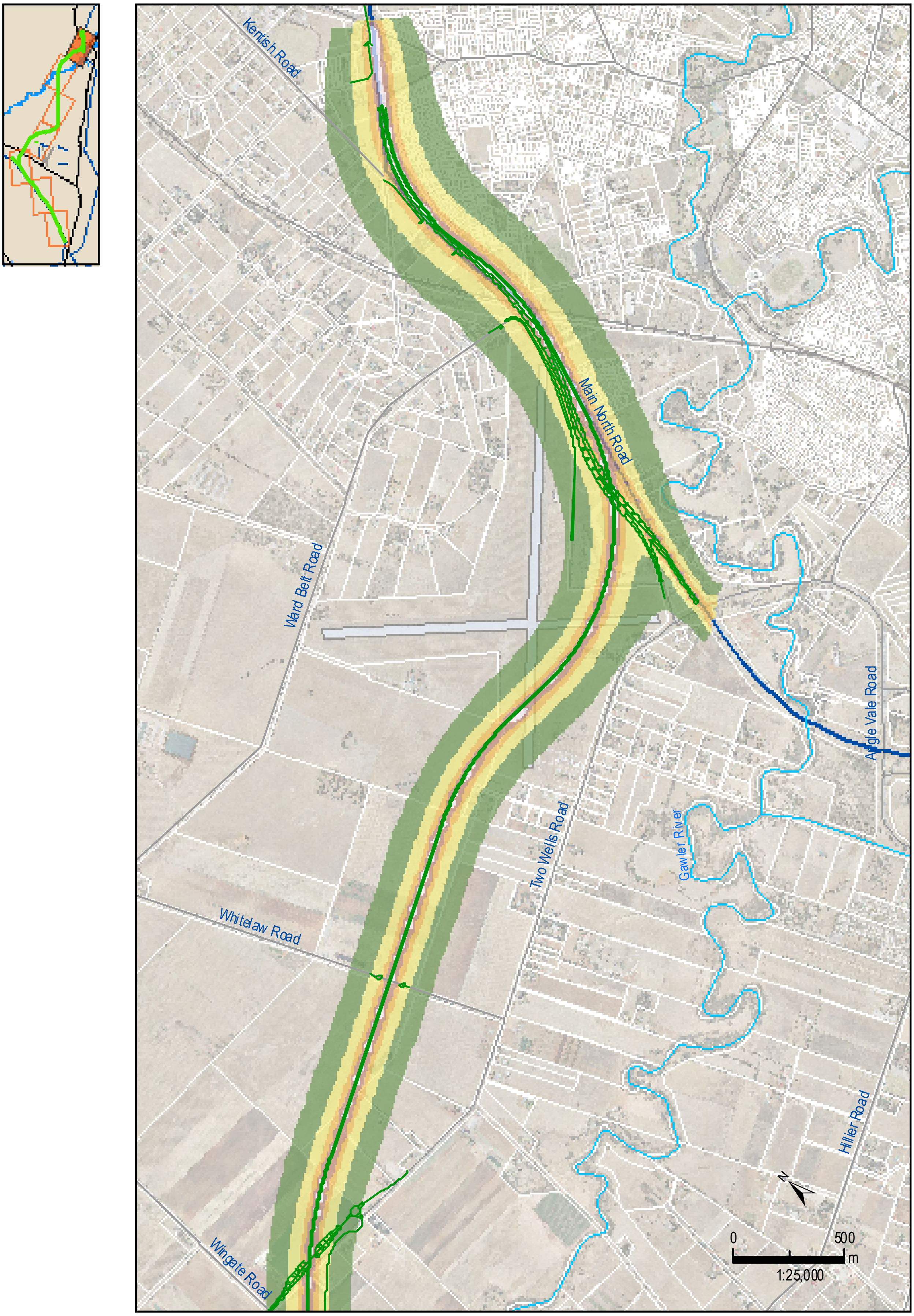
1. *Existing 2011 represents the predicted 2011 traffic noise impact with existing road network i.e. Northern Expressway alignment not present*
2. *NExy 2011 represent the predicted traffic noise impact of the Northern Expressway alignment at road opening in 2011*
3. *NExy 2026 represents predicted traffic noise impact of the Northern Expressway alignment 15 years after opening (2026).*

Table 5.3 Summary of predicted 2026 future day time road traffic noise levels

Catchment area (receptor no.)	> 8 dB(A) above	5–8 dB(A) above	3–5 dB(A) above	1–2 dB(A) above	Below criteria
A (139)	0%	0%	4%	37%	60%
B (41)	0%	5%	5%	10%	80%
C (16)	6%	0%	13%	19%	63%
D (12)	17%	0%	8%	17%	58%
E (56)	2%	5%	5%	5%	82%
F (11)	0%	0%	18%	27%	55%
G (31)	6%	6%	6%	10%	71%
All (306)	2%	2%	6%	23%	68%

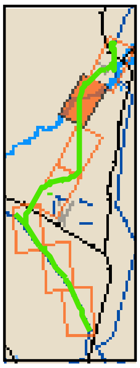
Table 5.4 Summary of predicted 2026 future night time road traffic noise levels

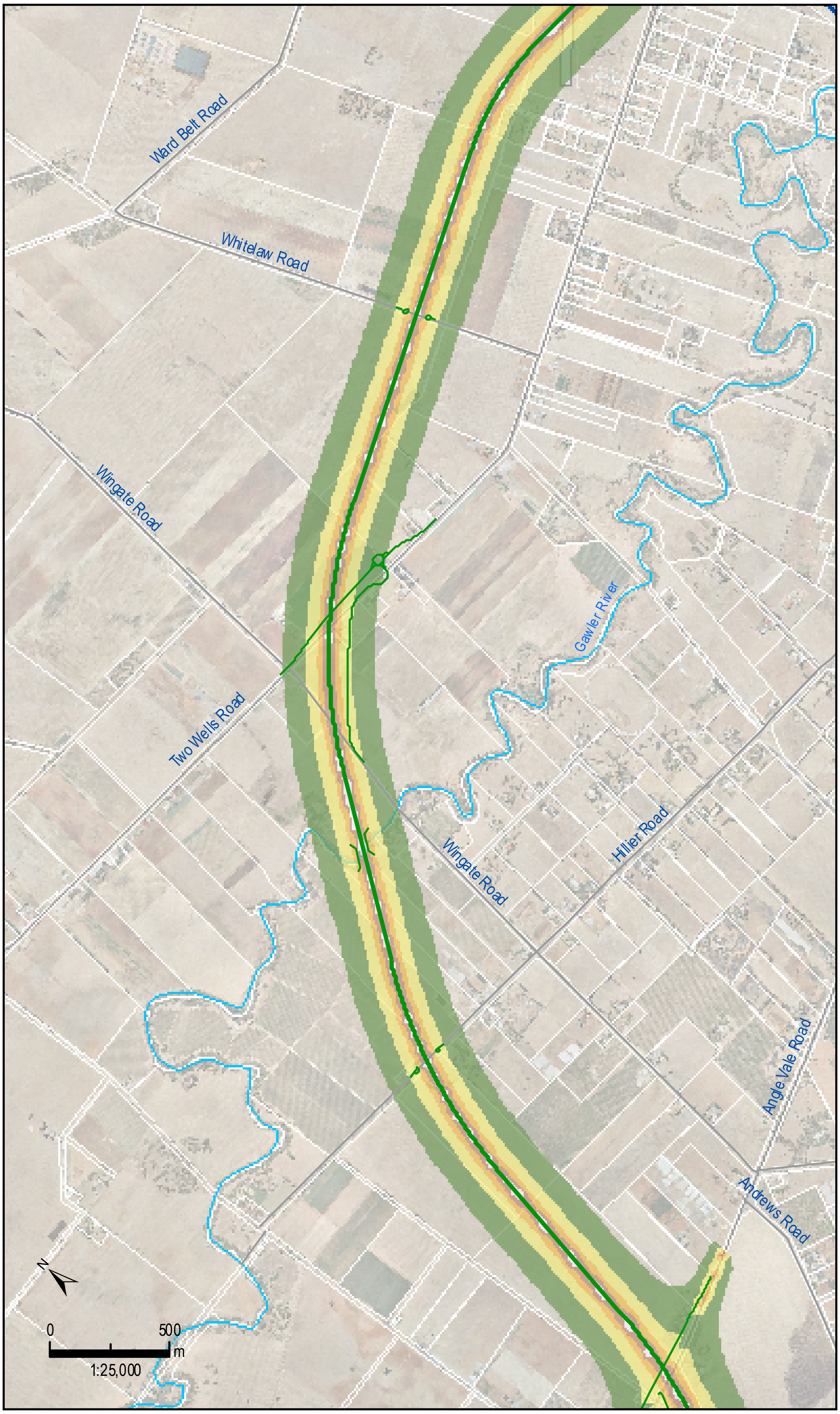
Catchment area (receptor no.)	> 8 dB(A) above	5–8 dB(A) above	3–5 dB(A) above	1–2 dB(A) above	Below criteria
A (139)	0%	0%	0%	4%	96%
B (41)	0%	2%	2%	5%	90%
C (16)	6%	0%	6%	6%	81%
D (12)	17%	0%	8%	0%	75%
E (56)	2%	0%	9%	2%	88%
F (11)	0%	0%	9%	9%	82%
G (31)	3%	10%	3%	3%	81%
All (306)	2%	1%	3%	4%	90%



55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

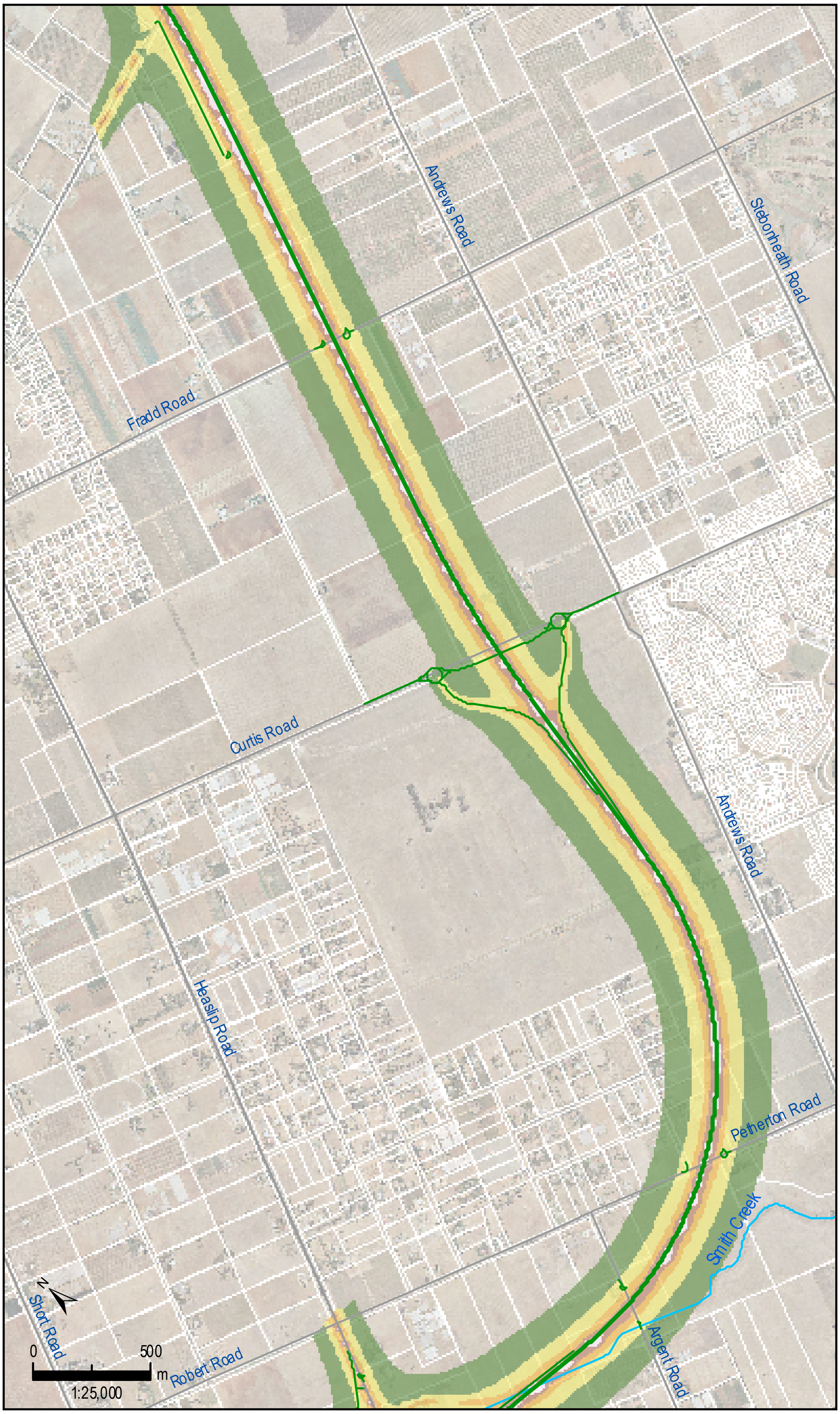
Figure 5.1 **2026 daytime noise projections sheet 1 of 4**

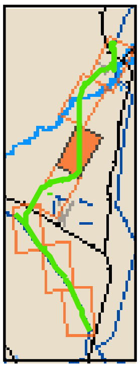




55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

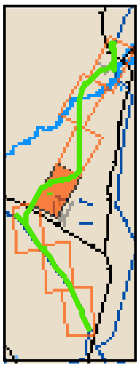
Figure 5.2 **2026 daytime noise projections sheet 2 of 4**





55 - 60 dB(A) band
60 - 65 dB(A) band
65 - 70 dB(A) band
70 - 75 dB(A) band
> 75 dB(A)

Figure 5.3 **2026 daytime noise projections sheet 3 of 4**



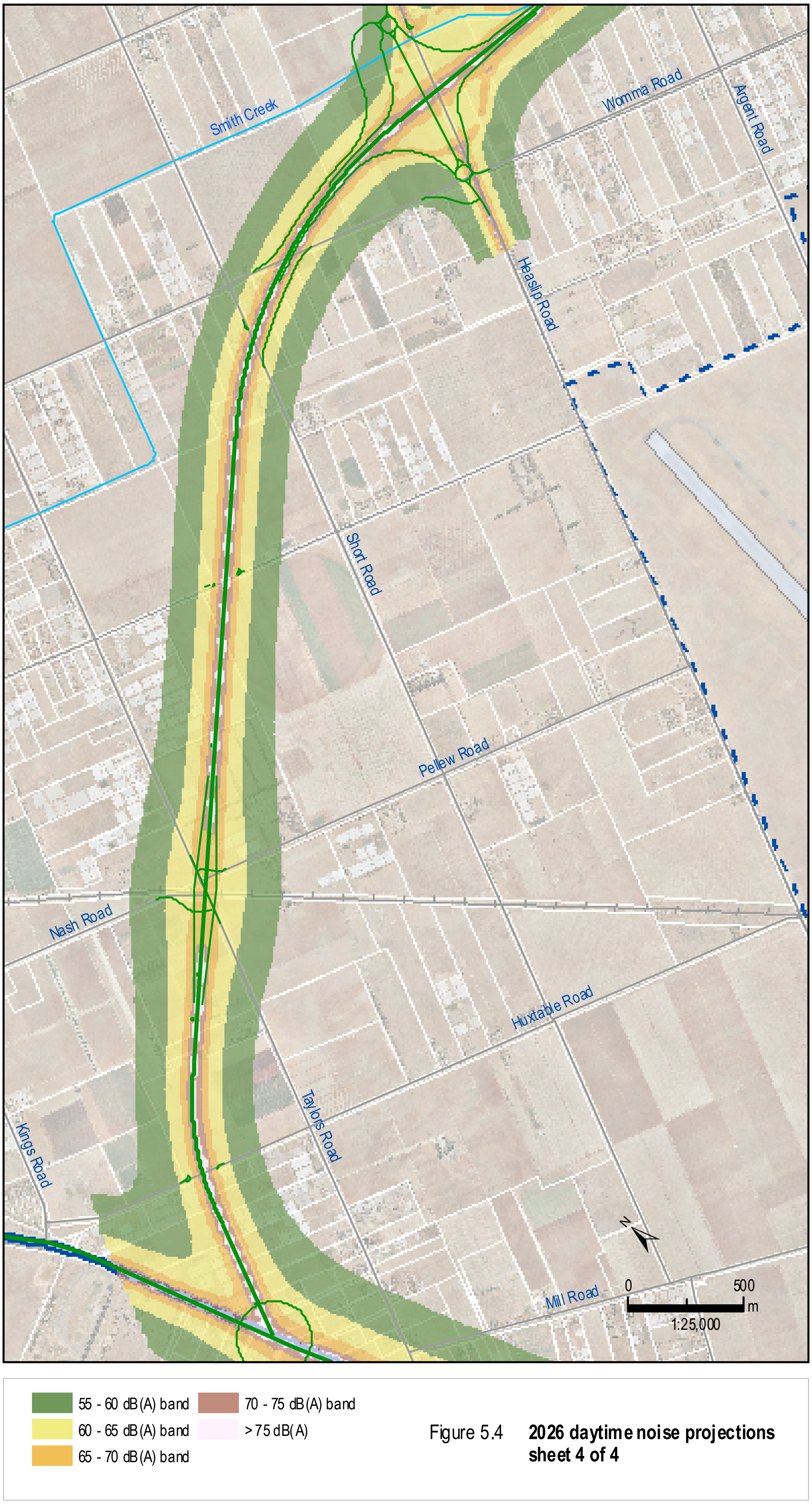


Figure 5.4 **2026 daytime noise projections sheet 4 of 4**

5.1.2 Port Wakefield Road

Port Wakefield Road has been recognised to be operating above capacity for 2026 predicted traffic levels. As such, an additional assessment of noise levels in catchment H five years after opening (2016) has been conducted.

Tables 5.5 and 5.6 summarise the predicted levels with and without the Northern Expressway for noise sensitive receptors located in catchment H (within 500 metres of Port Wakefield Road). The assessment was conducted assuming an SMA surface for the Northern Expressway alignment.

Table 5.5 Predicted day time network noise impact adjacent Port Wakefield Road

Catchment area (receptor no.)	Model scenario	> 70 dB(A)	65–70 dB(A)	60–65 dB(A)	55–60 dB(A)	< 55 dB(A)
H (185)	Without NExy 2011	0	33 (18%)	108 (58%)	11 (6%)	33 (18%)
	With NExy 2011	3 (2%)	109 (59%)	30 (16%)	23 (12%)	20 (11%)
	Without Nexy 2016	2 (1%)	83 (45%)	57 (31%)	11 (6%)	32 (17%)
	With NExy 2016	4 (2%)	115 (62%)	25 (14%)	22 (12%)	19 (10%)

Notes

1. *Existing 2011 represents the predicted 2011 traffic noise impact with the existing road network i.e. Northern Expressway alignment not present*
2. *NExy 2011 represent the predicted traffic noise impact of the Northern Expressway alignment at road opening in 2011*
3. *NExy 2016 represents predicted traffic noise impact of the Northern Expressway alignment 5 years after opening (2016).*

Table 5.6 Predicted night time network noise impact adjacent Port Wakefield Road

Catchment area (receptor no.)	Model scenario	> 65 dB(A)	65–70 dB(A)	60–65 dB(A)	55–60 dB(A)	< 50 dB(A)
H (185)	Without NExy 2011	4 (2%)	110 (59%)	29 (16%)	18 (10%)	24 (13%)
	With NExy 2011	7 (4%)	123 (66%)	19 (10%)	20 (11%)	16 (9%)
	Without Nexy 2016	2 (1%)	123 (66%)	17 (9%)	14 (8%)	28 (15%)
	With NExy 2016	9 (5%)	122 (66%)	21 (11%)	18 (10%)	15 (8%)

Notes

1. *Existing 2011 represents the predicted 2011 traffic noise impact with the existing road network i.e. Northern Expressway alignment not present*
2. *NExy 2011 represent the predicted traffic noise impact of the Northern Expressway alignment at road opening in 2011*
3. *NExy 2016 represents predicted traffic noise impact of the Northern Expressway alignment 5 years after opening (2016).*

Table 5.7 summarises the difference between the predicted 2016 day time and night time noise levels versus the noise criteria adopted for individual sensitive receptors in the Port Wakefield Road catchment area (noise impacts are worst case and do not include mitigation measures).

Receptors have been grouped into five classes based on the amount by which the predicted noise levels exceed the noise criteria:

- greater than 8 dB(A) above criteria

- 5–8 dB(A) above criteria
- 3–5 dB(A) above criteria
- 1–2 dB(A) above criteria
- below criteria.

Table 5.7 Predicted 2016 future noise impact versus noise criteria

Noise descriptor	> 8 dB(A) above	5–8 dB(A) above	3–5 dB(A) above	1–2 dB(A) above	Below criteria
day time ($L_{eq,15h}$)	0	3 (2%)	27 (15%)	101 (65%)	34 (18%)
night time ($L_{eq,9h}$)	0	6 (3%)	71 (33%)	51 (28%)	56 (30%)

Table 5.7 shows that the majority of noise sensitive receptors are predicted to be marginally above day time noise criteria with 65% 1–2 dB(A) above day time L_{eq} criteria. Additionally, the majority of receivers are predicted to be over the night time criteria with 33% exceeding by 3–5 dB(A).

Attachment E provides details of all receivers in catchment H which exceed either day time or night time noise criteria for 2016 predictions.

Figure 5.5 to 5.7 provide the 2016 difference noise level contours with/without the project.

5.1.3 Sleep disturbance

It is difficult to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance.

At locations where road traffic is continuous rather than intermittent, the $L_{eq,9h}$ (night) criteria may sufficiently account for sleep disturbance impacts. However, where the emergence of L_{max} over the ambient $L_{eq,1h}$ is equal to or greater than 15 dB, the $L_{eq,9h}$ criteria may not sufficiently account for sleep disturbance impacts. Practice note (iii) of the NSW Road and Traffic Authority's *Environmental Noise Management Manual* (2001) defines a maximum noise event as any pass-by where L_{max} is greater than 65 dB(A) and for which $L_{max} – L_{eq,1h}$ is greater than or equal to 15 dB.

In this case the majority of affected receptors located adjacent the new alignment will experience $L_{eq,1h}$ noise levels greater than 50 dB(A). In the absence of reliable hourly traffic count predictions the $L_{eq,1h}$ cannot be predicted; however, it would typically increase by 1–2 dB above the $L_{eq,9h}$.

For those receptors located adjacent to existing commercial vehicle routes, the change in maximum noise levels received from commercial vehicles passing during the night would be minimal. However, the frequency of maximum emergence events will vary depending upon the volume of commercial vehicles using the roads. In cases where commercial vehicles choose to use the Northern Expressway instead of local roads, existing sleep disturbance events would reduce for these residents.

Table 5.8 indicates the existing commercial vehicle volumes, corresponding noise levels and calculated sound power levels (Lw) for those worst case residents closest to existing roads. The results show that the calculated L_w is consistent with the exception of Two Wells Road, where the road has a lower speed limit, and Heaslip Road, where the logger was located very close to the road.

Table 5.8 2006 existing commercial vehicle volumes and measured noise levels

Road	Catchment area	Night time CVs	Average CVs per hour	Median L_{max} dB(A)	$L_{eq,9h}$ dB(A)	Average L_w dB (A)
Port Wakefield Road (Site #5)	H	550	61	79	57	112
Gawler Bypass (Site #7)	A	306	34	84	63	112
Angle Vale Road (Site #26)	D	150	17	79	61	112
Two Wells Road (Site #14)	B	150	17	76	59	107
Heaslip Road (Site #27)	F	236	26	90	71	116

Based upon the above analysis, the likelihood for sleep disturbance events were modelled for all residents within 500 metres of the Northern Expressway, under the assumption of a commercial vehicle sound power level of 112 dB(A). The predicted results indicate that none of the residents will experience maximum emergence events above 65 dB(A) from Northern Expressway road traffic, under the assumption of typical commercial vehicle noise emissions. However, those residents not currently exposed to traffic noise will experience sleep disturbance for a period of time until they become acclimatised to the general traffic noise 'hum' of the new road.

5.1.4 Traffic noise impacts on horses

Research information and analysis relative to impacts on horses is not readily available. However, studies of animal behavior patterns demonstrate the ability of horses to become acclimatised to sights and sounds in their environment. As history demonstrates, horses have been used by law enforcement, at parades, in the military, at sporting events, for hunting and public assembles. Numerous horse breeding and riding facilities would be located along major arterial roads around the world and would coexist with traffic without issue.

The Northern Expressway alignment is mostly without road gradient and is designed to ensure a high speed free flowing traffic without significant disruption such as stop/start traffic flow.

Characteristically the Northern Expressway would emit a relatively constant traffic noise 'hum' without a large number of extraneous noise events to startle horses, such as truck exhaust brakes and stop/start traffic which can invoke excessive noise events during acceleration or braking.

Therefore it is expected that there would be no significant adverse impacts over existing conditions after a short term period of initial acclimatisation for some horses.

5.2 Construction noise

Noise generated by construction activities and equipment will generally rise and fall as construction progresses along the route.

Noise levels have been predicted for typical major noise generating construction activities likely to occur at various receptor distances from the activity. The predicted levels assume sound pressure losses from geometric spreading only (i.e. distance attenuation) and do not include topographic shielding, ground or meteorological effects and are therefore conservative.

Typical operating scenarios are identified in Table 5.9.

Table 5.9 Construction noise activities

Construction activity	Description
Corridor clearing	Typical operations may be either one plant operating on its own or a bulldozer, chainsaw and tub grinder/ mulcher operating simultaneously
Bridgeworks	Typical operations at interchange bridges may be either one plant operating on its own or a piling rig, power generator, pneumatic jackhammer and crane operating simultaneously
Earthworks & drainage	The earthworks and drainage phase of the project is likely to last the longest and generate the highest levels of construction noise, especially from the operation of heavy plant and equipment including bulldozers, excavators and graders, excavation involving loading, haulage and ground compaction Typical operations may be either one plant operating or a simultaneous combination of bulldozer, scraper and excavator or scrapers, compactors and graders on road embankments
Pavement	Typically a paver, roller, generator and backhoe are all used simultaneously Concrete cutting may also occur
Retaining walls	Typical operations may be either one plant operating on its own or a crane, welding equipment and tracked excavator operating simultaneously
Construction compound	Typical operations during site establishment may be either one plant operating or a backhoe, excavator and delivery truck operating simultaneously; also cranes, semi-trailer deliveries of offices, some minor concrete works, some minor earthworks in establishing hard stands for parking areas, includes use of graders and body trucks, backhoe for general drainage works

5.2.1 Predicted construction noise

A noise management strategy can mitigate noise intensity, frequency and/or duration to affected residential locations. Such a strategy considers the methodology proposed by a construction contractor and the relative phasing of different construction activities in different areas to minimise noise.

The impact depends on the type of construction, the distance to affected residences or other noise sensitive uses, any natural or introduced shielding and the duration of the construction.

A basic construction noise mitigation strategy for sensitive residential locations aims to:

- minimise construction duration
- maximise opportunities for simultaneous activities (minimising total duration)
- minimise equipment noise generation – quietest (or quietening) equipment
- minimise the use of certain ‘noisy’ equipment in sensitive locations and/or time of day.

Table 5.10 lists predicted noise levels for a range of receptor distances from identified construction activities, based on the typical expected plant to be used for each activity. Calculations assume sound pressure loss from geometrical spreading only, hence the predictions are conservative.

Table 5.10 Predicted construction noise levels without mitigation

Noise generating activity	Plant type	Predicted dB(A)L_{eq} at various distances				
		7 m	25 m	50 m	100 m	200 m
Corridor clearing	Small bulldozer	90	79	73	67	61
	45 t tracked excavator	83	72	66	60	54
	4–5 hp chainsaw	89	78	72	66	60
	40–50 hp tub grinder and mulcher	91	80	74	68	62
	Front end loader	88	77	71	65	59
	50 t dump truck – loaded	76	65	59	53	47
	50 t dump truck – unloaded	83	72	66	60	54
Earthworks and drainage	Small bulldozer	90	79	73	67	61
	Large bulldozer	92	81	75	69	63
	Scraper	85	74	68	62	56
	45 t tracked excavator	83	72	66	60	54
	Line driller	89	78	72	66	60
	Grader	85	74	68	62	56
	Vibratory roller	84	73	67	61	55
	Spreader	70	59	53	47	41
	Vibratory rammer	83	72	66	60	54
	Vibroplates	76	65	59	53	47
	Dump truck	83	72	66	60	54
	Road truck	83	72	66	60	54
	Compactor	88	77	71	65	59
	Water cart	82	71	65	59	53
Bridges (piling)	Piling rig	91	80	74	68	62
	Power pack	78	67	61	55	49
	Crane	88	77	71	65	59
	Concrete pump	80	69	63	57	51
	Concrete vibrator	78	67	61	55	49
	Welding equipment	80	69	63	57	51
	45 t tracked excavator	83	72	66	60	54
	Pneumatic jackhammer	88	77	71	65	59
	Delivery truck	83	72	66	60	54
	Concrete truck	84	73	67	61	55

Noise generating activity	Plant type	Predicted dB(A)L_{eq} at various distances				
		7 m	25 m	50 m	100 m	200 m
Retaining walls	Bored piling rig	89	78	72	66	60
	Power pack	78	67	61	55	49
	Mobile crane	88	77	71	65	59
	Concrete vibrator	88	77	71	65	59
	Concrete pump	80	69	63	57	51
	Welding equipment	80	69	63	57	51
	45 t tracked excavator	83	72	66	60	54
	Air track drill	99	88	82	76	70
Pavement	Concrete batch plant	91	80	74	68	62
	Paver	89	78	72	66	60
	Road truck	83	72	66	60	54
	Concrete vibrator	78	67	61	55	49
	Asphalt truck/ sprayer	81	70	64	58	52
	Roller	82	71	65	59	53
	Concrete saw	93	82	76	70	64
	Generator	78	67	61	55	49
	Backhoe	79	68	62	56	50
	Pneumatic tyred roller	86	75	69	63	57

5.2.2 Predicted noise versus construction noise goals

Table 5.11 provides an assessment of construction noise levels at typical worst case receptor locations within each noise catchment area, and comparisons to the construction noise goal.

It shows that construction noise is predicted to exceed the high impact night time noise criteria in all catchments by 10–35 dB(A). Night time construction work should be avoided in all catchment areas without good reason.

Table 5.11 Predicted construction noise levels without mitigation

Catchment area	Description	12 h day noise goal	12 h night high impact noise goal	Expected noise level range	Exceed day criteria	Exceed night high impact criteria
A	< 500 m Main North Road	66	43	60-75	0-10	20-30
B	< 500 m Two Wells Road	60	44	60-75	0-15	15-30
C	Hillier–Gawler River	58	42	70-55	0-15	15-30
D	<500 m Angle Vale Road	63	46	60-75	0-15	15-30
E	MacDonald Park–Andrews Farm–Munno Para	55	45	60-75	0-20	10-30
F	<500 m Heaslip Road	68	49	60-75	0-10	10-25
G	Virginia–Penfield	61	44	70-55	0-10	10-25
H	<500 m Port Wakefield Highway	69	47	65-80	0-10	20-35

5.3 Vibration

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist (and vary in e.g. dimensions, materials, type and quality of construction and footing conditions). The intensity, duration, frequency and number of occurrences of a vibration, all play an important role in both the annoyances caused and the strains induced in structures.

The pattern of vibration radiation is very different from the pattern of airborne noise radiation, but the potential for vibration to cause disturbance to residents, or structural damage to buildings, is still largely dependent on the distance between the vibration generator and the receiver.

Major sources of ground vibration include pile drivers, bulldozers (ripping), hydraulic rock breakers and vibratory rollers during road construction and bridge work. In general the bridgeworks would most likely use driven piles rather than bored piles. Vibration generated by bored piling would be less than that generated by pile driving.

Vibrations generated from construction activities are characteristically greater in magnitude than those generated from operation roads after construction. This is particularly the case with a road surface in good condition without pot holes or significant irregularities in the road surface.

In summary, ground vibration impacts at specific levels of magnitude may either:

- disturb occupants of buildings
- disturb contents of buildings by rattling, shaking or movements
- affect structural integrity of the building.

Table 5.12 indicates the approximate vibration levels that may be expected for various vibration sources (based on previous measurement experience on other projects).

Table 5.12 Approximate generated vibration levels (mm/s) for various sources

Activity	Typical levels of ground vibration
Vibratory rollers	Up to 1.5 mm/s at distances of 25 m Higher levels could occur at closer distances but no damage would be expected for any building at distances greater than approximately 12 m (for a medium to heavy roller)
Hydraulic rock breakers (levels typical of a large rock-breaker operating in hard sandstone)	4.50 mm/s at 5 m 1.30 mm/s at 10 m 0.4 mm/s at 20 m 0.10 mm/s at 50 m
Compactor	20 mm/s at distances of approximately 5 m; 2 mm/s at distances of 15 m; usually below 0.3 mm/s at distances greater than 30 m
Pile driving/removal	1–3 mm/s at distances of 25–50 m depending on soil conditions and the energy of the pile driving hammer These levels are well below the threshold of any possibility of damage to structures in the vicinity of these works. At closer distances to the piling operations, some loose fill would compact due to vibratory effects.
Bulldozers	1–2 mm/s at distances of approximately 5 m; usually below 0.2 mm/s at distances greater than 20 m
Air Track Drill	4–5 mm/s at a distance of approximately 5 m; 1.5 mm/s at 10 m; usually below 0.6 mm/s at distances greater than 25 m; usually below 0.1 mm/s at 50 m or more
Truck traffic (over normal (smooth) road surfaces)	0.01–0.2 mm/s at the footings of buildings located 10–20 m from a roadway
Truck traffic (over irregular surfaces)	0.1–2.0 mm/s at the footings of buildings located 10–20 m from a roadway

Perceived vibration from heavy vehicles (such as trucks and buses) is often air-borne related – when the low frequency sound emission from the heavy vehicle has enough energy to excite, either in a forced or resonant response, lightly damped building elements, such as window panes and light fittings. It is often associated with ground-borne vibration but this may not be the case.

5.3.1 Vibration measurements

Vibration measurements along Port Wakefield Road on Friday 12 January 2007, in the Globe Derby Park area were undertaken adjacent to smooth and rough sections of the asphalt surface, at distances of 10 metres and 20 metres from the edge of the carriageway.

Smooth road surface measurements of ground vibration propagation from south bound traffic were taken on a smooth section of Port Wakefield Road immediately south of the Martins Road intersection.

Rough road surface measurements of ground vibration propagation from north bound traffic were taken at a rough section of Port Wakefield Road at the Daniel Avenue intersection. The rough road surface was located only in the left hand north bound lane of Port Wakefield Highway. The condition of the rough road surface is best described as a severely cracked and pitted asphalt surface.

Vibration measurements were taken in the vertical axis only. The vibration measurements, expressed in velocity (mm/s peak), are presented in Table 5.13 below.

Table 5.13 Measured vibration levels (mm/s) for various sources

Measure -ment	Peak vibration (mm/s) 10–87 Hz	Distance (m)	Road surface	Vehicle/s	Comments
1	0.037	10	Smooth	Cars	Vehicles in left-hand right-hand lanes
2	0.026	10	Smooth	Cars	Vehicles in left-hand right-hand lanes
3	0.040	10	Smooth	Cars	Vehicles in left-hand right-hand lanes
4	0.140	10	Smooth	Truck	Vehicle in left-hand lane
5	0.169	10	Smooth	Truck	Vehicle in left-hand lane
6	0.065	10	Smooth	Truck	Vehicle in right-hand lane
7	0.046	20	Smooth	Truck	Vehicle in right-hand lane
8	0.071	20	Smooth	4 trucks	Vehicles in left-hand right-hand lanes
9	0.025	20	Smooth	Mid-size truck	Vehicle in left-hand lane
10	0.125	10	Rough	Mid-size truck	Vehicle in left-hand lane
11	0.091	10	Rough	Cars	Vehicles in left-hand right-hand lanes
12	0.252	10	Rough	2 trucks	Vehicle in left-hand lane
13	0.228	10	Rough	Truck	Vehicle in left-hand lane
14	0.159	20	Rough	B-double	Vehicle in left-hand lane
15	0.167	20	Rough	B-double	Vehicle in left-hand lane
16	0.148	20	Rough	Truck	Vehicle in left-hand lane
17	0.124	20	Rough	Truck	Vehicle in left-hand lane
18	0.135	20	Rough	Truck	Vehicle in left-hand lane

The vibration measurements range in magnitude from 0.02 to 0.3 mm/s. The presented vibration levels are indicative only, as the transfer of vibration from the ground to the building foundation and other building elements is variable but not expected to vary significantly. Ground-borne vibration is seldom a problem for residents living adjacent to main roads and is commonly confused with high levels of low frequency air-borne noise.

5.3.2 Vibration and human disturbance

Residents nearest (i.e. < 75 m) to road works, particularly during vibratory compaction of earthworks, may perceive vibrations, albeit for a relative short period because the earthworks plant moves often. Typically resident perception of vibration is accompanied by concerns of structural damage, thus increasing annoyance levels.

Residents would be informed and consulted to reduce concerns as to potential building damage. The community consultation program will address vibration annoyance or structural concerns.

5.3.3 Vibration effects on building contents

Typical ground vibration from road and bridge construction activities is approximately 8–100 Hz. Within this frequency range building contents such as blinds and pictures would begin visible movement at 0.5 mm/s. At vibration levels higher than 0.9 mm/s, windows, crockery and loose objects would rattle and be audible and annoying.

Given the distance of residential buildings from the Northern Expressway alignment, this vibration symptom is not likely to affect most residents.

5.3.4 Structural damage to buildings

The highest levels of vibration are typically generated by compactors, vibratory rollers and pile driving (Table 5.12). In most cases the generated vibration levels are too low in magnitude to cause structural damage to buildings greater than 25 m from the construction activity.

Since residential buildings are outside this 25-m zone from the Northern Expressway alignment, structural damage is not probable.

6 Environmental management

6.1 Principles adopted to minimise effects of road traffic

DTEI is committed to investigating all ‘reasonable and practicable’ mitigation measures to meet appropriate target noise levels. Mitigation measures will only be considered adjacent to major roadworks.

6.1.1 Controlling vehicle noise at the source

Ideally the most effective way of minimising noise from vehicles and traffic is to control vehicle noise at the source, by :

- making vehicles quieter
- installing ‘low noise’ road surfaces
- modifying the road gradient
- reducing the design speed
- introducing traffic management schemes and traffic calming devices.

Quieter vehicles

The reduction of noise from vehicles is a major factor in reducing traffic noise. For maximum effectiveness vehicle noise management needs to include design, education and enforcement components.

DTEI actively supports and/or is involved in the following programs to achieve quieter vehicles:

- national processes for developing transport, vehicle or infrastructure noise standards or guidelines, particularly motor vehicle noise standards
- national processes for developing in-service transport vehicle noise standards, particularly those for motor vehicles (and champions the need to reflect improvements achieved in new vehicle noise standards)
- monitoring and enforcement of in-service vehicle noise standards
- enforcement of relevant legislation and regulations relating to transport noise and of compliance with vehicle noise standard.

‘Low noise’ road surfaces

For individual vehicles, road tyre noise begins to dominate powertrain noise (i.e. noise from drive train/drive system of a vehicle) at vehicle speeds of 30–50 km/h for cars and 40–80 km/h for trucks. For traffic as a whole, road tyre noise appears to dominate at around 70 km/h. This means that in areas with posted speeds of 70 km/h or more, the reduction of road tyre noise can be a useful noise reduction treatment.

The type of road surface can have a significant impact on traffic noise generated by pavement surface/tyre interactions.

The Northern Expressway is currently proposing to use SMA to reduce the pavement noise emissions. SMA reduces noise by the order of 2 dB(A) relative to DGA and 6 dB(A) relative to a hessian dragged or tined concrete surface.

Modifying the road gradient

Reducing the road gradient can have a positive effect on road traffic noise levels, as acceleration noise and engine/exhaust brake noise are both reduced. A 5% reduction in road gradient will reduce L_{eq} traffic noise levels by about 1.5 dB(A).

The Northern Expressway will have a 0% gradient for most of its length, except at grade separated interchanges and overpasses, which will have gradients of around 6–8%.

Reducing design speeds

On high-speed roads such as motorways, halving the average speed will reduce the traffic L_{eq} noise level by up to 5–6 dB(A). The Northern Expressway will be part of the National Network and will be designed to a freeway standard with a maximum speed limit of 110 kph. A reduction in design speed would negate part of the original purpose of the Expressway.

Traffic management schemes and traffic calming devices

Street closures can be beneficial in diverting traffic from local roads to arterial roads. Similarly, heavy vehicle access restrictions are an appropriate mechanism for reducing heavy vehicle noise. Heavy vehicle access restrictions adopted by local councils have included both weight and time restrictions. Traffic calming devices such as roundabouts, speed humps, midblock platforms and chicanes can all help reduce traffic noise on local roads. Research has shown that roundabouts provide the greatest benefit in noise reduction on local roads.

The Northern Expressway will have both positive and negative effects: it will increase traffic volume on new connector roads and reduce traffic volume on the existing Angle Vale Road–Heaslip Road corridor, especially though the township of Angle Vale.

Traffic management schemes are not suitable for a freeway, which is designed to minimise traffic congestion and interruptions to flow and thus provide a more continuous noise source and reduce extraneous loud noise events such as exhaust braking, acceleration and deceleration noise.

Traffic noise mitigation during planning and design

Non-vehicle based noise management strategies include:

- land-use and transport planning, to minimise noise-sensitive land uses along transport corridors, provide buffer zones and ensure land-use developments near roads are designed to minimise traffic noise impacts
- careful environmental assessment to identify existing and potential traffic noise problems and the most effective solutions

- new road route selection and design to minimise the propagation of noise from vehicles to sensitive receptors, though physical separation, landscaped noise moundings, noise barrier buildings and landscaped roadside noise walls
- noise-mitigation treatments near and within existing noise-sensitive buildings, or their conversion for less sensitive uses.

Land-use planning and development controls

Future road traffic noise problems can be avoided though zoning mechanisms that do not permit noise-sensitive land uses along transport corridors which have not been designed in accordance with good acoustic principles. Agricultural, recreational, commercial and light industrial land uses can provide effective buffer zones between busy roads and residential communities.

DTEI has no control over development approvals outside road reserves but takes an active role in advising other authorities during the preparation of planning instruments and during planning and approval processes for new developments.

As the Northern Expressway is located though a variety of agricultural land uses there is an excellent opportunity to work with councils to prevent noise-sensitive land uses adjacent to the corridor.

6.1.2 Controlling noise at the receiver

Even with effective vehicle controls, traffic noise will still be emitted. Management strategies at the receiver include:

- careful environmental assessment to identify existing and potential traffic noise problems and the most effective solutions.
- new road route selection and design to minimise the propagation of noise from vehicles to sensitive receptors, though physical separation, landscaped noise moundings, noise barrier buildings and landscaped roadside noise walls.
- noise mitigation treatments near and within existing noise-sensitive buildings, or their conversion for less sensitive uses.

Modifying road alignments

The Northern Expressway study area is a rural environment, characterised by a variety agricultural land-uses and interspersed with isolated dwellings and townships.

A number of route options were considered during the route selection phase. The effect of noise on adjacent dwellings was a significant criterion during the route selection process.

Modification of the road’s vertical alignment during the design phases can be a cost-effective approach with substantial urban design and acoustic benefits, particularly though densely populated areas.

The Northern Expressway is located through primarily flat terrain, with limited drainage opportunities. Lowering the pavement may result in ponding of stormwater in the swale drain. If water was allowed to infiltrate the pavement, it could lead to pavement failures.

In addition to the drainage issue, the soil type also poses excavation problems. The A and B soil horizon are moderately reactive and may require excavation and back-filling with more appropriate sub-base material.

Roadside noise walls and mounds

Acoustic barriers provide immediate reductions in road traffic noise at the shielded properties once barrier construction is complete. Road traffic noise barriers, in the form of 'noise walls' or mounded earthworks, must break the lines-of-sight between road traffic noise sources – including reflections of traffic noise from solid walls – and the noise-sensitive receiver, to gain maximum effectiveness. However, barriers of a lower height can still reduce noise.

The acoustic effectiveness of a barrier depends on its density, height, length and location. The higher the barrier (compared to the direct line-of-sight from the source to the receiver) and the closer its location to either the source or the receiver, the greater the noise attenuation provided. The barrier also needs to have a sufficient length.

Roadside barriers, as distinct from barriers close to dwellings, usually have to provide shielding along an appreciable length of road to be effective. They can therefore be efficient in providing attenuation to groups of residences, but will not be cost-effective for single structures and may be ineffective where openings are required for driveway access. The Northern Expressway Project is proposing to install barriers adjacent to moderately dense residential living areas such as MacDonald Park.

The physical heights of barriers can usually be reduced if the pavement is lowered. This is currently not possible along the Northern Expressway route due to reasons outlined in the previous section. Combinations of earth mounding and lower height noise walls can reduce the scale and potential visual impacts of fabricated barriers, especially in conjunction with landscape treatments.

The use of earth mounds is currently being investigated, but the earthworks balance will probably be equalised between the swale cuts and the pavement embankment fill requirements. As such, any material for earth mounds would have to be imported onto the site, making it cost prohibitive for large mounds. Smaller mounds may still be accommodated for landscaping purposes.

Noise walls can be constructed using timber, pre-cast concrete panels, lightweight aerated concrete, fibre cement panels, transparent acrylic panels and profiled steel cladding. Dense vegetation screen planting has visual and privacy benefits, but provides only minor acoustic attenuation, about 1 dB(A) for a 10 m depth. For significant noise attenuation, a solid barrier (e.g. earth mounding, noise wall, cutting) is required.

Roadside noise barriers are currently being investigated at a number of locations along the Northern Expressway alignment. The exact locations will depend on their acoustic benefits and a cost benefit analysis with other treatment options.

Noise barriers close to sensitive receptors

As already indicated, noise barriers such as moundings and noise walls are most effective when located either close to the road's traffic stream or close to the affected dwelling(s) or other noise-sensitive land uses.

With the consent of owners, acoustic barriers can sometimes be located within a residential property boundary so that they provide maximum shielding of the dwelling. They might be designed to form a courtyard, providing some benefit for an outdoor area near the dwelling.

This approach would reduce the extent of roadside barriers otherwise required, and is the most cost-effective solution for isolated, noise-exposed residences.

Noise mitigation treatment of existing sensitive receptors

Individual dwelling treatments can be provided in lieu of, or in conjunction with, noise control measures such as low noise road surfaces, roadside noise barriers and barriers near the dwellings.

Any such acoustic architectural treatments will require extensive consultation with, and the agreement of all affected parties.

Building treatments would generally be considered only when external road traffic noise criteria cannot be achieved at the premises and other measures are impractical or not cost effective. The mitigation measures would be designed to achieve the internal noise levels that would have prevailed had the external traffic noise criteria been achievable.

Most buildings will achieve an internal noise level 10–15 dB(A) below the external noise level with the windows open, without requiring additional treatment. Specific treatments of the windows and façades of buildings are somewhat expensive, as they usually necessitate alternative ventilation so that the windows can be kept closed during noisier times of the day.

Approaches to the acoustic treatment of buildings may include:

- improved glazing and door construction in the façades exposed to the road
- provision of fresh air ventilation or airconditioning systems – which do not introduce a sound 'leakage' path that could offset the benefits of the other acoustical measures
- installation of courtyard or screen walls on the private property that reduce external noise at the locality.

Other noise control measures that require modification of the building structure include:

- upgrading of the façades if the existing building materials are acoustically inadequate, such as weatherboard or metal-clad dwellings
- upgrading of the roof structure if the existing structure is inadequate, including applying additional sheet(s) of plasterboard to ceilings, laying insulation batts on the ceiling and fixing plywood above the ceiling joists
- closing off openings to the under-floor space or upgrading the floors if they are acoustically inadequate. Dwellings with timber floors on elevated piers are especially prone to poor acoustic performance.

A range of treatment measures will be agreed with the property owner during the detailed phase of the project.

6.2 Managing construction noise

Proactive noise control strategies to minimise noise during construction may include temporary acoustic barriers, enclosures, silencers or the substitution of alternative construction processes. All reasonable and feasible noise mitigation methods should be identified by the site supervisor on a daily if not hourly basis during noisy night works.

Noise level emissions and potential annoyance depend significantly on the condition of equipment, type of operation, its duration and the time of day it is conducted. Plant and equipment that performs at or better than industry expectations should be sourced as a priority. All major items of plant should be checked at the start of works on site and thereafter every 6 months and/or following a major service.

Generally, most residences identified as affected by construction noise will also be affected by operational traffic noise. Receptors where noise mitigation treatment is allocated for reducing operational noise, should have the treatment implemented to reduce noise during construction as well.

Mitigation measures can be taken in thee key areas:

Site management

- Locate noisy plant as far away from noise sensitive receptors as possible.
- Select and locate site access roads as far away from noise-sensitive receptors as possible.
- Take care not to drop materials to cause peak noise events, including materials from a height into a truck.
- Orientate plant known to emit noise strongly in one direction so that the noise is directed away from noise sensitive areas (if practicable).
- Shut down, or thottle down to a minimum, machines that are used intermittently in the intervening periods between works.
- Where possible, concentrate noisy activities at one location and move to another as quickly as possible.
- Avoid truck movements on residential streets where possible.
- Minimise the reversing of vehicles to reduce the noise from reversing signals.
- Ensure that truck operators clear tailgates and lock them at the point of unloading.
- Do not use vehicle warning devices such as horns as signalling devices.
- Use two-way radios at the minimum effective volume.
- Implement worksite induction training, educating staff on noise sensitive issues and the need to make as little noise as possible, and avoid shouting and whistling.
- Install temporary noise barriers.
- Locate equipment to take advantage of the noise barriers provided by existing site features and structures.
- When work is complete, minimise the noise of packing up plant and equipment and departing from the site.

Equipment management

- Ensure equipment has quality mufflers installed.
- Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the design specifications.
- Ensure silencers and enclosures are intact, rotating plants are balanced, loose bolts are tightened, frictional noise is reduced though lubrication and cutting noise reduced by keeping equipment sharp.
- Use only necessary power to complete the task.

- Rubber-line contact points of loaders and bobcats fitted with articulated buckets to ensure that noise levels are minimised during release of materials.
- Modify equipment, for example improve exhaust systems, stiffen panels to stop vibrations, apply noise dampening materials to panels to reduce noise transmission and fix resilient materials between contact surfaces.
- Use traffic practice controllers to prevent vehicles and equipment queuing, idling or reversing near noise sensitive receivers.

Sensitive receiver noise control

- Install any permanent noise barriers or at-house treatment required to minimise operational road traffic noise as early as possible in the construction process.
- Consult with affected residents to help develop acceptable noise management strategies.
- Provide an easily accessible and well-publicised complaint hotline, and suitably developed complaint handling procedure to effectively deal with any issues raised during the work.
- As a contingency measure, temporarily relocate sensitive receptors with special needs to alternate accommodation (hotel / motel) if necessary.

Mitigation measures in context

While the above measures will not necessarily result in meeting the construction noise goals at all times, they will serve to reduce impacts to levels most residents will find acceptable.

In some cases, a balance between a higher acceptable noise emission to enable a faster construction progress may be preferred by the community to ultimately reduce the perceived noise impact, that is, shorter duration of higher noise is better than longer term lower noise level.

6.3 Vibration mitigation measures

A detailed noise and vibration management plan, developed before construction begins, will outline the vibration mitigation measures to be implemented by the appointed contractor. Mitigation will most likely include the following actions:

- vibration monitoring at selected residences closer than 25 m to construction activities that are know to generate high ground vibration levels
- regular community (or affected residents) updates advising when and where construction activities may generate perceptible levels of vibration
- minimising piling energy (i.e. reduced hammer drop distance) as necessary depending upon receptor distance.

Where construction activities including pile driving, excavation by hammering or ripping, dynamic compaction or demolition of structures may cause damage though vibration to nearby public utilities, structures, buildings and their contents, or if the items are located within the distance from the construction activity as specified in Table 6.1, a building condition inspection of these items will be undertaken before construction.

Table 6.1 Distance from construction activity for building condition inspection

Activity	Distance
Pile driving	100 m
Vibration compaction	> 7 t plant: 50 m
Vibration compaction	< 7 t plant: 25 m
Demolition of structures	50 m

6.4 Measures to minimise effects post-construction

Every effort can be made to minimise the environmental noise impact of the Northern Expressway before opening, but further noise issues may become evident after construction. Noise monitoring will be performed after the opening to identify any problem areas that have not been addressed adequately or that may have changed during the detailed design process.

7 Conclusion

This report presents the predicted noise levels for the Northern Expressway at road opening in 2011, and 15 years after opening in 2026. Predicted noise levels for Port Wakefield Road in 2016 have also been presented.

Appropriate night time and day time criteria have been selected for all noise sensitive receptors within 500 metres of the Northern Expressway alignment, and the existing Gawler Bypass and Port Wakefield Road. These criteria were determined by predicting the road traffic noise exposure at each receiver for the existing alignment in 2011.

The majority of noise sensitive receptors have been identified as having predicted 2026 noise levels in excess of the applicable day time criteria.

Port Wakefield Road will be operating above capacity 15 years after the opening of the Northern Expressway. A large number of receivers located within 500 metres of Port Wakefield Road are predicted to exceed day time and night time criteria with the proposed alignment in 2026. It is expected that significant upgrade works of Port Wakefield Road will be required after the Northern Expressway opens.

During construction, it is not expected that vibration levels will cause structural damage, but a building condition inspection may be required for nearby properties during some construction activities. Vibration levels are expected to not be of a significant level after the Northern Expressway opens.

8 References

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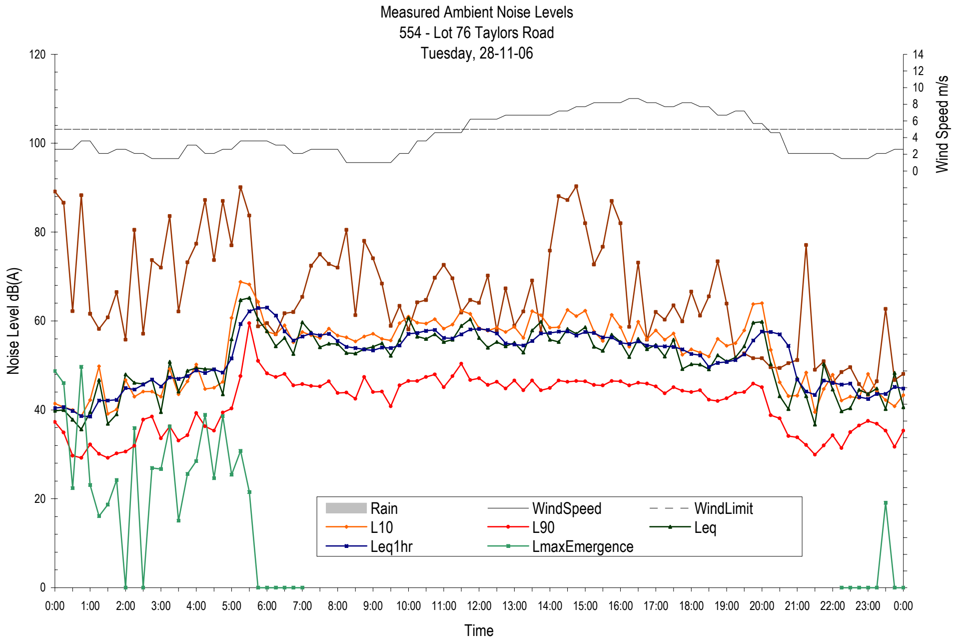
United Kingdom Department of Environment. 1988. *Calculation of Road Traffic Noise* (updated from 1975 version). UKDOE, Welsh Office HMSO.

Attachment A

Noise logger measurements

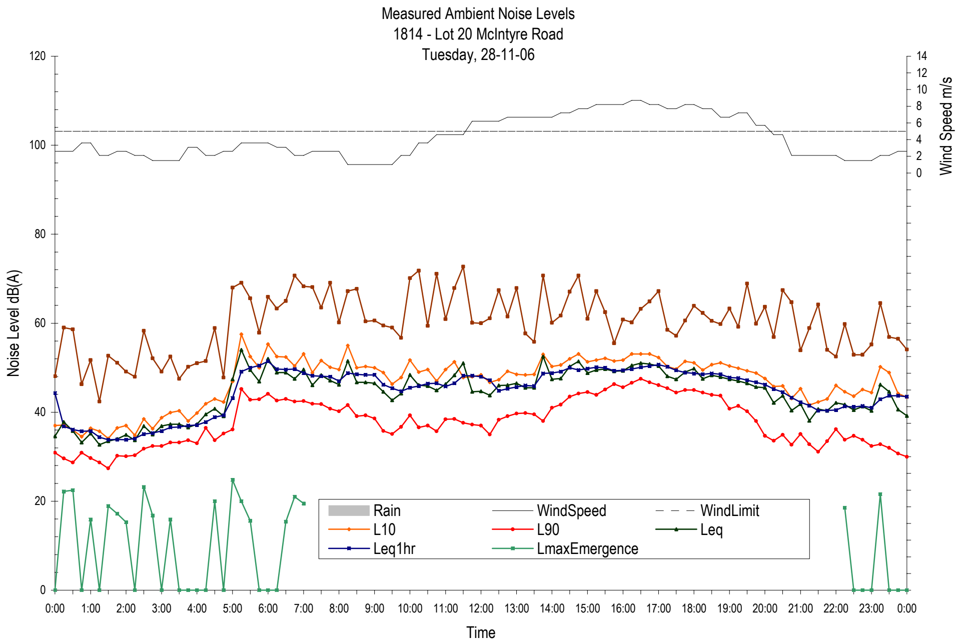
Site address: Location 1 – Lot 76 Taylors Road, Virginia

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



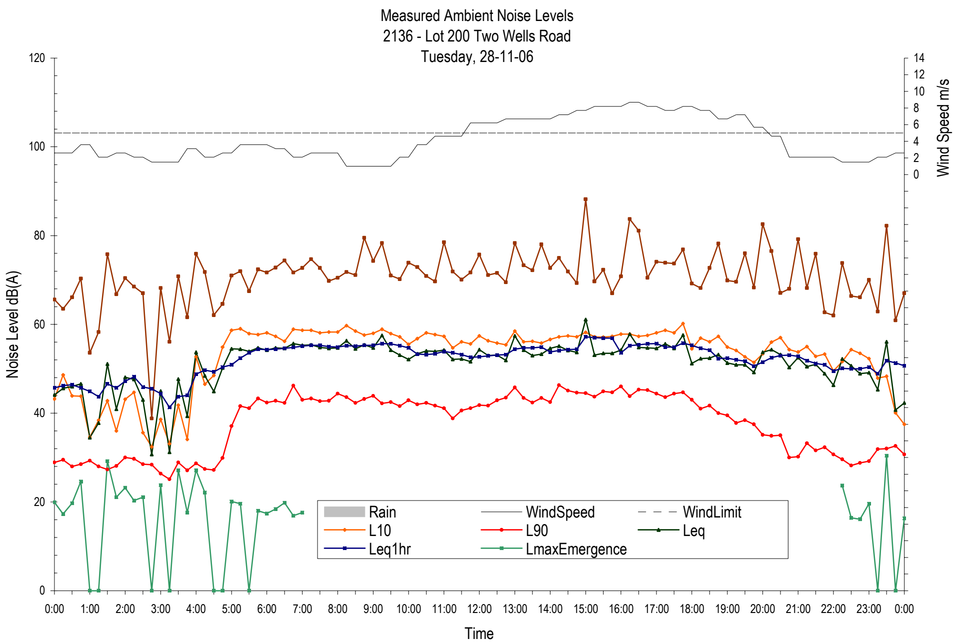
Site address: Location 2 – Lot 20 McIntyre Road, MacDonald Park

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



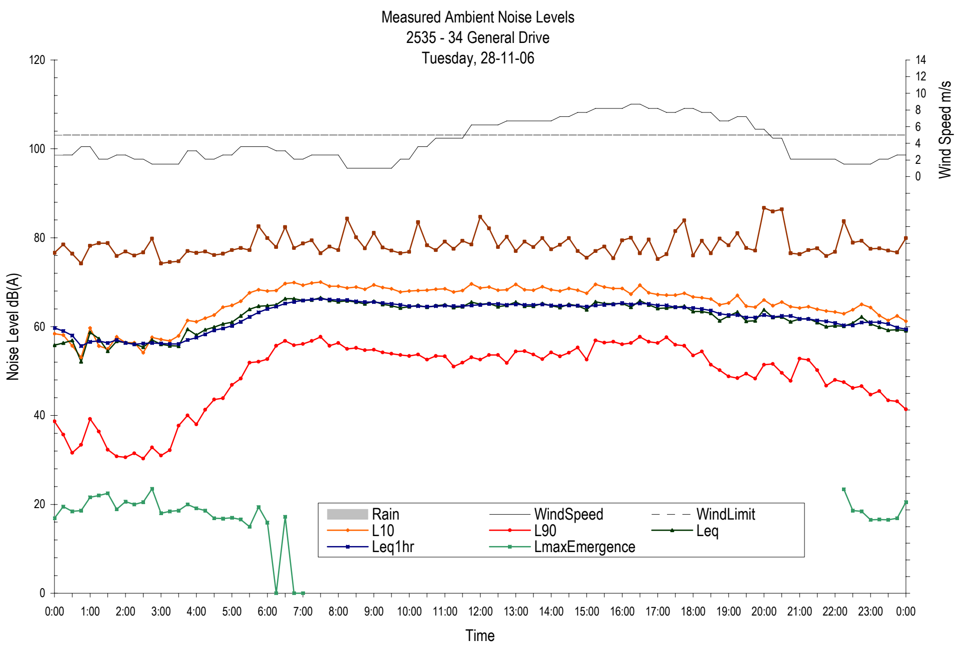
Site address: **Location 3 – Lot 200 Two Wells Road, Buchfelde**

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



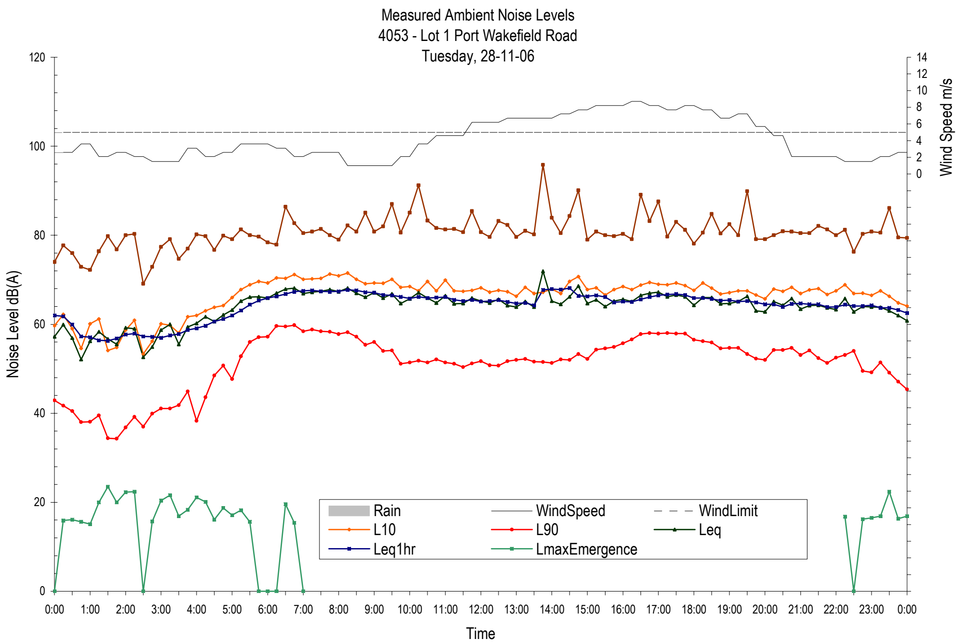
Site address: **Location 4 – 34 General Drive, Paralowie**

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



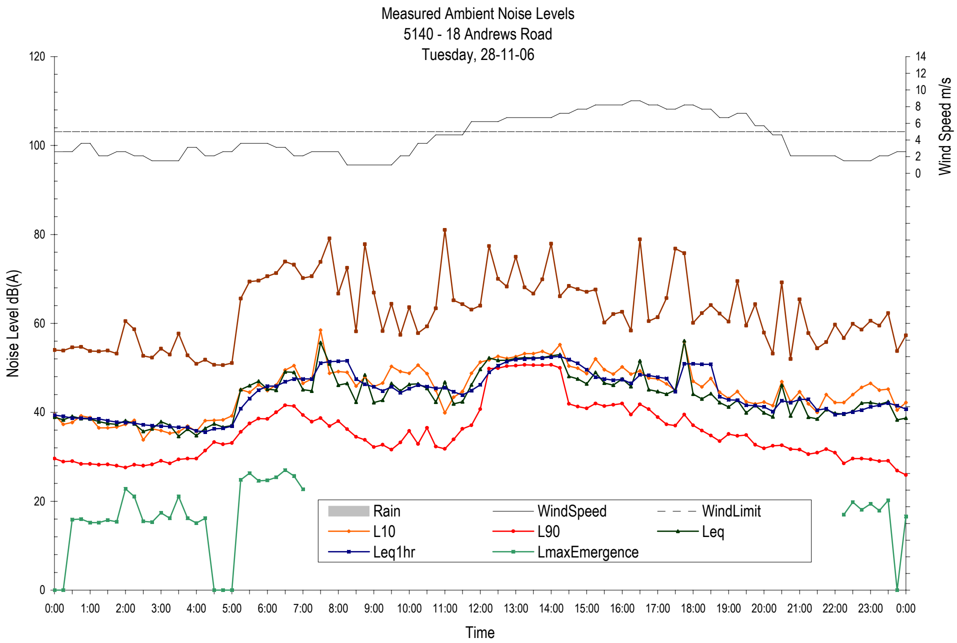
Site address: Location 5 – Lot 1 Port Wakefield Road, Waterloo Corner

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



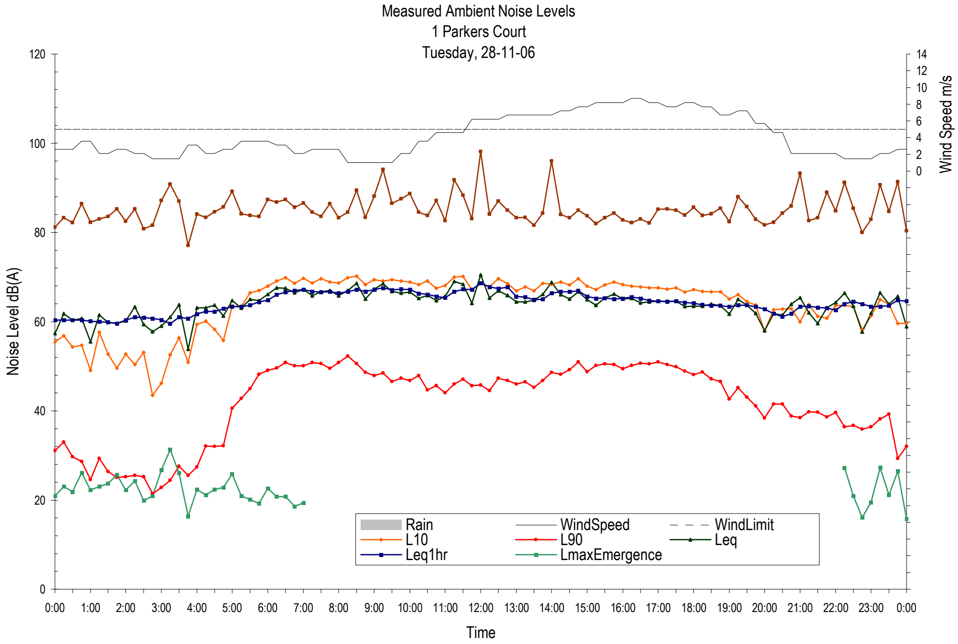
Site address: Location 6 – 18 Andrews Road, MacDonald Park

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



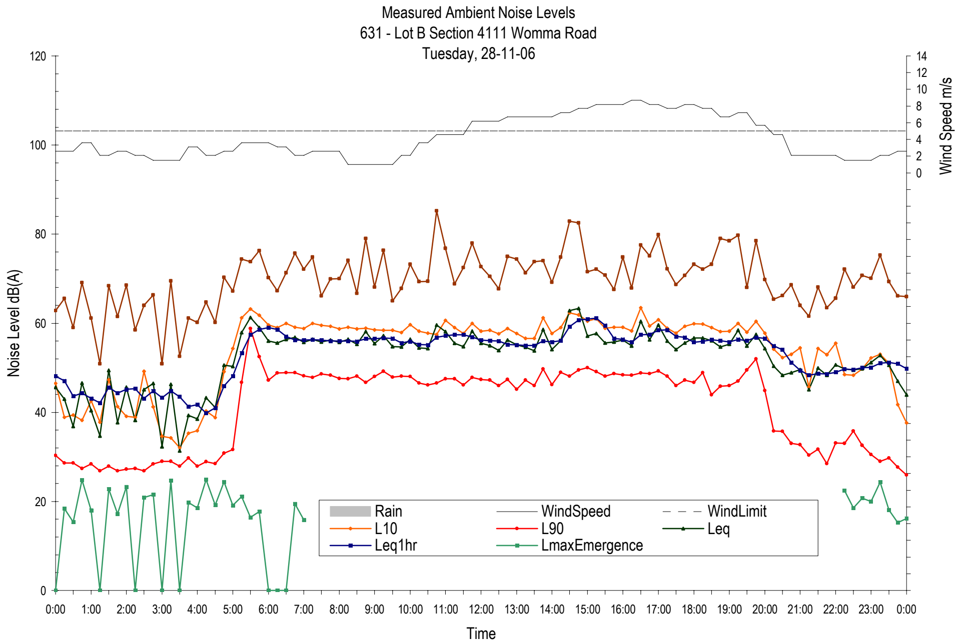
Site address: Location 7 – 1 Parkers Court, Willaston

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



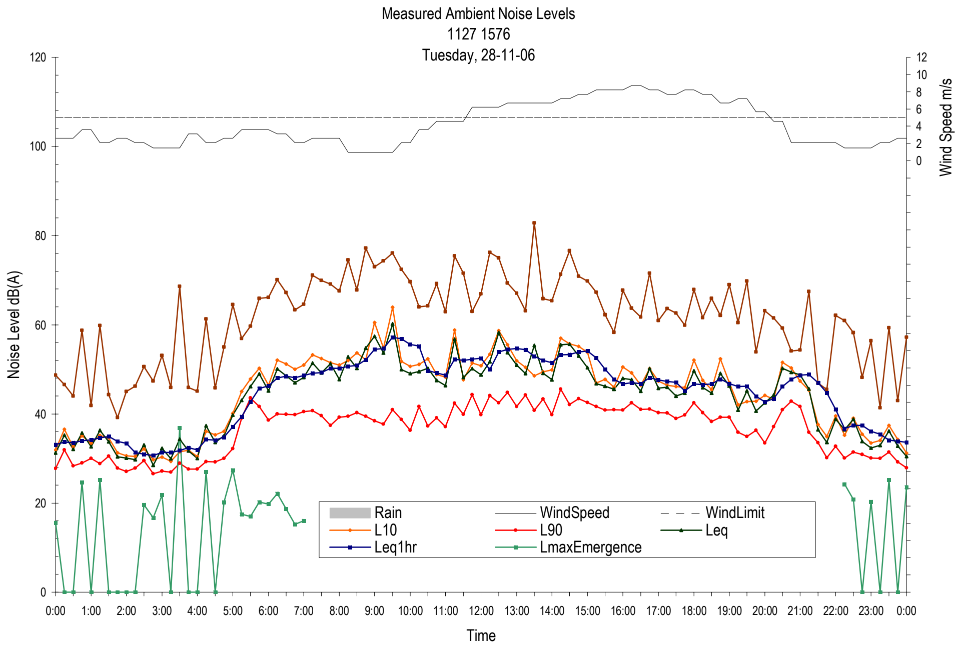
Site address: Location 8 – Lot B Section 4111 Womma Road, Penfield Gardens

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



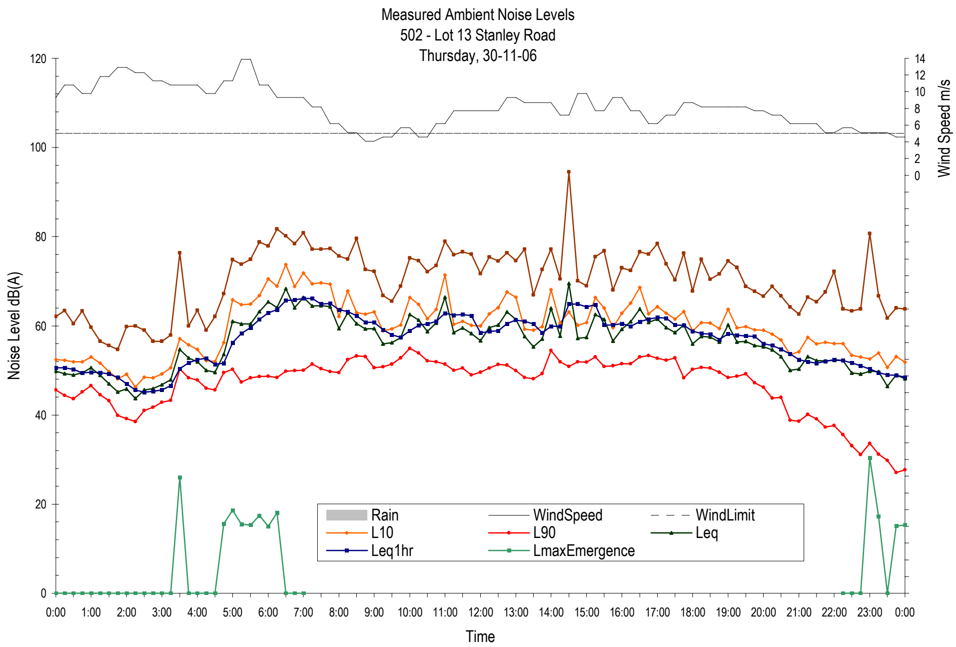
Site address: Location 9 – Lot 12 Hillier Road, Hillier

Duration: Monday 27 November 2006 to Wednesday 29 November 2006



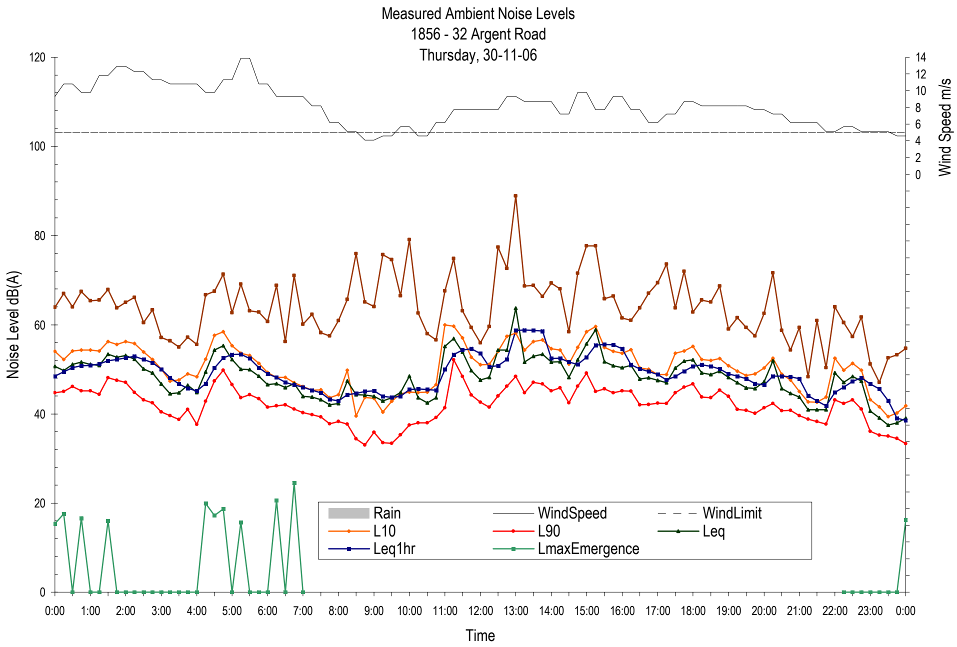
Site address: Location 10 – Lot 18 Stanley Road, Waterloo Corner

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



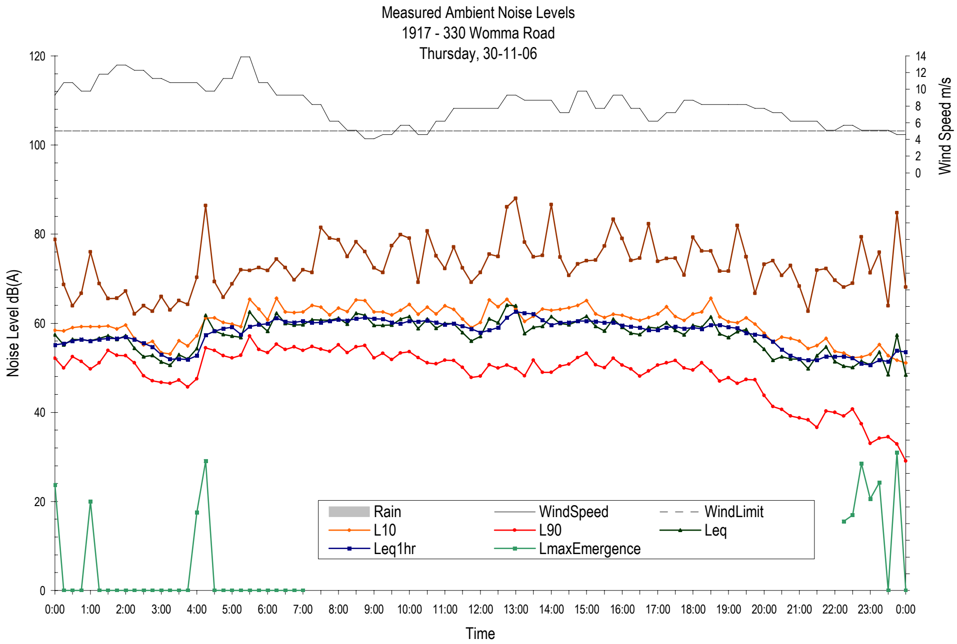
Site address: Location 11 – Lot 32 Argent Road, Penfield

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



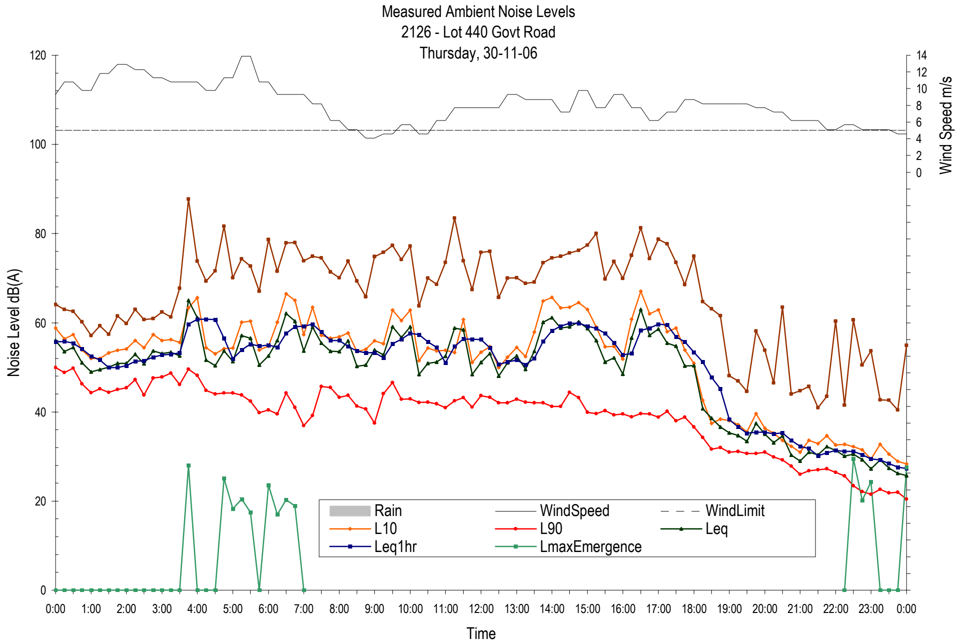
Site address: Location 12 – Lot 330 Womma Road, Penfield

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



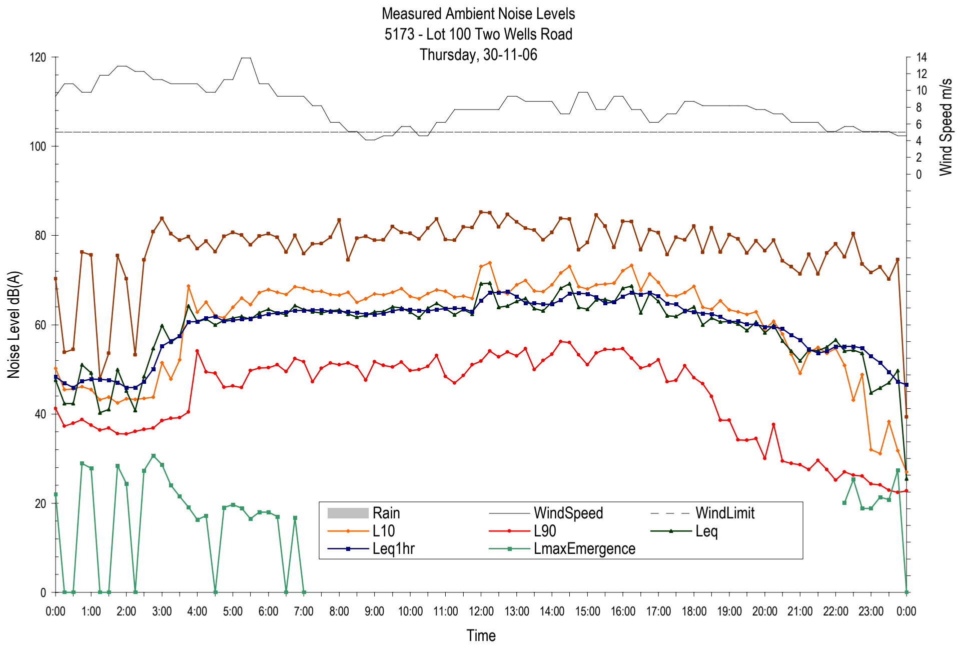
Site address: Location 13 – Lot 440 Government Road, Buchfelde

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



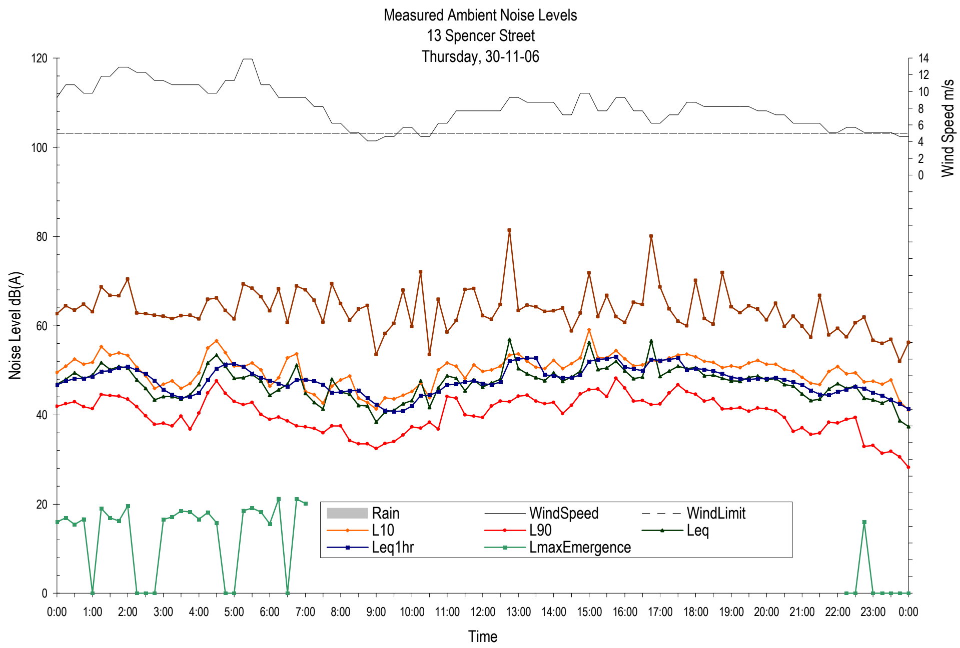
Site address: Location 14 – Lot 100 Two Wells Road, Buchfelde

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



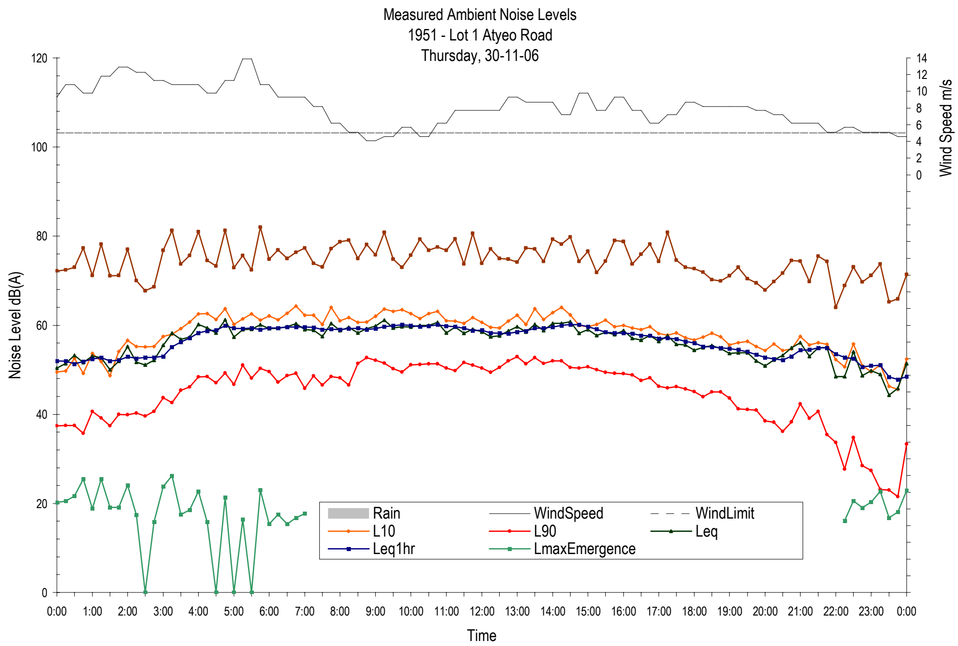
Site address: Location 15 – 13 Spencer Street, MacDonald Park

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



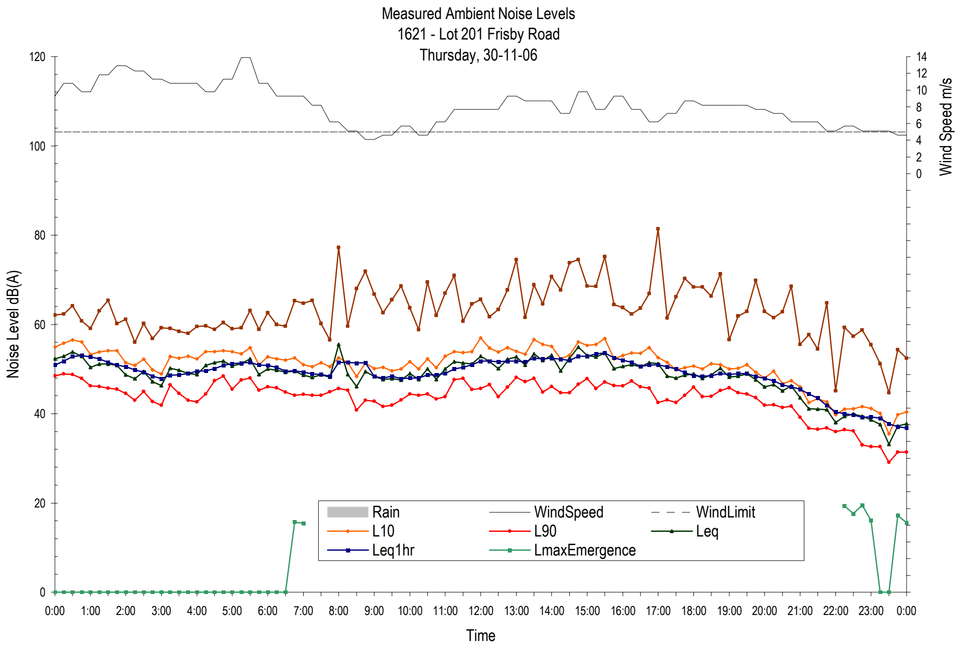
Site address: Location 16 – Lot 1 Atyeo Road, Gawler Belt

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



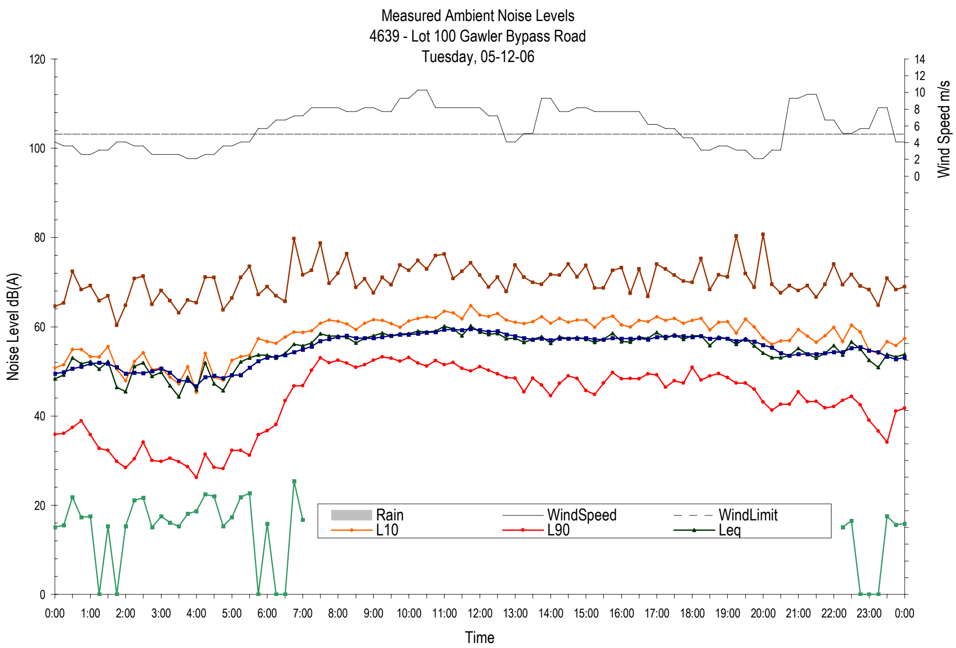
Site address: Location 17 – Lot 201 Frisby Road, Munno Para Downs

Duration: Wednesday 29 November 2006 to Friday 1 December 2006



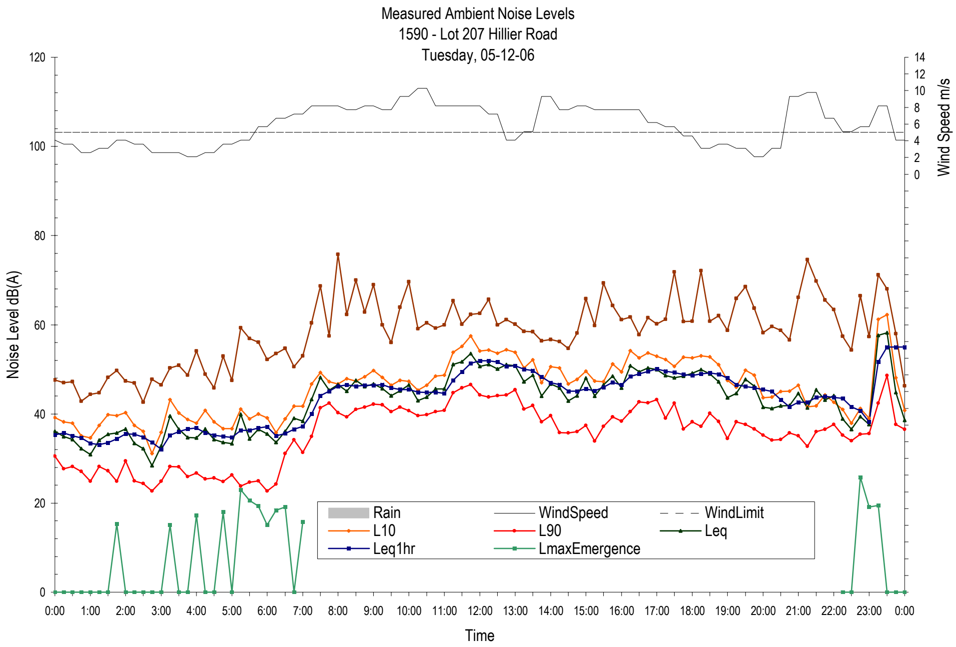
Site address: Location 18 – Lot 100 Gawler Bypass Road, Reid

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



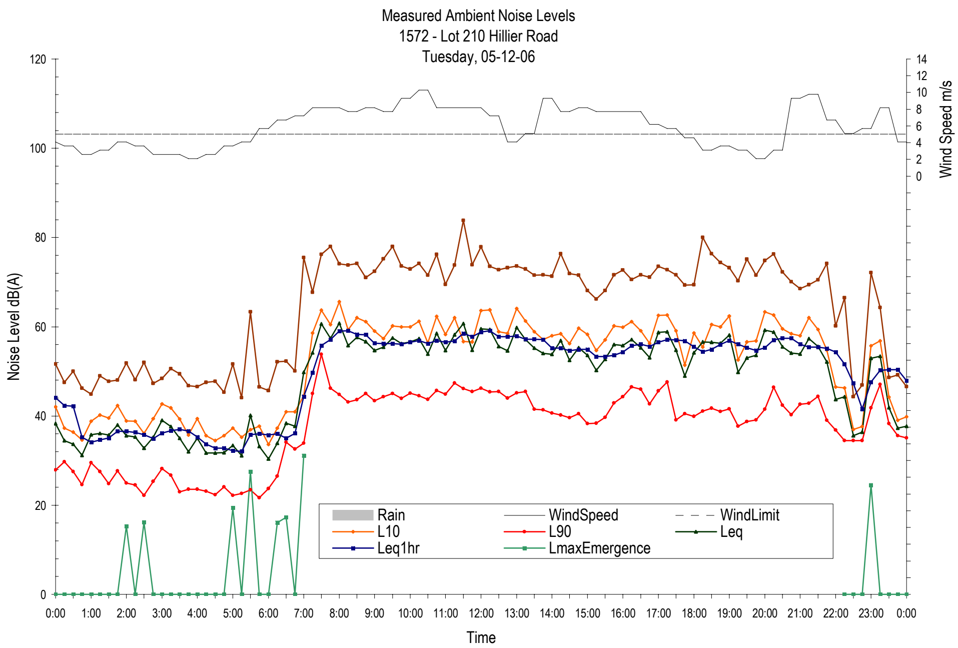
Site address: Location 19 – Lot 207 Hillier Road, Hillier

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



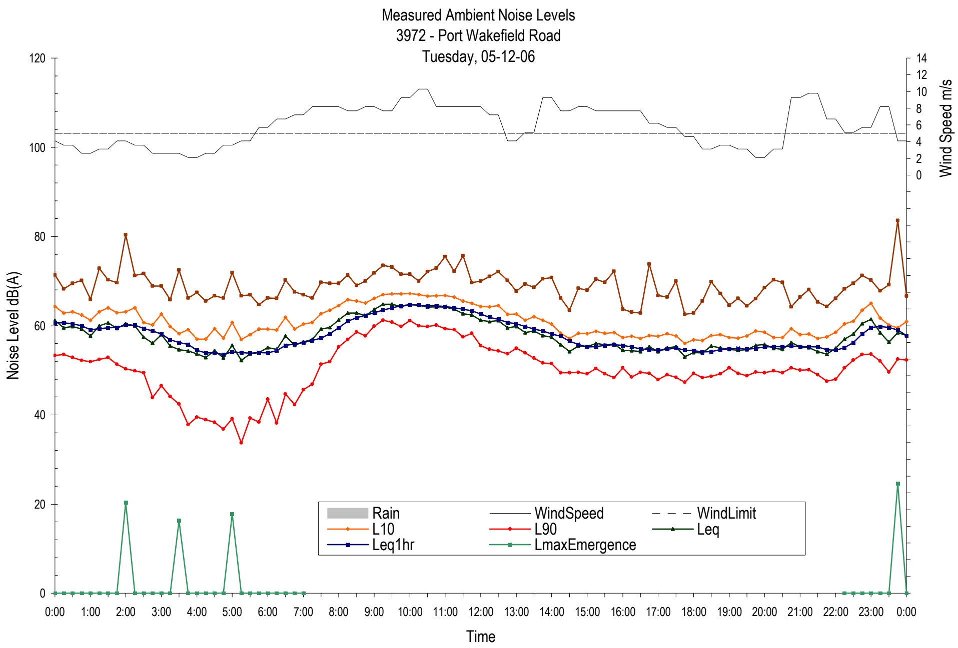
Site address: Location 20 – Lot 210 Hillier Road, Hillier

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



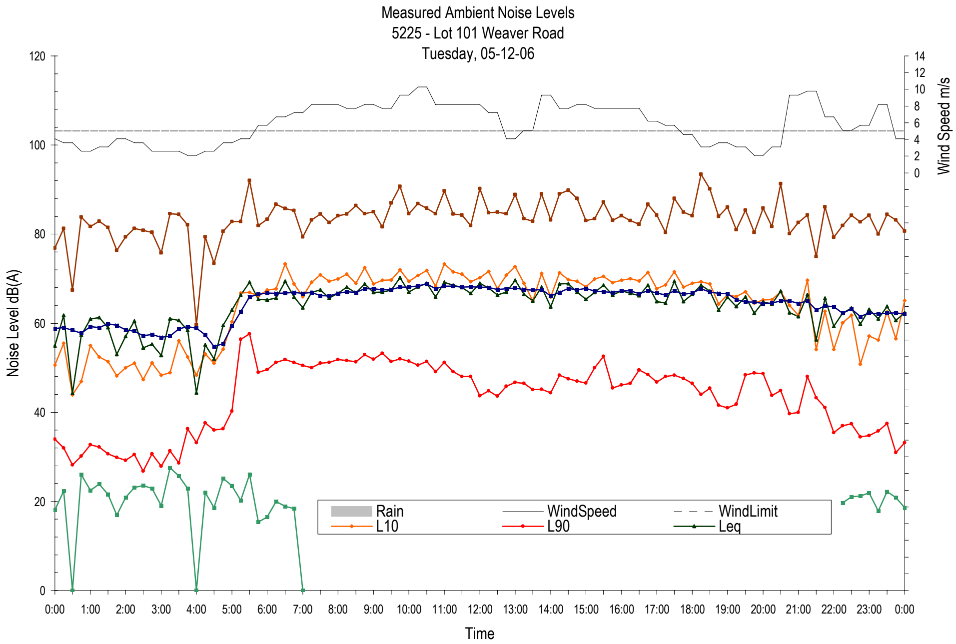
Site address: **Location 21 – Port Wakefield Road, Globe Derby Park**

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



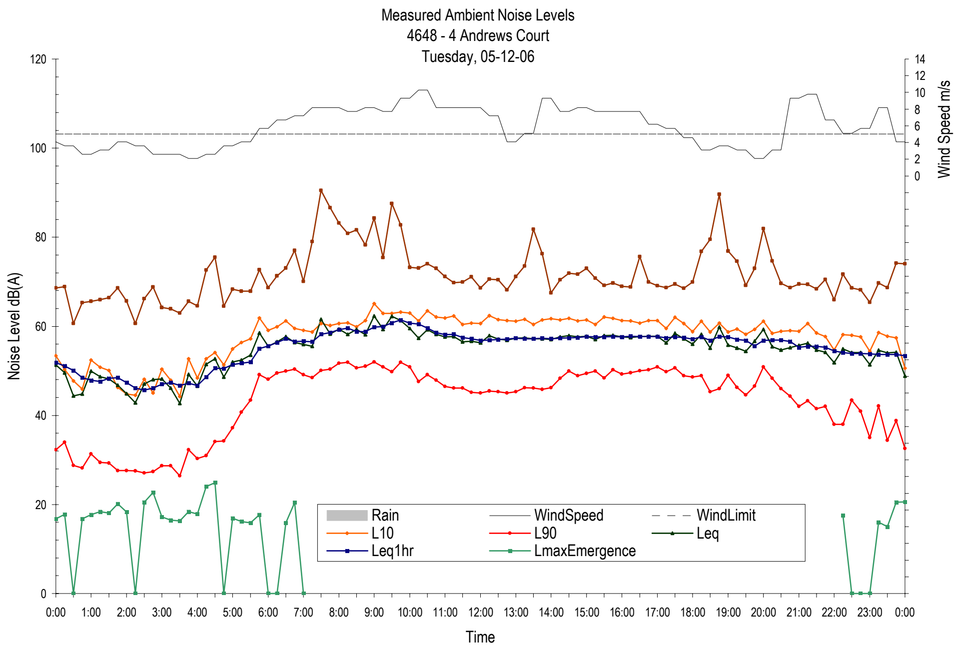
Site address: **Location 22 – Lot 101 Weaver Road, Buchfelde**

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



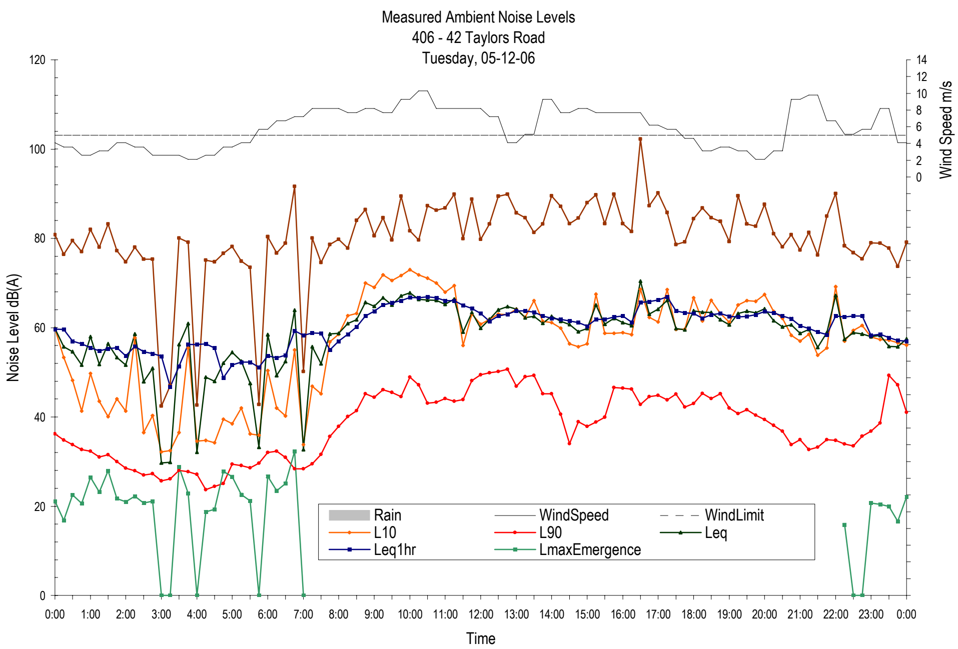
Site address: Location 23 – 4 Andrews Court, Reid

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



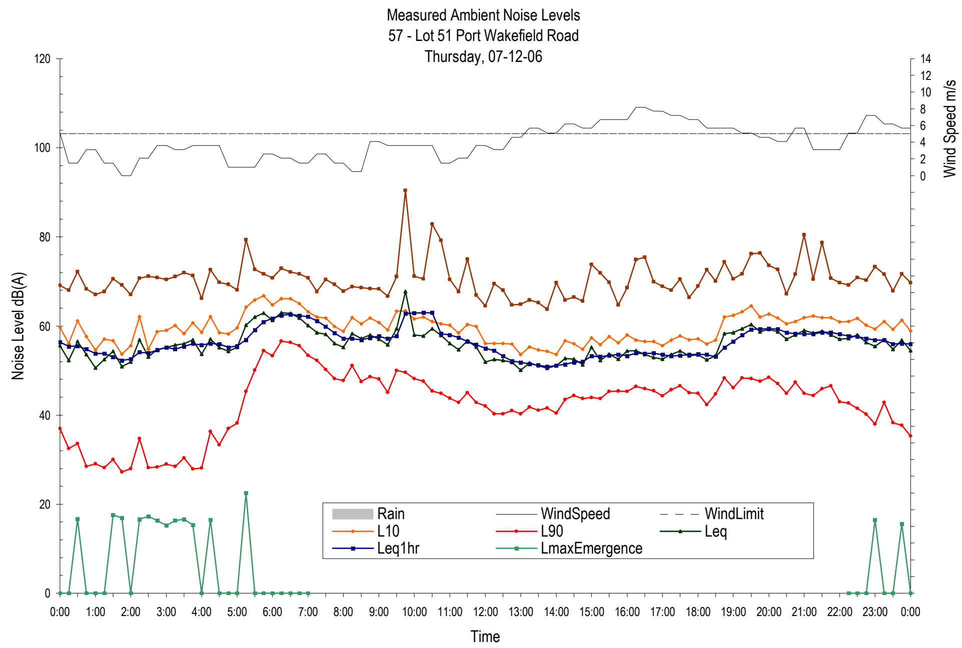
Site address: Location 24 – Lot 42 Taylors Road, Virginia

Duration: Monday 4 December 2006 to Wednesday 6 December 2006



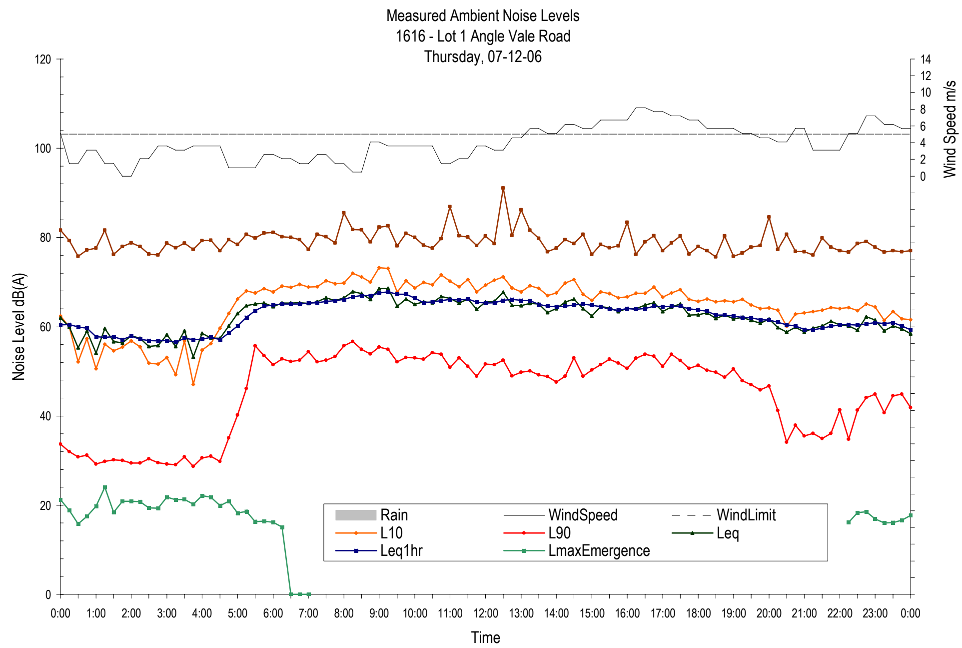
Site address: Location 25 – Lot 51 Port Wakefield Road, Waterloo Corner

Duration: Wednesday 6 December 2006 to Friday 8 December 2006



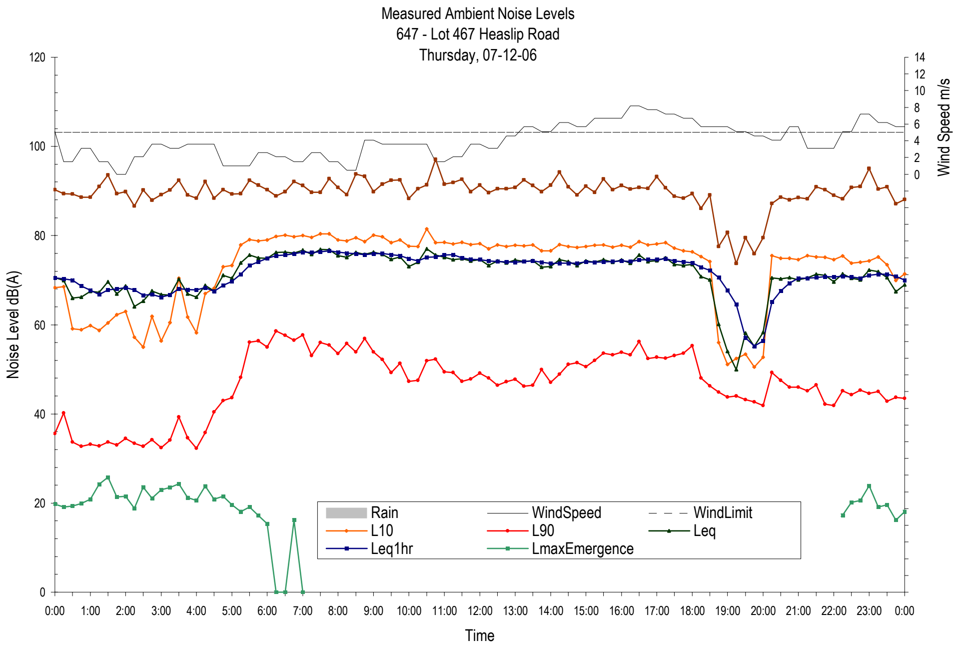
Site address: Location 26 – Lot 1 Angle Vale Road, Munno Para Downs

Duration: Wednesday 6 December 2006 to Friday 8 December 2006



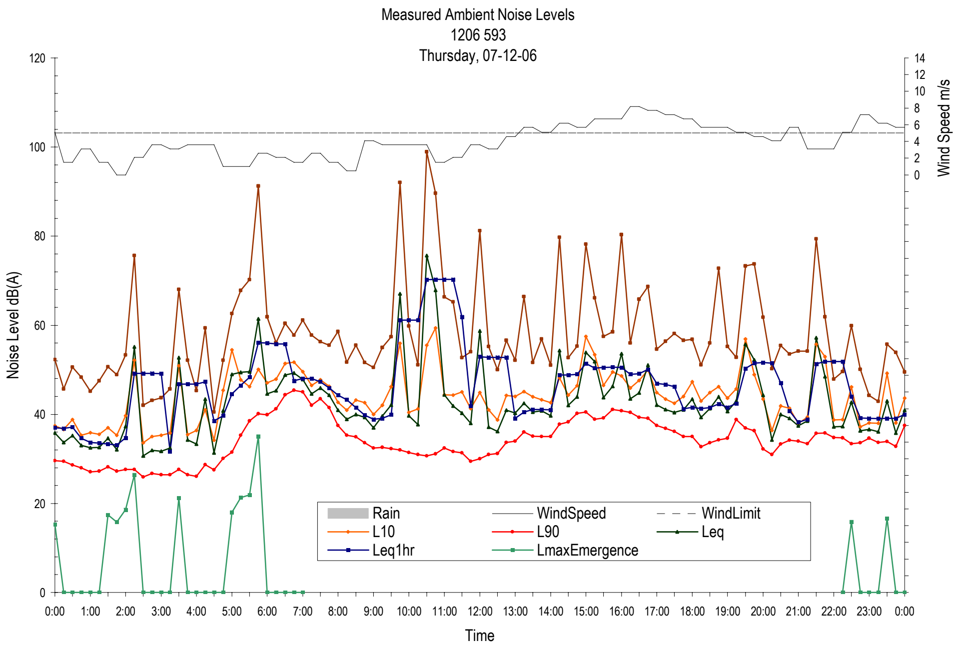
Site address: Location 27 – Lot 467 Heaslip Road, Penfield

Duration: Wednesday 6 December 2006 to Friday 8 December 2006



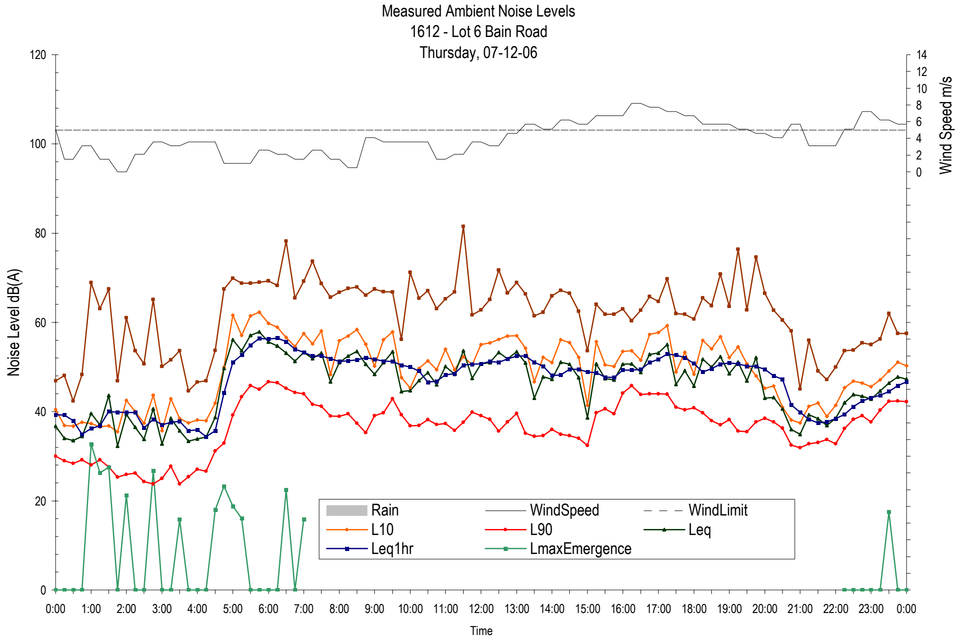
Site address: Location 22 – Lot 28 Pellew Road, Penfield

Duration: Wednesday 6 December 2006 to Friday 8 December 2006



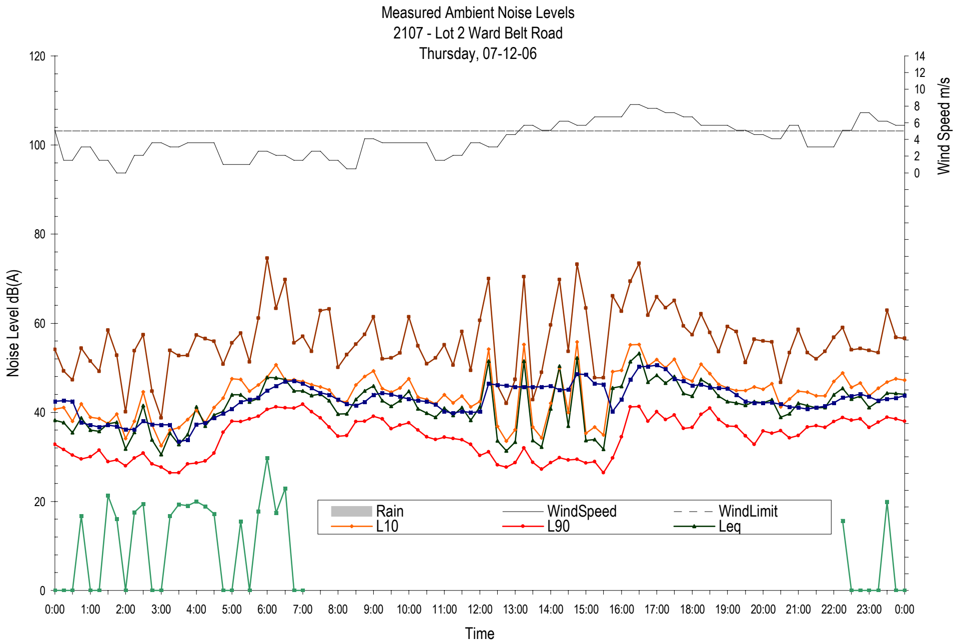
Site address: Location 29 – Lot 6 Bain Road, Munno Para Downs

Duration: Wednesday 6 December 2006 to Friday 8 December 2006



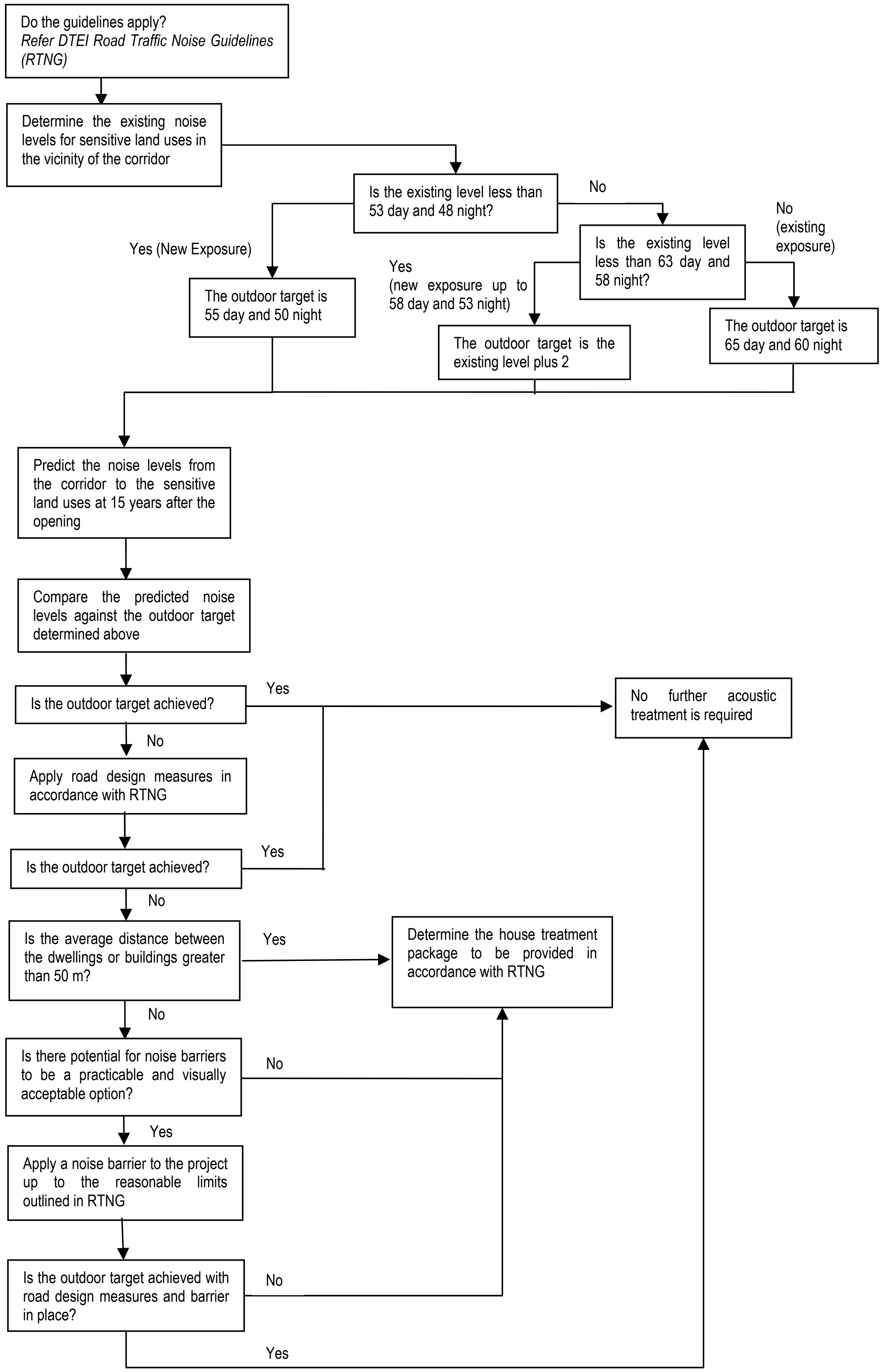
Site address: Location 30 – Lot 2 Ward Belt Road, Buchfelde

Duration: Wednesday 6 December 2006 to Friday 8 December 2006



Attachment B

Noise criteria assessment flowchart


Do the guidelines apply?
Refer DTEI Road Traffic Noise Guidelines (RTNG)
Determine the existing noise levels for sensitive land uses in the vicinity of the corridor
Is the existing level less than 53 day and 48 night?
Yes (New Exposure)
No
The outdoor target is 55 day and 50 night
Is the existing level less than 63 day and 58 night?
Yes (new exposure up to 58 day and 53 night)
No (existing exposure)
The outdoor target is the existing level plus 2
The outdoor target is 65 day and 60 night
Predict the noise levels from the corridor to the sensitive land uses at 15 years after the opening
Compare the predicted noise levels against the outdoor target determined above
Is the outdoor target achieved?
Yes
No further acoustic treatment is required
No
Apply road design measures in accordance with RTNG
Is the outdoor target achieved?
Yes
No
Is the average distance between the dwellings or buildings greater than 50 m?
Yes
Determine the house treatment package to be provided in accordance with RTNG
No
Is there potential for noise barriers to be a practicable and visually acceptable option?
No
Yes
Apply a noise barrier to the project up to the reasonable limits outlined in RTNG
Is the outdoor target achieved with road design measures and barrier in place?
No
Yes

Attachment C

Modelled traffic volumes

Table C.1 Measured and predicted traffic volumes for existing roads in 2006

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	47,000	40,050	11.1%	6,950	12.4%
	South of Martins Road	46,350	39,500	11.1%	6,850	12.4%
	North of Martins Road	39,550	33,700	11.1%	5,850	12.4%
	South of Bolivar Road	36,800	31,350	11.1%	5,450	12.4%
	North of Bolivar Road	29,500	25,400	15.2%	4,100	20%
	South of Waterloo Corner	29,500	25,400	15.2%	4,100	20%
	North of Waterloo Corner	20,050	17,300	15.2%	2,750	20%
	South of Huxtable Road	19,100	16,450	15.2%	2,650	20%
Waterloo Corner	East of Port Wakefield Road	10,650	9,050	12.7%	1,600	13.4%
Heaslip Road	North of Waterloo Corner	11,700	9,950	12.7%	1,750	13.4%
	South of Huxtable Road	11,600	9,850	12.7%	1,750	13.4%
	North of Huxtable Road	11,850	10,050	12.7%	1,800	13.4%
	South of Womma Road	12,300	10,450	12.7%	1,850	13.4%
	North of Womma Road	9,500	8,150	13.6%	1,350	17.5%
	South of Curtis Road	9,650	8,250	13.6%	1,400	17.5%
	North of Curtis Road	8,450	7,250	13.6%	1,200	17.5%
	South of Angle Vale Road	8,050	6,900	13.6%	1,050	17.5%
Angle Vale Road	West of Heaslip Road	2,750	2,450	16.6%	300	27.2%
	East of Heaslip Road	7,300	6,450	16.6%	850	27.2%
	West of Dalkeith Road	6,700	5,950	16.6%	750	27.2%
	East of Dalkeith Road	5,600	4,900	18.4%	700	28.8%
	West of Gawler Bypass	6,600	5,800	18.4%	800	28.8%
Gawler Bypass	North of Main North Road	14,000	12,600	11.9%	1,400	18%
	North of Jackson Cooper Drive	12,900	11,650	11.9%	1,250	18%
	North of Two Wells Road	17,300	15,600	11.9%	1,700	18%
Jackson Cooper Drive	East of Gawler Bypass	8,300	7,500	11.9%	800	18%
Two Wells Road	East of Gawler Bypass	5,550	5,000	11.9%	550	18%

Table C.2 Predicted traffic volumes for existing roads in 2011

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	58,000	49,400	11.1%	8,600	12.4%
	South of Martins Road	57,200	48,750	11.1%	8,450	12.4%
	North of Martins Road	48,800	41,600	11.1%	7,200	12.4%
	South of Bolivar Road	45,400	38,700	11.1%	6,700	12.4%
	North of Bolivar Road	32,000	27,600	15.2%	4,400	20%
	South of Waterloo Corner	30,600	26,350	15.2%	4,250	20%
	North of Waterloo Corner	20,800	17,900	15.2%	2,900	20%
	South of Huxtable Road	19,800	17,050	15.2%	2,750	20%
Waterloo Corner	East of Port Wakefield Road	16,200	13,750	12.7%	2,450	13.4%
Heaslip Road	North of Waterloo Corner	17,800	15,150	12.7%	2,650	13.4%
	South of Huxtable Road	17,600	14,950	12.7%	2,650	13.4%
	North of Huxtable Road	18,000	15,300	12.7%	2,700	13.4%
Heaslip Road	South of Womma Road	18,700	15,900	12.7%	2,800	13.4%
	North of Womma Road	11,100	9,500	13.6%	1,600	17.5%
	South of Curtis Road	11,300	9,700	13.6%	1,600	17.5%
	South of Angle Vale Road	9,900	8,500	13.6%	1,400	17.5%
Angle Vale Road	West of Heaslip Road	3,600	3,200	16.6%	400	27.2%
	East of Heaslip Road	9,600	8,500	16.6%	1,100	27.2%
	West of Dalkeith Road	8,800	7,800	16.6%	1,000	27.2%
	East of Dalkeith Road	7,300	6,400	18.4%	900	28.8%
	West of Gawler Bypass	8,600	7,550	18.4%	1,050	28.8%
Gawler Bypass	North of Main North Road	15,600	14,050	11.9%	1,550	18%
	North of Jackson Cooper Drive	14,400	13,000	11.9%	1,400	18%
	North of Two Wells Road	19,300	17,400	11.9%	1,900	18%
Jackson Cooper Drive	East of Gawler Bypass	9,300	8,400	11.9%	900	18%
Two Wells Road	East of Gawler Bypass	6,200	5,600	11.9%	600	18%

Table C.3 Predicted traffic volumes for proposed roads in 2011

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	67,800	60,400	18%	7,400	21.5%
	South of Martins Road	66,500	59,250	18%	7,250	21.5%
	North of Martins Road	58,800	52,400	18%	6,400	21.5%
	South of Bolivar Road	56,100	50,000	18%	6,100	21.5%
	North of Bolivar Road	44,100	39,300	18%	4,800	21.5%
	South of Waterloo Corner	42,700	38,050	18%	4,650	21.5%
	North of Waterloo Corner	37,300	33,250	18%	4,050	21.5%
	South of Expressway	36,300	32,350	18%	3,950	21.5%
	North of Expressway	18,200	16,200	18%	2,000	21.5%
Northern Expressway	East of Port Wakefield Road	18,100	16,100	15.1%	2,000	14.5%
	East Heaslip Road	18,300	16,300	15.1%	2,000	14.5%
	North Curtis Road	17,100	15,200	15.1%	1,900	14.5%
	North Gawler Bypass	25,200	22,400	15.1%	2,800	14.5%
Heaslip Road turn-off lanes	North-west and south-west	2,800	2,500	15.1%	300	14.5%
	North-east and south-east	2,900	2,600	15.1%	300	14.5%
Curtis Road turn-off lanes		600	550	15.1%	50	14.5%
Waterloo Corner	East of Port Wakefield Road	12,100	10,300	12.7%	1,800	13.4%
Heaslip Road	North of Waterloo Corner	12,100	10,300	12.7%	1,800	13.4%
	South of Huxtable Road	11,800	10,050	12.7%	1,750	13.4%
	South of Expressway	12,500	10,650	12.7%	1,850	13.4%
	North of Expressway	7,000	5,950	12.7%	1,050	13.4%
Heaslip Road	South of Curtis Road	5,900	5,000	12.7%	900	13.4%
	North of Curtis Road	4,400	3,750	12.7%	650	13.4%
	South of Angle Vale Road	3,900	3,300	12.7%	600	13.4%
Angle Vale Road	West of Heaslip Road	3,100	2,750	16.6%	350	27.2%
	East of Heaslip Road	3,500	3,100	16.6%	400	27.2%
	West of Dalkeith Road	2,700	2,400	16.6%	300	27.2%
	East of Dalkeith Road	2,000	1,750	16.6%	250	27.2%
	West of Gawler Bypass	2,000	1,750	16.6%	250	27.2%
Gawler Bypass	North of Main North Road	5,900	5,300	11.9%	600	18%
	North of Jackson Cooper Drive	4,700	4,250	11.9%	450	18%
	South of Expressway	7,700	6,950	11.9%	750	18%
Jackson Cooper Drive	East of Gawler Bypass	3,900	3,500	11.9%	400	18%
Two Wells Road	East of Gawler Bypass	4,300	3,850	11.9%	450	18%

Table C.4 Predicted traffic volumes for existing roads in 2016

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	66,800	59,450	18%	7,350	21.5%
	South of Martins Road	65,400	58,200	18%	7,200	21.5%
	North of Martins Road	55,100	49,050	18%	6,050	21.5%
	South of Bolivar Road	52,500	46,750	18%	5,750	21.5%
	North of Bolivar Road	36,900	32,850	18%	4,050	21.5%
	South of Waterloo Corner	35,500	31,600	18%	3,900	21.5%
	North of Waterloo Corner	23,200	20,650	18%	2,550	21.5%
	South of Huxtable Road	22,200	19,750	18%	2,450	21.5%
Waterloo Corner	East of Port Wakefield Road	19,400	16,500	12.7%	2,900	13.4%
Heaslip Road	North of Waterloo Corner	20,200	17,200	12.7%	3,000	13.4%
	South of Huxtable Road	20,700	17,600	12.7%	3,100	13.4%
	North of Huxtable Road	21,000	17,850	12.7%	3,150	13.4%
Heaslip Road	South of Womma Road	21,700	18,450	12.7%	3,250	13.4%
	North of Womma Road	13,400	11,400	13.6%	2,000	17.5%
	South of Curtis Road	12,300	10,450	13.6%	1,850	17.5%
	South of Angle Vale Road	10,200	8,650	13.6%	1,550	17.5%
Angle Vale Road	West of Heaslip Road	4,400	3,900	16.6%	500	27.2%
	East of Heaslip Road	11,100	9,750	16.6%	1,350	27.2%
	West of Dalkeith Road	9,600	8,500	16.6%	1,100	27.2%
	East of Dalkeith Road	7,800	6,900	18.4%	900	28.8%
	West of Gawler Bypass	9,100	8,100	18.4%	1,000	28.8%
Gawler Bypass	North of Main North Road	17,100	15,450	11.9%	1,650	18%
	North of Jackson Cooper Drive	15,800	14,250	11.9%	1,550	18%
	North of Two Wells Road	21,500	19,400	11.9%	2,100	18%
Jackson Cooper Drive	East of Gawler Bypass	9,800	8,850	11.9%	950	18%
Two Wells Road	East of Gawler Bypass	6,900	6,250	11.9%	650	18%

Table C.5 Predicted traffic volumes for proposed roads in 2016

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	75,300	67,000	18%	8,300	21.5%
	South of Martins Road	74,500	66,300	18%	8,200	21.5%
	North of Martins Road	65,600	58,400	18%	7,200	21.5%
	South of Bolivar Road	63,000	56,100	18%	6,900	21.5%
	North of Bolivar Road	50,600	45,000	18%	5,600	21.5%
	South of Waterloo Corner	49,200	43,800	18%	5,400	21.5%
	North of Waterloo Corner	43,800	39,000	18%	4,800	21.5%
	South of Expressway	42,800	38,100	18%	4,700	21.5%
	North of Expressway	20,300	18,100	18%	2,200	21.5%
Northern Expressway	East of Port Wakefield Road	22,600	20,100	15.1%	2,500	14.5%
	East Heaslip Road	20,200	18,000	15.1%	2,200	14.5%
	North Curtis Road	18,500	16,450	15.1%	2,050	14.5%
	North Gawler Bypass	27,100	24,000	15.1%	3,100	14.5%
Heaslip Road turn-off lanes	North-west and south-west	4,200	3,750	15.1%	450	14.5%
	North-east and south-east	3,000	2,650	15.1%	350	14.5%
Curtis Road turn-off lanes		850	750	15.1%	100	14.5%
Waterloo Corner	East of Port Wakefield Road	12,300	10,450	12.7%	1,850	13.4%
Heaslip Road	North of Waterloo Corner	13,500	11,500	12.7%	2,000	13.4%
	South of Huxtable Road	14,000	11,900	12.7%	2,100	13.4%
	South of Expressway	14,900	13,250	12.7%	1,650	13.4%
	North of Expressway	7,800	6,950	12.7%	850	13.4%
Heaslip Road	South of Curtis Road	6,700	5,700	12.7%	1,000	13.4%
	North of Curtis Road	4,900	4,150	12.7%	750	13.4%
	South of Angle Vale Road	4,400	3,750	12.7%	650	13.4%
Angle Vale Road	West of Heaslip Road	3,400	2,900	16.6%	500	27.2%
	East of Heaslip Road	4,300	3,850	16.6%	450	27.2%
	West of Dalkeith Road	2,800	2,400	16.6%	400	27.2%
	East of Dalkeith Road	2,100	1,800	16.6%	300	27.2%
	West of Gawler Bypass	3,300	2,800	16.6%	500	27.2%
Gawler Bypass	North of Main North Road	6,700	5,700	11.9%	1,000	18%
	North of Jackson Cooper Drive	5,500	4,700	11.9%	800	18%
	South of Expressway	9,600	8,150	11.9%	1,450	18%
Jackson Cooper Drive	East of Gawler Bypass	4,200	3,600	11.9%	600	18%
Two Wells Road	East of Gawler Bypass	4,000	3,400	11.9%	600	18%

Table C.6 Predicted traffic volumes for proposed roads in 2026

Road name	Section	AADT	15 hour flow	15 hour % CVs	9 hour flow	9 hour % CVs
Port Wakefield	North of Salisbury Highway	75,300	67,100	18%	8,200	21.5%
	South of Martins Road	74,500	66,400	18%	8,100	21.5%
	North of Martins Road	76,000	67,750	18%	8,250	21.5%
	South of Bolivar Road	73,000	65,050	18%	7,950	21.5%
	North of Bolivar Road	61,700	55,000	18%	6,700	21.5%
	South of Waterloo Corner	60,500	53,900	18%	6,600	21.5%
	North of Waterloo Corner	62,000	55,250	18%	6,750	21.5%
	South of Expressway	60,900	54,300	18%	6,600	21.5%
	North of Expressway	23,300	20,800	18%	2,500	21.5%
Northern Expressway	East of Port Wakefield Road	37,600	33,450	15.1%	4,150	14.5%
	East Heaslip Road	32,500	28,900	15.1%	3,600	14.5%
	North Curtis Road	25,700	22,850	15.1%	2,850	14.5%
	North Gawler Bypass	34,300	30,500	15.1%	3,800	14.5%
Heaslip Road turn-off lanes	North-west and south-west	7,300	6,500	15.1%	800	14.5%
	North-east and south-east	3,700	3,300	15.1%	400	14.5%
Curtis Road turn-off lanes		2,600	2,300	15.1%	300	14.5%
Waterloo Corner	East of Port Wakefield Road	15,600	13,250	12.7%	2,350	13.4%
Heaslip Road	North of Waterloo Corner	15,600	13,250	12.7%	2,350	13.4%
	South of Huxtable Road	15,600	13,250	12.7%	2,350	13.4%
	South of Expressway	17,000	14,450	12.7%	2,550	13.4%
	North of Expressway	12,800	1,950	12.7%	10,850	13.4%
Heaslip Road	South of Curtis Road	10,500	8,900	12.7%	1,600	13.4%
	North of Curtis Road	7,000	5,950	12.7%	1,050	13.4%
	South of Angle Vale Road	7,000	5,950	12.7%	1,050	13.4%
Angle Vale Road	West of Heaslip Road	4,000	3,550	16.6%	450	27.2%
	East of Heaslip Road	4,000	3,550	16.6%	450	27.2%
	West of Dalkeith Road	4,000	3,550	16.6%	450	27.2%
	East of Dalkeith Road	4,000	3,550	16.6%	450	27.2%
	West of Gawler Bypass	4,000	3,550	16.6%	450	27.2%
Gawler Bypass	North of Main North Road	5,200	4,700	11.9%	500	18%
	North of Jackson Cooper Drive	6,500	5,850	11.9%	650	18%
	South of Expressway	8,500	7,650	11.9%	850	18%
Jackson Cooper Drive	East of Gawler Bypass	4,300	3,900	11.9%	400	18%
Two Wells Road	East of Gawler Bypass	4,750	4,300	11.9%	450	18%

Attachment D

Predicted traffic noise levels versus adopted criteria at identified receiver locations

Catchment A to G – Main North Road to Port Wakefield Road

Table D.1 Identified receivers above adopted day time noise criteria

Property no.	Catchment	Day time noise criteria	Predicted opening (2011) levels	2011 exceedence	Predicted future (2026) levels	2026 exceedence	Noise mitigation required
494	G	55	55		58	3	✓
592	G	55	53		56	1	✓
623	F	55	53		56	1	✓
625	G	55	53		56	1	✓
628	G	55	53		56	1	✓
631[1]	G	55	63	8	66	11	✓
632	G	55	60	5	63	8	✓
634[1]	G	55	59	4	62	7	✓
635[1]	G	55	61	6	64	9	✓
645	G	55	56	1	59	4	✓
1572	C	55	56	1	58	3	✓
1580	C	55	58	3	60	5	✓
1590	C	55	55		57	2	✓
1591[1]	C	55	67	12	69	14	✓
1610	D	55	57	2	59	4	✓
1611[1]	D	60	76	16	79	19	✓
1612[1]	D	55	77	22	79	24	✓
1613[1]	E	55	74	19	76	21	✓
1616	D	56	55		57	1	✓
1617	D	62	61		63	1	✓
1631	E	55	58	3	61	6	✓
1813	E	55	54		56	1	✓
1814	E	55	56	1	59	4	✓
1833	E	55	54		56	1	✓
1842	E	55	59	4	61	6	✓
1848	E	55	54		56	1	✓
1856[1]	E	55	60	5	62	7	✓
1863	F	55	53		58	3	✓
1864	F	55	53		57	2	✓
1865[1]	F	55	58	3	60	5	✓
1871 – 1[1]	E	55	58	3	60	5	✓
1871 – 2[1]	E	55	57	2	59	4	✓
1917	F	55	54		56	1	✓
1951	A	65	66	1	69	4	✓

Property no.	Catchment	Day time noise criteria	Predicted opening (2011) levels	2011 exceedence	Predicted future (2026) levels	2026 exceedence	Noise mitigation required
1963	A	65	66	1	69	4	✓
1967	A	55	53		56	1	✓
1968	A	56	54		57	1	✓
1969	A	56	55		57	1	✓
1970	A	57	55		58	1	✓
1971	A	58	56		59	1	✓
1972	A	59	57		60	1	✓
1973	A	62	60		63	1	✓
1974	A	65	65		68	3	✓
1977	A	56	54		57	1	✓
1978	A	55	53		56	1	✓
1979	A	55	53		56	1	✓
1980	A	56	54		57	1	✓
1981	A	58	56		59	1	✓
1995	A	57	55		58	1	✓
1996	A	56	54		57	1	✓
1997	A	57	55		58	1	✓
1998	A	56	55		57	1	✓
2060	A	55	53		56	1	✓
2068	A	55	54		56	1	✓
2069	A	56	54		57	1	✓
2070	A	57	55		58	1	✓
2071	A	59	57		60	1	✓
2074	A	65	65		68	3	✓
2076	A	60	58		61	1	✓
2077	A	65	64		67	2	✓
2078	A	57	55		58	1	✓
2082	A	55	53		56	1	✓
2126	B	55	55		57	2	✓
2126	B	55	60	5	62	7	✓
2129 – 1	B	55	57	2	59	4	✓
2129 – 2	B	55	55		56	1	✓
2135	B	55	54		56	1	✓
2136	B	55	61	6	62	7	✓
2138	C	55	54		56	1	✓
2139	C	55	54		56	1	✓
2192	B	55	54		56	1	✓

Property no.	Catchment	Day time noise criteria	Predicted opening (2011) levels	2011 exceedence	Predicted future (2026) levels	2026 exceedence	Noise mitigation required
2198	B	55	56	1	58	3	✓
4704	A	64	62		65	1	✓
4839	A	65	64		67	2	✓
4874	A	65	65		67	2	✓
4875	A	65	64		67	2	✓
4876	A	65	64		67	2	✓
4877	A	65	65		68	3	✓
4878	A	65	64		67	2	✓
4879	A	65	64		67	2	✓
4880	A	65	64		67	2	✓
4881	A	65	64		67	2	✓
4882	A	65	63		66	1	✓
4883	A	65	63		66	1	✓
4884	A	65	63		66	1	✓
4885	A	65	63		66	1	✓
4889	A	65	63		66	1	✓
4891	A	65	63		66	1	✓
4892	A	65	63		66	1	✓
4893	A	65	63		66	1	✓
4894	A	65	63		66	1	✓
4895	A	65	63		66	1	✓
4896	A	65	63		66	1	✓
4897	A	65	63		66	1	✓
4898	A	65	63		66	1	✓
4948	A	65	64		67	2	✓

Notes:

1. *Site is located within road corridor and will be aquired*
2. *Day time results are presented only due to day time noise levels along the Northern Expressway controlling exceedance of adopted noise criteria.*

Catchment H – Port Wakefield Road

Table D.2 Identified receivers above noise 2016 criteria

Property no.	Night time noise criteria	Predicted 2016 night time levels	Night time exceedence	Day time noise criteria	Predicted 2016 day time levels	Day time exceedence	Noise mitigation required
7	60	64	4	65	68	3	✓
9	60	60		63	64	1	✓
10	60	66	6	65	70	5	✓
55	60	62	2	65	e6	1	✓
57	60	62	2	65	66	1	✓
60	60	62	2	65	66	1	✓
61	60	61	1	65	65		✓
499	60	61	1	65	65		✓
502	54	54		57	58	1	✓
505	53	52		55	56	1	✓
508	60	61	1	64	65	1	✓
513	60	61	1	64	65	1	✓
516	56	55		58	59	1	✓
517	60	62	2	65	66	1	✓
522	60	65	5	65	69	4	✓
523	60	62	2	65	66	1	✓
545	55	54		57	58	1	✓
546	56	55		58	59	1	✓
571	53	53		56	57	1	✓
2207	60	64	4	65	68	3	✓
2208	60	64	4	65	67	2	✓
2209	60	62	2	65	66	1	✓
2210	60	62	2	65	66	1	✓
2211	60	61	1	65	65		✓
2212	60	62	2	65	66	1	✓
2215	60	63	3	65	67	2	✓
2344	60	64	4	65	68	3	✓
2451	60	62	2	65	66	1	✓
2465	60	62	2	65	66	1	✓
2466	60	62	2	64	65	1	✓
2467	60	62	2	65	66	1	✓
2468	60	62	2	65	66	1	✓
2469	60	63	3	65	66	1	✓
2470	60	62	2	65	66	1	✓

Property no.	Night time noise criteria	Predicted 2016 night time levels	Night time exceedence	Day time noise criteria	Predicted 2016 day time levels	Day time exceedence	Noise mitigation required
2471	60	63	3	65	66	1	✓
2472	60	62	2	65	66	1	✓
2473	60	62	2	65	66	1	✓
2474	60	63	3	65	66	1	✓
2475	60	62	2	65	66	1	✓
2476	60	62	2	65	66	1	✓
2527	60	62	2	65	66	1	✓
2528	60	62	2	65	66	1	✓
2529	60	62	2	65	66	1	✓
2530	60	62	2	65	66	1	✓
2531	60	62	2	65	66	1	✓
2532	60	62	2	65	66	1	✓
2533	60	62	2	65	66	1	✓
2534	60	62	2	65	66	1	✓
2535	60	62	2	65	66	1	✓
2536	60	62	2	65	66	1	✓
2537	60	62	2	65	66	1	✓
2538	60	62	2	65	66	1	✓
2539	60	62	2	65	66	1	✓
2540	60	62	2	65	66	1	✓
2541	60	62	2	64	65	1	✓
2542	60	62	2	65	66	1	✓
2544	60	62	2	65	66	1	✓
2545	60	62	2	65	66	1	✓
2546	60	63	3	65	66	1	✓
2547	60	62	2	65	66	1	✓
2548	60	62	2	65	66	1	✓
2549	60	62	2	65	66	1	✓
2835	60	63	3	65	67	2	✓
3063	60	62	2	65	66	1	✓
3064	60	62	2	65	66	1	✓
3065	60	62	2	65	66	1	✓
3066	60	62	2	65	66	1	✓
3066	60	63	3	65	67	2	✓
3067	60	62	2	65	66	1	✓
3067	60	63	3	65	67	2	✓
3068	60	62	2	65	66	1	✓

Property no.	Night time noise criteria	Predicted 2016 night time levels	Night time exceedence	Day time noise criteria	Predicted 2016 day time levels	Day time exceedence	Noise mitigation required
3068	60	63	3	65	67	2	✓
3069	60	61	1	64	65	1	✓
3070	60	60		63	64	1	✓
3071	60	60		63	64	1	✓
3237	60	61	1	64	65	1	✓
3238	60	61	1	64	65	1	✓
3239	60	61	1	64	64		✓
3257	60	61	1	64	65	1	✓
3258	60	61	1	64	65	1	✓
3259	60	61	1	64	65	1	✓
3260	60	61	1	64	65	1	✓
3261	60	61	1	64	65	1	✓
3262	60	61	1	64	65	1	✓
3263	60	61	1	64	65	1	✓
3264	60	61	1	64	65	1	✓
3336	60	60		63	64	1	✓
3461	60	61	1	64	65	1	✓
3476	60	61	1	64	65	1	✓
3478	60	60		63	64	1	✓
3479	60	60		63	64	1	✓
3480	60	60		63	64	1	✓
3481	60	61	1	63	64	1	✓
3569	60	64	4	65	68	3	✓
3570	60	64	4	65	68	3	✓
3589	60	64	4	65	68	3	✓
3590	60	64	4	65	68	3	✓
3591	60	64	4	65	68	3	✓
3592	60	64	4	65	68	3	✓
3594	60	64	4	65	67	2	✓
3595	60	64	4	65	68	3	✓
3968	60	63	3	65	67	2	✓
3969	60	63	3	65	66	1	✓
3970	60	62	2	65	66	1	✓
3971	60	62	2	65	66	1	✓
3977	60	61	1	65	65		✓
3978	60	62	2	65	66	1	✓
3980	60	64	4	65	68	3	✓

Property no.	Night time noise criteria	Predicted 2016 night time levels	Night time exceedence	Day time noise criteria	Predicted 2016 day time levels	Day time exceedence	Noise mitigation required
3986 – 1	60	63	3	65	67	2	✓
3986 – 2	60	63	3	65	67	2	✓
3996	60	63	3	65	67	2	✓
3999 – Caravan 01	60	61	1	65	65		✓
3999 – Caravan 05	60	62	2	65	66	1	✓
3999 – Caravan 06	60	62	2	65	66	1	✓
3999 – Caravan 07	60	62	2	65	66	1	✓
3999 – Caravan 11	60	61	1	65	65		✓
3999 – Caravan 12	60	61	1	65	65		✓
3999 – Caravan 13	60	61	1	65	65		✓
3999 – Caravan 14	60	61	1	65	65		✓
3999 – Caravan 15	60	61	1	65	65		✓
4008	60	62	2	65	66	1	✓
4019	60	64	4	65	68	3	✓
4028	60	61	1	65	65		✓
4029	60	64	4	65	68	3	✓
4052	59	58		61	62	1	✓
4054	60	65	5	65	69	4	✓
4055	60	65	5	65	69	4	✓
4059	60	68	8	65	72	7	✓
4060	60	62	2	65	66	1	✓
4061	60	62	2	65	66	1	✓
4126	56	55		58	59	1	✓
4128	60	66	6	65	70	5	✓
4129	60	65	5	65	69	4	✓
4130	60	65	5	65	69	4	✓
4131	55	54		57	58	1	✓
4152	60	68	8	65	72	7	✓

Notes:

1. *Day time and night time results are presented for Port Wakefield Road and some sites are predicted to exceed either day time or night time criteria only.*