APPENDIX I

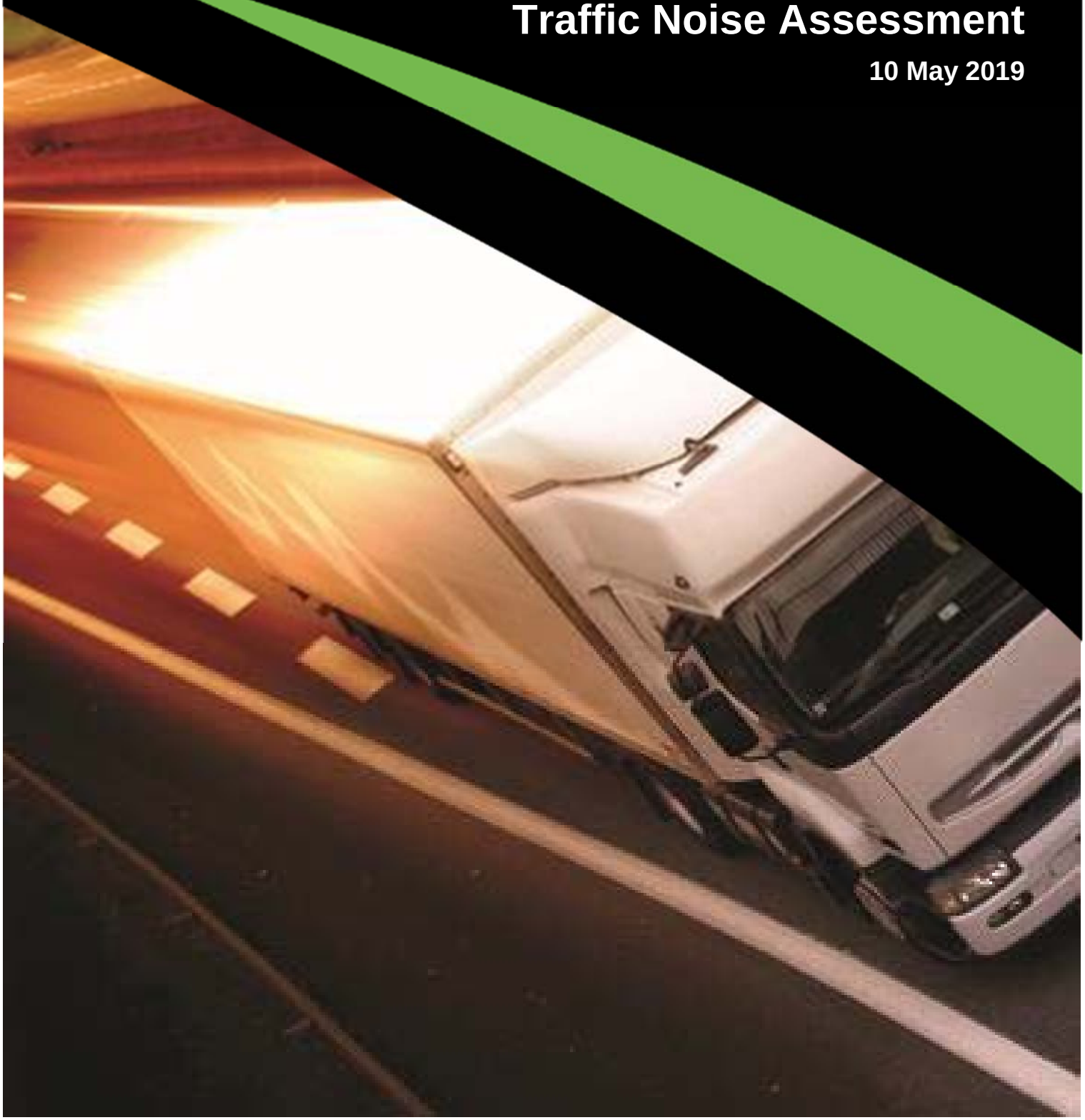
BORR Northern and Central Sections Traffic Noise Assessment (BORR IPT 2019d) - Part 1 (part 1 of 2)

BORR Team

Bunbury Outer Ring Road
Northern and Central Sections

Traffic Noise Assessment

10 May 2019



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Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	29/01/2019	Draft for Main Roads review	BORR Team	CG	PM
B	28/02/2019	Draft for Main Roads review	BORR Team	CG	PM
C	2/04/2019	Draft for Main Roads review	BORR Team	CG	PM
D	10/5/2019	Draft for Main Roads review	BORR Team	CM	PM

ABBREVIATIONS

Term	Definition
BORR	Bunbury Outer Ring Road
BoM	Bureau of Meteorology
CoRTN	United Kingdom Department of Transport, Calculation of Road Traffic Noise (Algorithm)
CS	Chip seal
DA	Development Application
DGA	Dense grade asphalt
GBRS	Greater Bunbury Regional Scheme
HV	Heavy vehicle
LV	Light vehicle
PSP	Principle shared path
SPP 5.4	*State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning*
SWTC	Scope of Works and Technical Criteria

Note: Refer to Appendix B for an explanation of the noise terminology used throughout this report.

1 INTRODUCTION

1.1 General

The Commissioner of Main Roads Western Australia (Main Roads) is proposing to construct and operate the Northern and Central sections of the Bunbury Outer Ring Road (BORR) project (Figure 1, Appendix A). The BORR is a planned Controlled Access Highway linking the Forrest Highway and Bussell Highway, and will provide a high standard route for access to the Bunbury Port. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic and freight, reducing traffic on the local road network, and facilitate proposed development to the east of the city of Bunbury.

BORR forms a major component of the planned regional road network for the Greater Bunbury area.

The proposed BORR comprises three sections:

- 'BORR Northern Section' – Forrest Highway to Boyanup-Picton Road
- 'BORR Central Section' – Boyanup-Picton Road to South Western Highway (south), an existing 4 km section which was completed in May 2013, along with a 3 km extension of Willinge Drive southwards to South Western Highway
- 'BORR Southern Section' – South Western Highway (near Bunbury Airport) to Bussell Highway.

This document refers to BORR Northern and Central sections only.

The Central Section has been previously constructed however further improvements are proposed for this section, including the extension of Willinge Drive southwards to South Western Highway.

The alignment of the BORR Southern Section is currently being reviewed. As the final alignment of BORR South section is currently unknown, Main Roads have excluded this section from the Proposal so that this process does not hold up BORR North and Central sections construction timeframes.

1.2 Project description

The Proposal is located within the City of Bunbury and Shires of Capel, Dardanup and Harvey, and at its closest point is approximately 6 km south-east of Bunbury and 200 km south of Perth.

The Proposal includes construction and operation of BORR North and Central sections. These sections comprise 19 km of new dual carriageway and associated bridges, interchanges and other road infrastructure including, but not limited to, culverts, lighting, noise barriers, fencing, landscaping, road safety barriers and signs. The components of the Proposal are described below.

The area being referred by Main Roads is up to 651 hectares (ha), which includes existing road reserves, agricultural land and native vegetation. This area is referred to as the Proposal area. The Proposal area excludes areas within BORR Central Section which was constructed in 2013. The Proposal area is illustrated in Figure 1 (Appendix A).

The Project will include the following components:

- 19 km of new rural freeway standard, dual carriageway
- A grade separated interchange at the intersection of Forrest Highway, BORR, Paris Road and Clifton Road (partial connection)
- A grade separated interchange at Raymond Road (partial connection)

- New bridge over the Collie River
- A grade separated interchange at South Western Highway (North) (partial connection)
- New bridge over the Perth Bunbury rail line and Railway Road (servicing PTA and ARC)
- New grade separated interchange at Wireless Road
- New bridge over Golding Crescent, Ferguson River, Boyanup Railway and Boyanup-Picton Road
- New grade separated interchange at Willinge Drive
- New bridge over South Western Highway (South) near Davenport
- Extension of Willinge Drive south to intersect with South West Highway
- Principal shared path (PSP) for the full length of BORR Northern and Central sections
- Drainage basins, drains and other associated infrastructure
- Local road modifications
- Utility modifications
- Other road infrastructure and furniture, including but not limited to culverts, lighting, noise barriers, fencing, landscaping, road safety barriers and signs.

1.3 Project Justification

The existing north-south route of Forrest Highway, Robertson Drive and Bussell Highway runs through a highly populated area of the Greater Bunbury area resulting in increased congestion, inefficient freight operations, significant road safety issues, reduced social amenity and community separation. The future planning for the Greater Bunbury Area projects a population growth from approximately 86,400 persons in 2011 to approximately 122,400 persons by 2026 (WAPC, 2018). This, in conjunction with increased freight and tourist movements to the South West, will lead to unsustainable traffic growth within the existing north-south route corridor resulting in further congestion and reduced amenity.

Main Roads proposes to complete the BORR on which initial construction was completed in 2012. The ultimate BORR will extend from Forrest Highway in the north to Bussell Highway in the south.

1.4 Report Purpose

The purpose of the study was to support the Environmental Referral, by conducting a traffic noise assessment based upon the Ultimate Design concept to identify sensitive receptors which will require some form of mitigation treatment to satisfy the noise criteria prescribed within SPP 5.4.

1.5 Scope of Work

The road traffic noise assessment scope of work is as follows:

- Development of a road traffic noise model based on existing (2018) traffic flows on surrounding roads and predicted future (2041) traffic flows on the BORR Project and existing roads.
- Validation of noise model by comparing forecast 2018 noise levels to noise measurements of existing roads.
- Assessment of future (2041) predicted noise levels in order to identify sensitive receptors which will require some form of mitigation treatment to satisfy the noise criteria prescribed within SPP 5.4.
- A comprehensive report on the noise model and results.

1.6 Approach

The road traffic noise assessment was completed as follows:

- Identification of sensitive receptors and selection of locations for unattended noise monitoring at existing roads in proximity to sensitive receptors and the current BORR alignment.
- Unattended monitoring was undertaken for one week at each site. Noise monitoring was used to provide existing noise measurements and to validate the noise model.
- Develop a validated road traffic noise model to assess noise impacts from the potential increase in traffic movements associated with the project.
- Use validated noise model to quantify noise impact and determine if measures are required to mitigate noise to sensitive receptors such that criteria established by the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (SPP 5.4) are met.

1.7 Limitations

This report may only be used and relied on for the purpose set out in Sections 1.4 and 1.5 of this report. The services undertaken in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. There is no responsibility nor obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions described in this report. Liability arising from any of the assumptions being incorrect is disclaimed.

This report has been prepared on the basis of information provided by others, which has not independently verified or checked beyond the agreed scope of work.

The opinions, conclusions and any recommendations in this report are also based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points. Site conditions may change after the date of this Report. There will be no acceptance of responsibility arising from, or in connection with, any change to the site conditions. There is no responsibility for updating this report if the site conditions change.

Responsibility to third parties arising in connection with this report or any implied warranties and conditions is disclaimed, to the extent legally permissible.

2 NOISE CRITERIA

2.1 Road Traffic Noise

State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP 5.4)[1] outlines the most relevant criteria for transportation noise. SPP 5.4 has been adopted by the Western Australian Planning Commission as a whole of Government approach to managing noise from transportation sources.

Table 2-1 outlines outdoor noise criteria applying to proposals for new noise-sensitive developments or new major roads and railways assessed under SPP 5.4.

Table 2-1 Outdoor noise criteria

Time period	Noise target[2]	Noise limit[3]
Day (16 hour) **6:00 am to 10:00 pm**	L_{Aeq} 55 dB	L_{Aeq} 60 dB
Night (8 hour) **10:00 pm to 6:00 am**	L_{Aeq} 50 dB	L_{Aeq} 55 dB

As this Project involves both upgrades to an existing major road and a new road, the following SPP 5.4 policy measures apply:

- Screening traffic noise assessment and, if necessary, a detailed assessment in accordance with the guidelines.
- Practicable noise management and mitigation measures should be considered in accordance with sections 5.6 and 5.8 of the policy, having regard to:
  - The existing transport noise levels
  - The likely changes in noise emissions resulting from the proposal
  - The nature and scale of works and the potential for noise emissions
- The proponent should prepare a noise management plan for the redevelopment works in accordance with the guidelines, and in consultation with the state environmental agency and local government.

Section 5.6 of the SPP 5.4 policy refers to possible noise management and mitigation measures such as using separation distances, noise attenuation barriers and building design.

Section 5.8 of the SPP 5.4 policy refers to reasonable and practicable measures, recognising that it may sometimes not be reasonable and practical to meet noise target criteria. Measures are expected to be

[1] Department of Planning, Lands and Heritage (2009) *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning*
[2] The *Draft State Planning Policy 5.4 Road and Rail Noise* (draft SPP 5.4) (September 2017) proposes that the noise target applies for all new roads.
[3] Draft SPP 5.4 proposes that the noise limit applies for all road upgrades. Further it is noted that *'The 5 dB difference in the criteria between new and upgrade infrastructure proposals acknowledges the challenges in achieving noise level reduction where existing infrastructure is surrounded by existing noise-sensitive development.'*

implemented to balance reasonable and practical considerations including noise benefit, cost, feasibility, community preferences, amenity impacts, safety, security and conflict with other planning and transport policies.

3 NOISE MONITORING

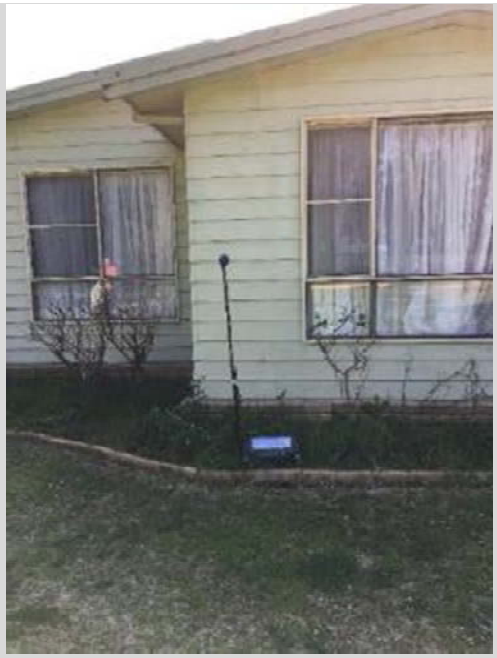
3.1 Noise Monitoring Locations

Noise monitoring was used to measure existing noise levels experienced by receptors located within the project area. Unattended noise monitoring was undertaken at five sites within the vicinity of the proposed alignment of BORR Northern and Central sections for the purpose of validating noise predictions made using the model.

Monitoring locations were chosen so as to be located on existing road sections which are forecast to contribute to combined noise levels at the properties most affected by BORR Northern and Central sections. The monitoring locations were also identified as being safe and secure for unattended equipment, minimising the risk of theft or vandalism.

A summary of relevant information such as site coordinates, distance to the nearest road and a photo of noise logger setup is provided in Table 3-1. Noise monitoring site summaries for each site are provided in Appendix C. The five monitoring locations are shown in Figure 3-1.

Table 3-1 Noise monitoring location summary

Site ID	Address	Road	PCG94 Easting (m)	PCG94 Northing (m)	Distance of logger to road (m)	Noise logger setup
A	662 Clifton Road, Brunswick	Clifton Road (2840 VPD)	46060	117874	50	

Site ID	Address	Road	PCG94 Easting (m)	PCG94 Northing (m)	Distance of logger to road (m)	Noise logger setup
B	15 Bevan Loop, Roelands	Raymond Road (3800 VPD)	44606	115041	150	

Site ID	Address	Road	PCG94 Easting (m)	PCG94 Northing (m)	Distance of logger to road (m)	Noise logger setup
C	14411 South Western Highway, Waterloo	South Western Highway (North) (6512 VPD)	44468	110634	15	

Site ID	Address	Road	PCG94 Easting (m)	PCG94 Northing (m)	Distance of logger to road (m)	Noise logger setup
D	105 Martin-Pelusey Road, Waterloo	Martin-Pelusey Road (3120 VPD)	42384	108581	20	

Site ID	Address	Road	PCG94 Easting (m)	PCG94 Northing (m)	Distance of logger to road (m)	Noise logger setup
E	365 Harris Rd, Paradise	Harris Road (288 VPD)	42657	107493	30	

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 Perth Coastal Grid 1994

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Main Roads Western Australia
Bunbury Outer Ring Road IPS

Project No. **61-37041**
Revision No. **A**
Date **06/05/2019**

Noise monitoring locations

FIGURE 3-1

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Print date: 06 May 2019 - 10:32

Data source: BORR Team: Noise monitoring locations, Modelled roads - 20190307; Landgate: WA Now Aerial Imagery - accessed 20190506. Created by: mmikkonen

3.2 Unattended Noise Monitoring Methodology

Unattended noise logging for Sites A, B, D and E was conducted from 10 to 26 September 2018 and logging at Site C was conducted from 13 to 20 December 2018.

It is noted that whilst the logging at Site C was undertaken during the school holiday period, the traffic on South West Highway is not forecast to be significantly different from normal work days. This is borne out by results from the permanent traffic count stations on Forest Highway, Bussell Highway and Coalfields Highway. With the later, some 6.5 km from the logger site, showing that in general school holiday periods have a similar volume profile by day of the week and hour of the day to that of normal days.

During the measurement campaign, Site A experienced an equipment failure and only recorded three days of measurements, of which only one day and two nights were valid due to meteorological conditions. Given the low sensitivity of the model to noise emission from this road for overall predictions at sensitive receptors, this data is considered to be adequate for validation purposes. Site B was also subject to non-ideal meteorological conditions during this time period, however due to the longer duration of the measurement, three valid weekday periods were able to be obtained.

The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15-minutes for the entire monitoring period Table 3-2 provides details of the noise logger and which site the loggers were used.

Table 3-2 Noise monitoring equipment summary

Specification	Type	Sites
Model	SVAN 955 Rion NL18	A, B, D, E C
Serial number	27621 27625 0099828	B, E A, D C
Type	Type 1	A – E
Time interval	15-minutes	A – E
Frequency weighting	A weighted	A – E

Prior to deployment and at monitoring completion, the loggers were calibrated with a sound pressure level of 94 dB at 1 kHz using a Larson Davis CAL200 sound level calibrator. The data collected by the loggers was downloaded and analysed and any invalid data removed.

All noise sampling activities were undertaken with consideration to the specifications outlined in *AS2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*.

3.3 Noise Monitoring Results

Sampled noise levels for the monitoring period are provided in graphically in Appendix D along with the corresponding meteorological conditions during the monitoring period at each site, including precipitation and wind speed and direction for each site. Sample periods of rainfall of > 0.2 mm and/or wind speed > 19 km/h at the noise logger have been highlighted for consideration for exclusion in Appendix D, as per procedures specified by MRWA *Appendix 23 – Traffic Noise Measurement Specification*. These data points

have generally been excluded from the L_{Aeq} calculation, except for Site C (which was determined to have little impact from wind speeds by considering data with lower wind speeds, and the close proximity of the logger to the road).

Daily noise monitoring results for each site are shown in Table 3-4, with entries significantly affected by meteorological conditions removed. The overall weekday and weekend-inclusive noise levels at each site are presented in Table 3-3.

The attended noise monitoring results are considered to be acceptable for noise model validation (refer to Section 4.3), with the exception of Site E. The CoRTN algorithms are only applicable where traffic volumes are greater than 1000 vehicles per day. Site E does not meet this requirement (288 VPD) and therefore has not been used for the purpose of model validation.

Table 3-3 Overall traffic noise facade levels measured at each site

	$L_{Aeq, day\ (16\ hour)}$ (dBA) (6:00 am to 10:00 pm)		$L_{Aeq, night\ (8\ hour)}$ (dBA) (10:00 pm to 6:00 am)	
Site ID	**Weekday**	**Weekly**	**Weekday**	**Weekly**
A	54.3	54.3	46.5	46.5
B	51.1	54.5	43.1	43.4
C	71.1	70.7	66.6	66.6
D	60.2	59.4	51.0	50.2
E	51.8	50.7	44.5	45.2

Table 3-4 Noise logging results for all sites – Weekday average

	$L_{Aeq\ (day)\ (16\ hour)}$ (dBA) (6:00 am to 10:00 pm)		$L_{Aeq\ (night)\ (8\ hour)}$ (dBA) (10:00 pm to 6:00 am)	
1st monitoring period	**A**	**B**	**A**	**B**
Monday, 10 Sept 2018	54.0	-	43.8	42.9
Tuesday, 11 Sept 2018	55.2	51.5	48.1	42.4
Wednesday, 12 Sept 2018	53.5	51.0	-	44.3
Thursday, 13 Sept 2018	-	50.8	-	42.9
Friday, 14 Sept 2018	-	-	-	42.5
Saturday, 15 Sept 2018	-	59.8	-	44.2
Sunday, 16 Sept 2018	-	48.6	-	43.9
Monday, 17 Sept 2018	-	-	-	-

2nd monitoring period	D	E	D	E
Monday, 17 Sept 2018	-	-	-	40.0
Tuesday, 18 Sept 2018	-	52.4	-	44.6
Wednesday, 19 Sept 2018	60.7	54.2	50.9	44.7
Thursday, 20 Sept 2018	61.4	49.5	51.9	46.4
Friday, 21 Sept 2018	59.9	48.5	51.6	44.8
Saturday, 22 Sept 2018	58.2	48.3	48.8	46.5
Sunday, 23 Sept 2018	55.9	45.8	47.3	46.6
Monday, 24 Sept 2018	58.3	-	48.8	-
3rd monitoring period	C		C	
Thursday, 14 Dec 2018	-		-	
Friday, 15 Dec 2018	71.3		66.9	
Saturday, 16 Dec 2018	69.6		64.0	
Sunday, 17 Dec 2018	68.3		63.2	
Monday, 18 Dec 2018	71.1		66.8	
Tuesday, 19 Dec 2018	71.2		67.0	
Wednesday, 20 Dec 2018	71.3		-	

4 NOISE MODELLING

4.1 Noise Model

Noise modelling was undertaken using CadnaA 2019. CadnaA is a computer program for the calculation, assessment and prognosis of noise exposure. Environmental noise propagation in CadnaA was calculated using the CoRTN algorithm with the -1.7 dB adjustment for Australian roads as recommended in the SPP 5.4 guideline.

Noise modelling assumptions and model configurations to reflect the design and site specific conditions are presented in Table 4-1.

Table 4-1 Noise modelling assumptions and configurations

Inputs/Assumptions	Data Incorporated into Noise Model
Noise model	CadnaA 2019
Prediction algorithm	United Kingdom Department of Transport, Calculation of Road Traffic Noise (CoRTN)
Heavy vehicle %	Day and night heavy vehicle (HV) percentages assumed to be the same as current measured traffic data.
Existing traffic speeds, volumes and road surfaces	As shown in Table 4-3
Future traffic speeds, volumes and road surfaces	Speeds for future design year as provided by the design team, refer to Table 4-4
Low traffic flow correction	Enabled
Road gradient	Taken into account based upon the concept Ultimate Road Design.
Terrain resolution	5 m ground contours with spot heights for earthworks, triangular grid.
Buildings	Buildings modelled at 4.5 m height, digitised from aerial imagery
Façade noise maps	1.4 m receiver height (ground floor), 1 m from building façade
Road surface adjustments	Existing (2018): • 10 mm chip seal: +2.5 dB • 14 mm chip seal: +3.5 dB Future (2041 Build): • Interchange (on/off ramps and connecting roads – up to 100 m on approach) and Raymond Rd (west of BORR): DGA: + 0 dB • All other areas of BORR: 14 mm chip seal: +3.5 dB • Minor rural roads: 10 mm chip seal: +2.5 dB
Façade correction	+2.5 dB to account for noise reflected from the façade
CoRTN conversion factor	3 dB

Inputs/Assumptions	Data Incorporated into Noise Model
L_{A10} - L_{Aeq}	
CoRTN factor	-1.7 dB (adapted to Australian conditions through research undertaken by the Australian Road Research Board)
Source height	Light vehicles 0.5 m Heavy vehicles – Engine at 1.5 m (-0.8 dB), exhaust at 3.6 m (-8 dB)
Receiver heights	1.4 m above ground level
Ground absorption	Roads are reflecting (G=0), all other areas outside road reserve, G=0.7
Fences and existing noise walls	Significant fences and noise walls have been included in the model

4.2 Traffic Data

Short-Term Traffic Counts

Short-term traffic counts located at 31 major roads were provided by Main Roads, which was used for verification of the existing (2018) modelling scenario. The traffic survey was undertaken in between 2015 to 2018 and used to extract total traffic counts during the day (6:00 am to 10:00 pm) and night (10:00 pm to 6:00 am).

Traffic count data from four permanent sites was also provided by Main Roads. The permanent count sites were not used to verify the noise model, as the count sites were not located within the noise model domain. However, as the traffic data was conducted over a longer period (1 December 2015 to 1 June 2018), permanent traffic counts were used to analyse trends in traffic counts.

The locations of the short-term traffic counters are described in Table 4-2, and are shown in Figure 4-2.

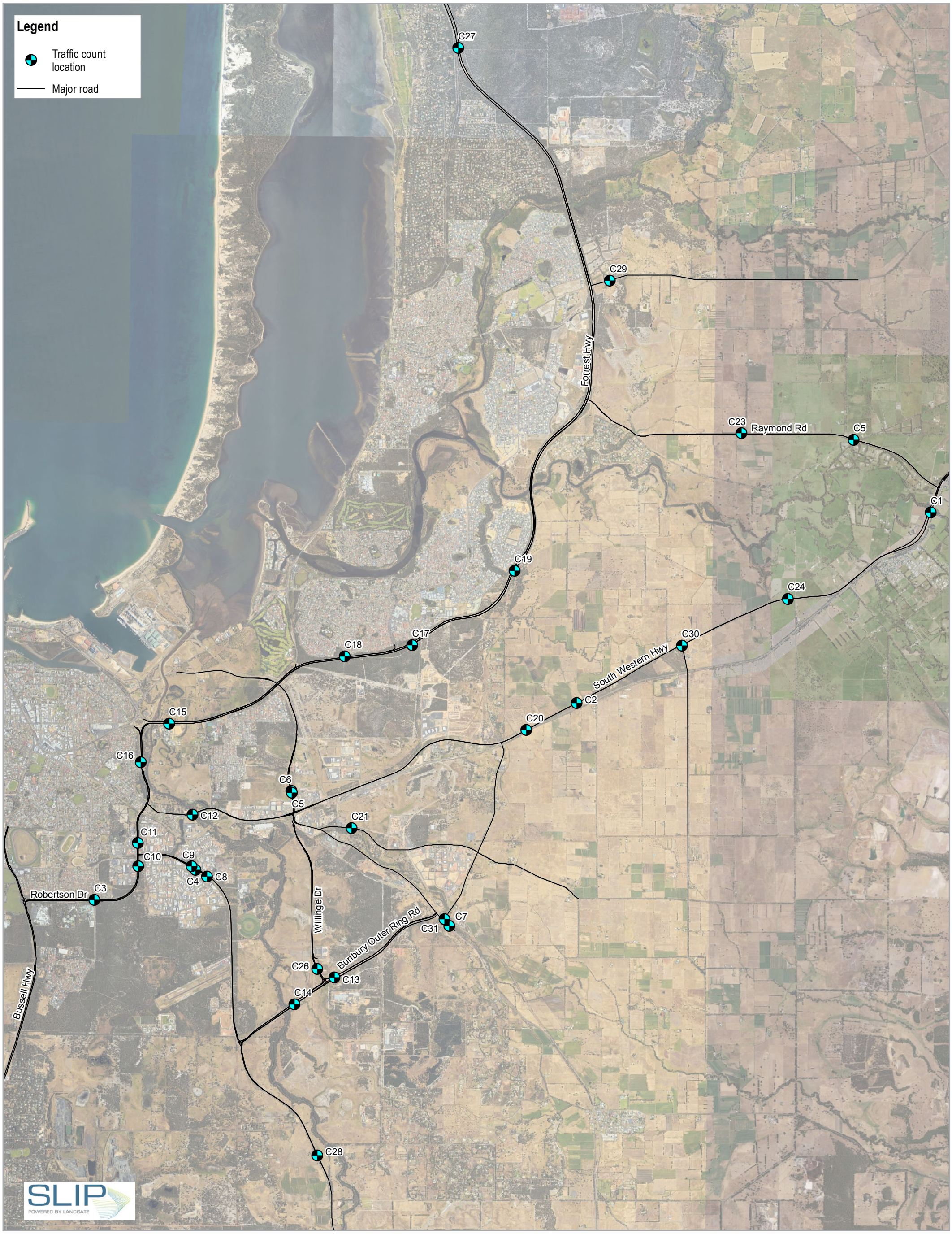
The Bunbury Outer Ring Road Integrated Project Team provided the existing and design traffic volumes for the noise model. The existing volumes were based on the short term count data available and the 2041 volumes were based on the 2041 land use scenario.

In order to provide the 16-hour day volume and the 8-hour night volume, existing traffic flow profiles and heavy vehicle percentages were applied to the 2041 forecast volumes. For further information on the existing traffic, reference can be made to the Existing Traffic Data Report (BORR-00-RP-NO-0003_Rev C).

Table 4-2 Main Roads traffic count sites and description

Count ID number	Location description
C1	South Western Hwy, south of Coalfields Road
C2	South Western Hwy, west of Wireless Road
C3	Robertson Drive
C4	South Western Hwy, east of Dodson Road
C5	Raymond Road
C6	Willinge Drive

Count ID number	Location description
C7	Boyanup-Picton Road
C8	South Western Hwy, east of Dodson Rd
C9	South Western Hwy, west of Dodson Rd
C10	Bussell Hwy, south of South Western Hwy
C11	South Western Hwy, north of Brittain Rd
C12	South Western Hwy, east of Dodson Road
C13	BORR, east of Willinge Drive
C14	BORR, west of Willinge Drive
C15	Eelup Rotary, eastern leg
C16	Eelup Rotary, southern leg
C17	Forrest Hwy, between Eaton Drive and Hynes Road
C18	Forrest Hwy, between Eaton Drive and Old Coast Road
C19	Forrest Hwy, between Raymond Road and Hynes Road
C20	South Western Hwy, approximately 200 m East of Hynes Rd
C21	Harris Road, between Boyanup-Picton Road and Golding Cres
C23	Raymond Rd, between Balaclava Road and Inkerman Road
C24	South Western Hwy , between Henty Brook Road and Waterloo Road
C25	South Western Hwy, north of Kelly Road (Coalfields Road)
C26	Willinge Drive, north of BORR
C27	Forrest Highway, north of Old Coast Road
C28	South Western Hwy at north Boyanup Road
C29	Clifton Road
C30	Waterloo Road, south of South Western Hwy
C31	Martin-Pelusey Road, north of Boyannup Picton Rd



Paper Size ISO A3

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 Perth Coastal Grid 1994

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Bunbury Outer Ring Road IPS

Traffic count locations - Short term

Project No. **61-37041**
Revision No. **A**
Date **13/05/2019**

FIGURE 4-1

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Print date: 15 May 2019 - 09:56

Data source: BORR Team: Traffic count locations - 20190513; Landgate: WA Now Aerial Imagery - accessed 20190513, Main roads - 2018. Created by: mmikkonen

Traffic Volume for 2018 Existing and 2041 Build scenarios

Traffic volume data was extracted for both total daily average (6:00 am to 10:00 pm) and total night average (10:00 pm to 6:00 am). This was then calculated as an hourly average for use with the CoRTN algorithm.

Table 4-3 provides traffic data used for the 2018 model, and Table 4-4 provides traffic data used for the 2041 model. Figure 4-2 and Figure 4-3 show the locations of the roads.

A road surface correction (inclusive of the -1.7 dB factor for Australian roads) of 1.8 dB corresponds to 14 mm chip seal, 0.8 dB to 10 mm chip seal and -1.7 dB to dense graded asphalt.

Table 4-3 Average weekday traffic data for 2018 existing scenario

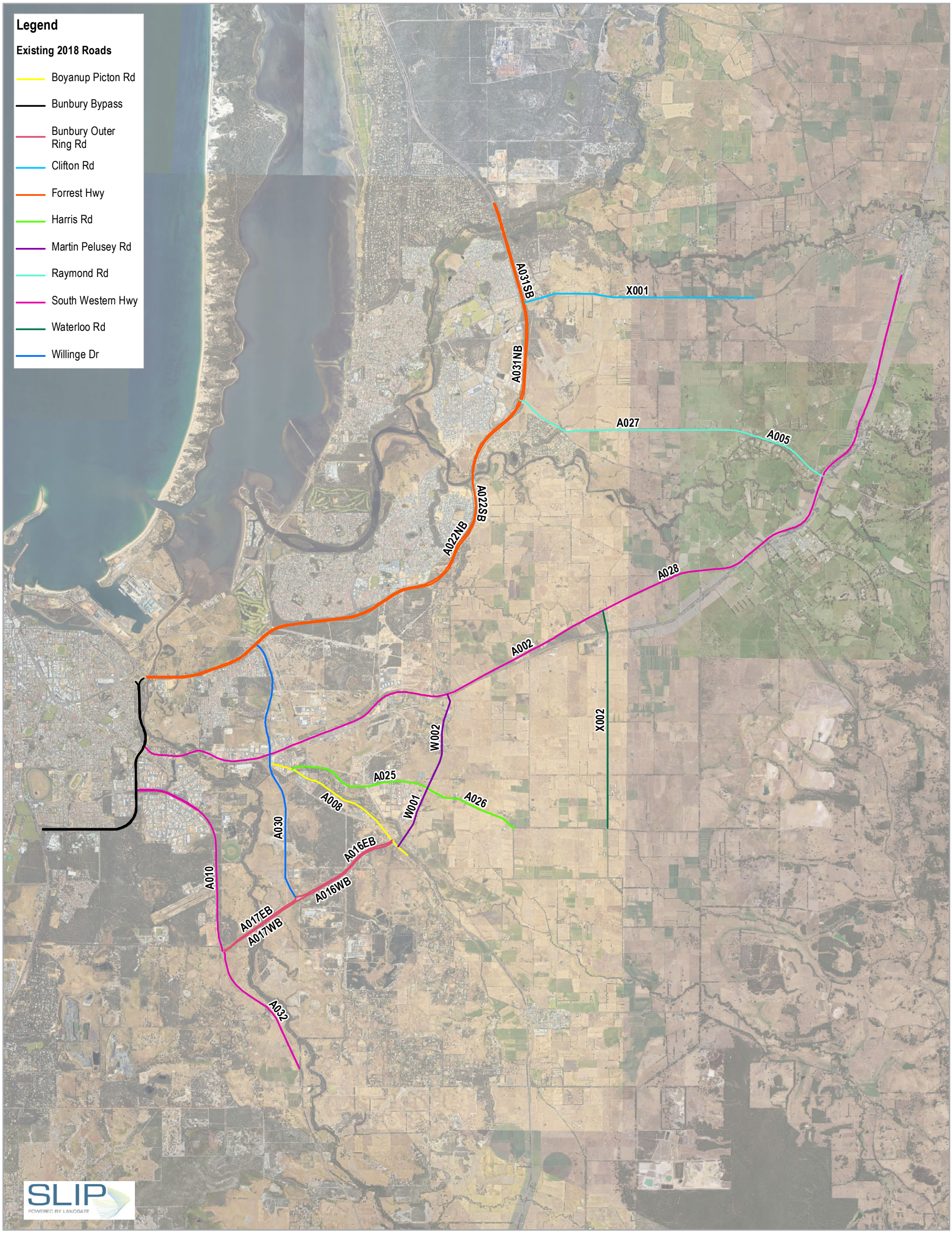
Road ID	Road name	VPH (day)	VPH (night)	%HV (day)	%HV (night)	Speed limit	Road surface
A002	South Western Hwy - Hynes Rd & Waterloo Rd	367	80	20	17	100	1.8
A005	Raymond Rd - East of Alma Rd	210	49	10	12	100	1.8
A008	Boyanup Picton Rd	258	24	16	16	90	1.8
A010	South Western Hwy - N of Bunbury Outer Ring Rd	521	101	15	30	80	1.8
A016EB	Bunbury Outer Ring Rd - E of Willinge Dr EB	92	27	23	15	100	1.8
A016WB	Bunbury Outer Ring Rd - E of Willinge Dr WB	87	15	17	35	100	1.8
A017EB	Bunbury Outer Ring Rd - W of Willinge Dr EB	129	35	25	13	100	1.8
A017WB	Bunbury Outer Ring Rd - W of Willinge Dr WB	104	17	29	50	100	1.8
A022NB	Forrest Hwy - Raymond Rd & Hynes Rd NB	545	97	12	19	100	1.8
A022SB	Forrest Hwy - Raymond Rd & Hynes Rd SB	568	74	14	20	100	1.8
A025	Harris Rd - W of Martin Pelusey Rd	80	19	30	19	80	0.8
A026	Harris Rd - E of Martin Pelusey Rd	13	10	11	6	80	0.8
A027	Raymond Rd - W of Alma Rd	209	57	11	13	80	1.8
A028	South Western Hwy - Henty Brook Rd & Waterloo Rd	399	86	18	12	100	1.8
A030	Willinge Dr - S of South Western Hwy	141	30	31	39	90	1.8
A031NB	Forrest Hwy - N of Raymonds Rd NB	575	111	13	24	110	1.8
A031SB	Forrest Hwy - N of Raymonds Rd SB	630	75	14	25	110	1.8
A032	South Western Hwy - S of Bunbury Outer Ring Rd	404	50	15	30	110	1.8
X001	Clifton Rd	166	23	5	3	100	0.8
X002	Waterloo Rd - S of South Western Hwy	52	6	36	53	100	0.8
W001	Martin Pelusey Rd - N of Boyannup Picton Rd	178	34	20	20	80	0.8
W002	Martin Pelusey Rd - S of South Western Hwy	178	34	20	20	80	0.8

Table 4-4 Average weekday traffic data for 2041 build scenario

Road ID	Road name	VPH (day)	VPH (night)	%HV (day)	%HV (night)	Speed limit	Road surface
A002	South Western Hwy - Hynes Rd & Waterloo Rd	513	111	20	17	80	1.8
A005	Raymond Rd - East of BORR	125	29	10	12	80	1.8
A008	Boyanup Picton Rd	64	6	16	16	90	1.8
A010	South Western Hwy - N of Bunbury Outer Ring Rd	168	20	15	30	80	1.8
A016EB	Bunbury Outer Ring Rd - E of Willinge Dr EB - Mod.	807	156	15	24	100	1.8
A016WB	Bunbury Outer Ring Rd - E of Willinge Dr WB - Mod.	834	99	15	25	100	1.8
A017EB	Bunbury Outer Ring Rd - W of Willinge Dr EB - Mod.	792	153	15	24	100	1.8
A017WB	Bunbury Outer Ring Rd - W of Willinge Dr WB - Mod.	796	95	15	25	100	1.8
A022NB	Forrest Hwy - Raymond Rd & Hynes Rd NB	663	118	12	19	80	1.8
A022SB	Forrest Hwy - Raymond Rd & Hynes Rd SB	759	99	14	20	80	1.8
A025	Harris Rd - W of Martin Pelusey Rd	617	146	30	19	80	0.8
A027EB	Raymond Rd - W of BORR EB	116	55	11	10	80	-1.7
A027WB	Raymond Rd - W of BORR WB	223	21	11	23	80	-1.7
A028	South Western Hwy - Henty Brook Rd & Waterloo Rd	564	123	18	12	100	1.8
A030	Willinge Dr - S of South Western Hwy - Mod.	313	97	28	15	90	1.8
A032	South Western Hwy - S of Bunbury Outer Ring Rd	352	43	15	30	110	1.8
B001NB	BORR - Willinge Drive Extension NB	259	50	30	41	90	1.8
B001SB	BORR - Willinge Drive Extension SB	248	59	32	37	90	1.8
B002EB	BORR - MP to Waterloo Interchange EB	807	156	15	24	110	1.8
B002WB	BORR - MP to Waterloo Interchange WB	834	99	15	25	110	1.8
B003NB	BORR - Waterloo Interchange to SWH NB	853	165	15	24	110	1.8
B003SB	BORR - Waterloo Interchange to SWH SB	799	95	15	25	110	1.8
B004NB	BORR - SWH to Raymond Road NB	650	126	15	24	110	1.8
B004SB	BORR - SWH to Raymond Road SB	585	70	15	25	110	1.8
B005NB	BORR - Raymond Road to Paris/Clifton NB	508	98	15	24	110	1.8
B005SB	BORR - Raymond Road to Paris/Clifton SB	523	62	15	25	110	1.8

Road ID	Road name	VPH (day)	VPH (night)	%HV (day)	%HV (night)	Speed limit	Road surface
B006NB	BORR - Paris/Clifton Forrest Highway North NB	508	98	15	24	110	1.8
B006SB	BORR - Paris/Clifton Forrest Highway North SB	782	93	15	25	110	1.8
B007	BORR SB to Forrest Ramp	187	22	15	25	80	-1.7
B008NB	BORR - Forrest Hwy N of Raymond Road NB	358	69	15	24	80	1.8
B008SB	BORR - Forrest Hwy N of Raymond Road to BORR Merge SB	423	50	15	25	80	1.8
B009	BORR - Forrest SB Paris/Clifton to BORR Merge	236	28	15	25	80	1.8
B010	BORR - Paris/Clifton to Forrest Highway NB Merge	250	48	15	24	60	1.8
B011N	BORR - Forrest Highway / BORR North NB	757	146	15	24	110	1.8
B011S	BORR - Forrest Highway / BORR North SB	782	93	15	25	110	1.8
B012	BORR -Paris/Clifton WEST	679	111	6	3	80	0.8
B013	BORR - Paris/Clifton MIDDLE	138	16	6	3	80	-1.7
B014	BORR - Paris/Clifton EAST	67	9	5	3	80	0.8
W001	BORR - Waterloo Loop Rd	194	38	20	20	70	0.8
W002	Martin Pelusey Rd - S of South Western Hwy	774	150	20	20	70	0.8
W003	BORR - Waterloo Wireless Rd - Link Road	813	201	30	19	70	0.8
W004N	BORR - Waterloo Wireless Rd - S of Link Road NB	114	33	30	19	70	0.8
W004S	BORR - Waterloo Wireless Rd - S of Link Road SB	186	61	27	12	70	0.8
W005	BORR - Waterloo Wireless Rd - N of Link Road	325	76	30	19	70	0.8
W006NB	BORR - Waterloo Wireless Rd - S of BORR NB	39	8	30	41	70	0.8
W006SB	BORR - Waterloo Wireless Rd - S of BORR SB	38	9	32	37	70	0.8
X001	Clifton Rd	67	9	5	3	100	0.8
Y001	BORR - Raymond Road off ramp NB	142	27	15	24	70	1.8
Y002	BORR - Raymond Road on ramp SB	62	7	15	25	70	1.8
Y003	BORR - South Western Highway off ramp NB	203	39	15	24	80	1.8
Y004	BORR - South Western Highway on ramp SB	215	26	15	25	80	1.8
Y005	BORR - Waterloo Wireless off ramp EB	95	18	15	24	70	1.8
Y006	BORR - Waterloo Wireless on ramp WB	99	12	15	25	70	1.8

Road ID	Road name	VPH (day)	VPH (night)	%HV (day)	%HV (night)	Speed limit	Road surface
Y007	BORR - Waterloo Wireless on ramp EB	141	27	15	24	70	1.8
Y008	BORR - Waterloo Wireless off ramp WB	64	8	15	25	70	1.8
Y009	BORR - Willinge Dr off ramp EB	167	32	15	24	70	1.8
Y010	BORR - Willinge Dr on ramp EB	160	19	15	25	70	1.8
Y011	BORR - Willinge Dr on ramp WB	182	35	15	24	70	1.8
Y012	BORR - Willinge Dr off ramp WB	198	24	15	25	70	1.8
Y013	BORR - Raymond Road on ramp NB	46	9	15	24	70	1.8
Y014	BORR - Raymond Road off ramp SB	48	6	15	25	70	1.8



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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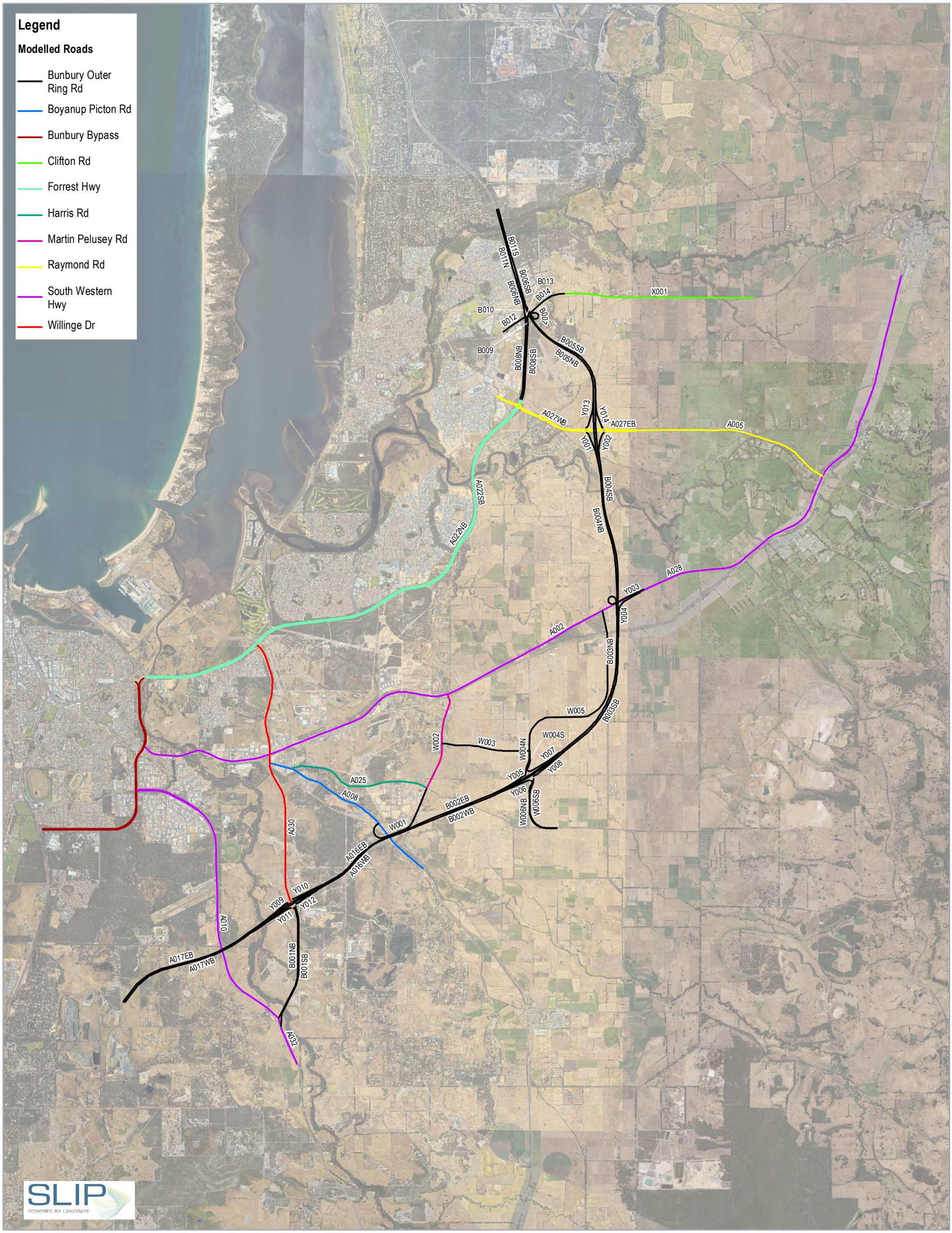
2018 Existing scenario road locations

Project No.	**61-37041**
Revision No.	**C**
Date	**10/05/2019**

FIGURE 4-2

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-2_2018ExistingRoad_RevC.mxd
Print date: 10 May 2019 - 09:16

Data source: BORR Team: Existing 2018 roads - 20190307; Landgate: WA Now Aerial Imagery - accessed 20190402. Created by: mmikkonen



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2041 Build scenario road locations

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Revision No. **C**
Date **10/05/2019**

FIGURE 4-3

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-3_2041BuildRoad_RevC.mxd
Print date: 10 May 2019 - 09:30

Data source: BORR Team: Modelled roads - 20190326; Landgate: WA Now Aerial Imagery - accessed 20190402. . Created by: mmikkonen

4.3 Noise Model Validation

The purpose of noise model validation is to demonstrate that the noise model produced for the existing situation, is an accurate representation of the real world within the limitations of the prediction algorithm and to identify errors associated with geospatial data and modelling approach. This is to provide greater confidence in the recommendations and assessment completed for the 2041 scenario.

Table 4-5 shows the measured noise levels, predicted noise levels and the difference between measured and predicted noise levels at five locations within the study area. The results are discussed below by drawing a comparison between measured and predicted noise levels.

A review of the difference between predicted and measured noise levels in Table 4-5 shows that the predicted noise levels are generally within an accepted modelling tolerance of +/- 2 dB, except for Site E during the day. This logger location is measuring low traffic roads with a high ratio of noise from other ambient noise sources compared to the noise from the road. On site leaves rustling and birds were clearly audible, and thus may explain the high measured levels.

On the basis of variability in conditions, which is likely to remain in the future, the existing noise model is considered valid to undertake the assessment.

Table 4-5 Noise model validation

Location	Distance from logger to road (m)	$L_{Aeq\ (16\text{-}hr)\ (Day)}$ (dBA)		Over prediction (dBA)	$L_{Aeq\ (8\text{-}hr)\ (Night)}$ (dBA) (6:00 am – 10:00 pm)		Over prediction (dBA)
		Measured	Modelled		Measured	Modelled	
Site A **662 Clifton Road, Brunswick**	65	54.3	57.1	2.8	46.5	48.3	1.7
Site B **15 Bevan Loop, Roelands**	150	51.1	52.6	1.5	43.1	46.6	3.5
Site C **14411 South Western Highway, Waterloo**	15	71.1	72.5	1.4	66.6	65.3	-1.3
Site D **105 Martin-Pelusey Road, Waterloo**	20	60.2	62.2	2.0	51.0	54.8	3.8
Site E **365 Harris Rd, Paradise**	30	51.8*	48.3	-3.5*	44.5	44.8	0.3

*Day time measured levels are increased due to ambient noise sources other than the road (due to the low traffic count on Harris Road). Rustling of leaves in moderate daytime wind and bird noises were observed on site to affect the measurement.

4.4 Predicted Noise Levels – Without Mitigation Treatment

The predicted existing (2018) day (Figure 4-4) and night (Figure 4-5) road traffic noise maps are presented and compared to the predicted future (2041) day (Figure 4-6) and night (Figure 4-7) noise maps (2041) with BORR present and no noise mitigation treatment. All sensitive receivers were found to have a predicted day L_{Aeq} noise level more than 5 dB above the night L_{Aeq} noise level, and therefore where compliance with the SPP 5.4 noise criteria are predicted to be achieved during the day, they are also achieved at night. For clarity, predictions at non-residential structures such as commercial use, sheds and garages are not included as SPP 5.4 does not apply at these structures.

Whilst all but four of the properties near the Raymond Road interchange and along Raymond Road are forecast to meet the noise target (using an upgraded road surface of DGA for Raymond Road which in 2018 was chip seal), it is noted that the increase in noise level of up to 7 dBA will be perceptible by the residents and is likely to result in annoyance due to the low noise exposure prior to the completion of BORR.

Exceedances

It is found that without any noise mitigation treatment, some 77 properties are predicted to experience noise levels above the SPP 5.4 noise target of $L_{Aeq,day}$ 55 dBA in 2041, of which 44 are also predicted to experience noise levels above the threshold of $L_{Aeq,day}$ 60 dBA. The large majority of these 44 properties are located adjacent the existing Forrest Highway, north of the BORR/Forrest Interchange. 24 of the properties are predicted to experience noise levels marginally above the threshold (up to 2 dBA) whilst the other 20 properties are forecast to experience noise levels more than 2 dBA above the threshold.

Properties closest to the new road are forecast to receive levels up to $L_{Aeq,day}$ 67 dBA. With this level of noise exposure, each property above the 55 dBA day noise target (blue dots on Figure 4-8) or 50 dBA night noise target (blue dots on Figure 4-9) would need to be considered for acoustic treatment. In recognising the challenges in achieving noise level reduction where existing road infrastructure is surrounded by existing noise-sensitive development, such as in the area adjacent the existing Forrest Highway, north of the BORR/Forrest Interchange, the Project aims to mitigate noise levels to as low as possible and at a minimum to meet 60 dBA day noise limit or 55 dBA night noise limit.

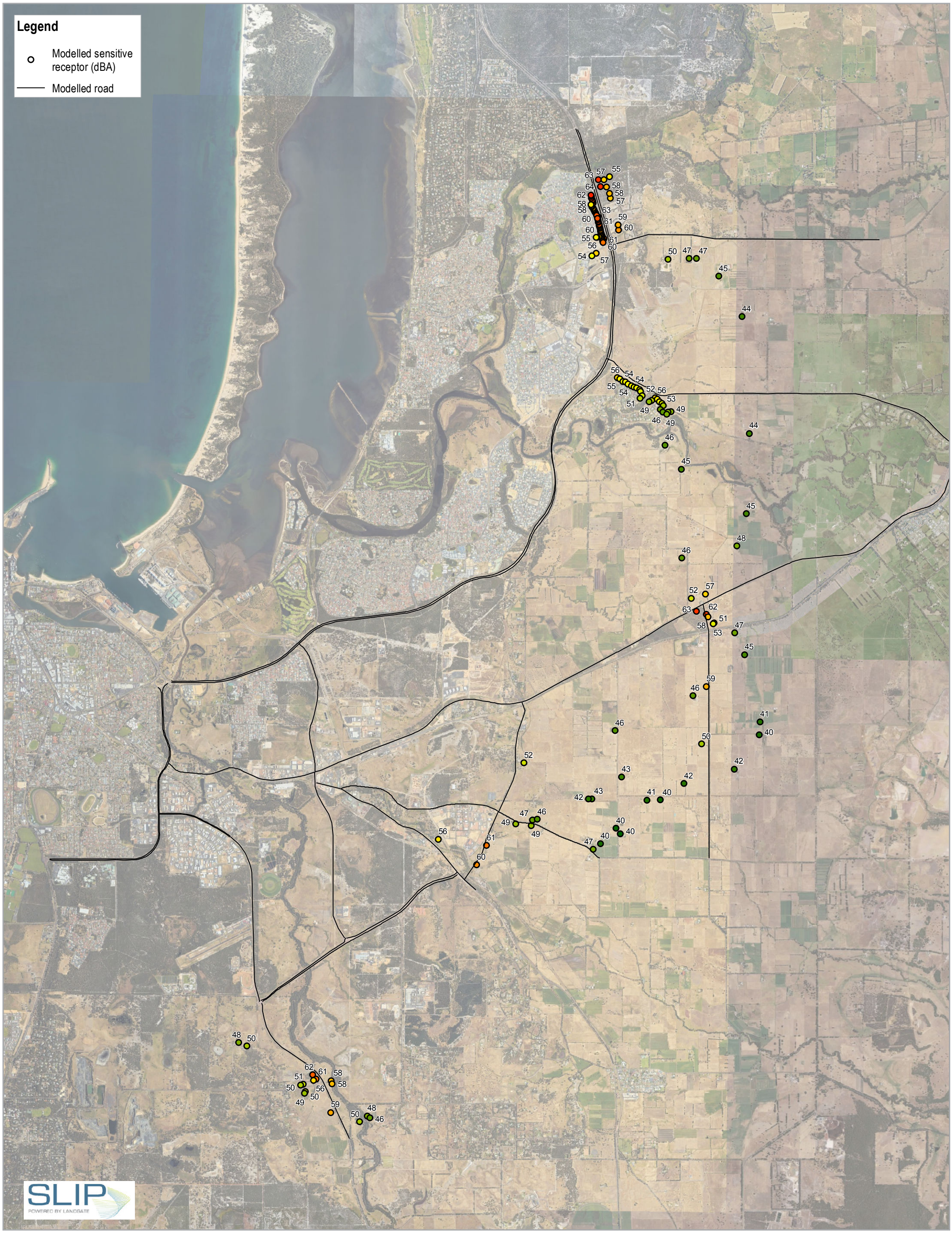
Friday and Sunday Peak Traffic Sensitivity

The SPP 5.4 guideline states that traffic analysis on weekends is generally not used. It is worth mentioning however, that BORR is forecast to have an atypical Friday and Sunday peak pattern following Forrest Highway. The Friday (southbound) and Sunday (northbound) daily volumes show an extended peak, resulting in a 1.5 fold increase over the average weekday traffic. This increase in traffic of 50% is forecast to increase noise levels by less than 2 dBA, and the total increase in $L_{Aeq,\ day}$ and $L_{Aeq,\ night}$ is forecast to be less than 1 dBA compared to the weekday average.

Bridge Expansion Joints

Where located close to sensitive receptors, bridge expansion joints may lead to elevated noise levels, depending on the type of joint installed and ongoing maintenance. Bridge expansion joints are not included in noise modelling procedures used for assessing road projects, as the approved calculation algorithms, such as CoRTN, do not parameterise noise from such sources.

Bridge expansion joint selection during detailed design will take into consideration noise impacts on surrounding sensitive receptors.



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Kilometres

Map Projection: Transverse Mercator
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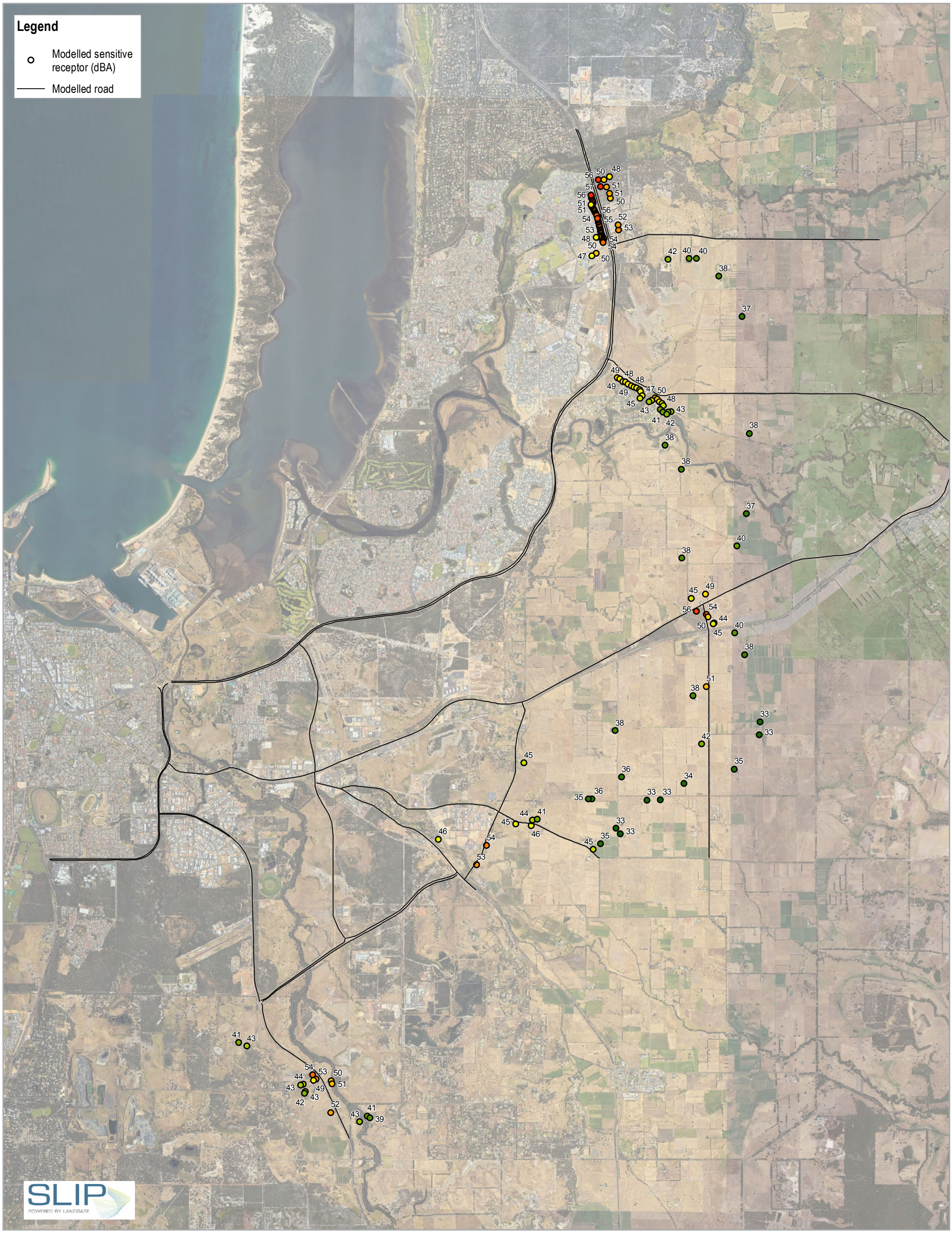
Forecast traffic noise $L_{Aeq, day}$
Existing 2018 noise levels at the most affected façade (dBA)

Project No. **61-37041**
Revision No. **E**
Date **05/04/2019**

FIGURE 4-4

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-4_2018ExistingLevelsDay_RevE.mxd
Print date: 05 Apr 2019 - 16:12

Data source: BORR Team: Noise level predictions, Modelled roads - 20190307; Landgate: WA Now Aerial Imagery - accessed 20190402. Created by: mmikkonen



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Forecast traffic noise $L_{Aeq, night}$
Existing 2018 noise levels at the most affected façade (dBA)

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Revision No. **C**
Date **02/04/2019**

FIGURE 4-5

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-5_2018ExistingLevelsNight_RevC.mxd
Print date: 05 Apr 2019 - 16:24

Data source: BORR Team: Noise level predictions, Modelled roads - 20190307; Landgate: WA Now Aerial Imagery - accessed 20190402. . Created by: mmikkonen

Legend

- Modelled sensitive receptor (dBA)
- Modelled road

Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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Forecast traffic noise $L_{Aeq, day}$
Build 2041 noise levels at the most affected façade (dBA) - No treatment

Project No. **61-37041**
Revision No. **C**
Date **01/04/2019**

FIGURE 4-6

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-6_2041NoTreatmentDay_RevC.mxd
Print date: 05 Apr 2019 - 15:50

Data source: BORR Team: Noise level predictions, Modelled roads - 20190326; Landgate: WA Now Aerial Imagery - accessed 20190401. Created by: mmikkonen

Legend

- Modelled sensitive receptor (dBA)
- Modelled road

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 Perth Coastal Grid 1994

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Forecast traffic noise $L_{Aeq, night}$
Build 2041 noise levels at the most affected façade (dBA) - No treatment

Project No. **61-37041**
Revision No. **B**
Date **01/04/2019**

FIGURE 4-7

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-7_2041NoTreatmentNight_RevB.mxd
Print date: 05 Apr 2019 - 15:56

Data source: BORR Team: Noise level predictions, Modelled roads - 20190326; Landgate: WA Now Aerial Imagery - accessed 20190401. . Created by: mmikkonen

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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Forecast traffic noise $L_{Aeq, day}$
Build 2041 noise contours - No treatment

Project No.	**61-37041**
Revision No.	**C**
Date	**01/04/2019**

FIGURE 4-8

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-8_2041TrafficNoiseNoTreatmentDay_RevC.mxd
Print date: 12 Apr 2019 - 15:41

Data source: BORR Team: Noise level predictions, Modelled roads, Noise level contour (dBA) - 20190326; Landgate: WA Now Aerial Imagery - accessed 20190401. Created by: mmikkonen

Legend

- Property forecast to require no treatment
- Property forecast to potentially require treatment
- Modelled road

Noise level contour (dBA)

- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70
- 75

Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

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Forecast traffic noise $L_{Aeq, night}$
Build 2041 noise contours - No treatment

Project No. **61-37041**
Revision No. **B**
Date **01/04/2019**

FIGURE 4-9

G:\61\37041\19_0_GIS\Maps\Working\BORRNorth_NoiseFigs\6137041_4-9_2041TrafficNoiseNoTreatmentNight_RevB.mxd
Print date: 05 Apr 2019 - 15:58

Data source: BORR Team: Noise level predictions, Modelled roads, Noise level contour (dBA) - 20190326; Landgate: WA Now Aerial Imagery - accessed 20190401. Created by: mmikkonen

4.5 Predicted Noise Levels – Potential Mitigation Treatment

Noise mitigation will be required to reduce received noise levels at properties as identified in the previous section. Noise mitigation treatments typically consist of the following for road projects:

- Earth bunds, located on the road or property boundary. In some areas constrained by the required surface area to obtain sufficient height. Most effective for groups of properties rather than single rural properties.
- Noise walls, located on the road or property boundary. Require less area for installation than earth bunds. Like earth bunds, most effective for groups of properties rather than single rural properties.
- Architectural treatment package consisting of, for example, upgraded glazing (such as double glazing) and mechanical ventilation (to allow windows to be kept closed). Specific architectural treatment packages are determined for each individual sensitive receptor following completion of an architectural treatment inspection.

Due to the isolated nature of the existing sensitive receptors along the route and cognisant of the current and future land use planning (e.g. rural farmland to future industrial park), mitigation treatment will need to be discussed on a one-to-one basis with impacted landowners.

4.6 Conclusions

A road traffic noise assessment has been undertaken to predict the impact of the BORR build scenario for 2041 compared to the existing 2018 forecast. The model was validated using 2018 noise measurements.

The noise modelling has identified sensitive receptors which require some form of noise mitigation in order to meet the requirements of SPP 5.4. Main Roads is committed to satisfying the noise criteria as per SPP5.4 and will now commence discussions with impacted landowners regarding form of potential mitigation treatment measures.

APPENDIX I

BORR Northern and Central Sections Traffic Noise Assessment (BORR IPT 2019d) - Part 2 (part 2 of 2)

APPENDIX A PROJECT OVERVIEW

APPENDIX B NOISE TERMINOLOGY

Ambient noise	Level of noise from all sources, including background noise from near and far and the source of interest
A-weighted	A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. A-weighted sound level is described as L_A dB.
Background noise	Noise level from sources other than the source of concern.
dB	Decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.
Hz	Units for frequency are known as Hertz.
Impulsive noise	An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness is: "A variation in the emission of a noise where the difference between L_{Apeak} and L_{Amax} slow is more than 15 dB when determined for a single representative event".
$L_{A\ slow}$	This is the noise level in decibels, obtained using A-weighting and S time weighting as specified in AS1259.1-1990. Unless assessing modulation, all measurements use the slow time weighting characteristic.
$L_{A\ fast}$	This is the noise level in decibels, obtained using A-weighting and F time weighting as specified in AS1259.1-1990. This is used when assessing the presence of modulation only.
$L_{A\ peak}$	This is the maximum reading in decibels using A-weighting and P time weighting as specified in S1259.1-1990.
$L_{A\ max}$	L_{Amax} level is the maximum A-weighted noise level during a particular measurement.
L_{A1}	L_{A1} level is the A-weighted noise level which is exceeded for 1% of the measurement period and is considered to represent the average of the maximum noise levels measured.
L_{A10}	L_{A10} level is the A-weighted noise level which is exceeded for 10% of the measurement period and is considered to represent the intrusive noise level.
L_{A90}	L_{A90} level is the A-weighted noise level which is exceeded for 90% of the measurement period and is considered to represent the background noise level.
L_{Aeq}	The equivalent steady state A-weighted sound level ('equal energy') in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the average noise level.
L_{Amax} assigned level	Means an assigned level which, measured as a L_{Aslow} value, is not to be exceeded at any time.
L_{A1} assigned level	Means an assigned level which, measured as a L_{Aslow} value, is not to be exceeded for more than one percent of the representative assessment period.

L_{A10} assigned level	Means an assigned level which, measured as a L_{Aslow} value, is not to be exceeded for more than 10 percent of the representative assessment period.
Linear	Sound levels measured without any weightings are referred to as 'linear' and the units are expressed as dB(lin).
$L_{linear, peak}$	Maximum reading in decibels obtained using P-time-weighting characteristic as specified in AS 1259.1-1990.
Maximum design sound level	The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.
Modulating noise	A modulating source is regular, cyclic and audible and is present for at least 10 percent of the measurement period. The quantitative definition of modulation is: • Is more than 3 dB L_{Afast} or is more than 3 dB L_{Afast} in any one-third octave band • Is present for at least 10 percent of the representative assessment period • Is regular, cyclic and audible
One-third octave band	Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20,000 Hz inclusive.
Representative assessment period	Means a period of time not less than 15 minutes and not exceeding four hrs, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.
Reverberation time	Of an enclosure, for a sound of a given frequency or frequency band, the time that would be required for the reverberantly decaying sound pressure level in the enclosure to decrease by 60 decibels.
RMS	Root mean square level; used to represent the average level of a wave form such as vibration.
Satisfactory design sound level	The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.
Sound pressure level	The sound pressure level of a noise source is dependent upon its surroundings (influenced by distance, ground absorption, topography, meteorological conditions etc.) and is what the human ear actually hears. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.
Sound power level (L_W)	Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.
Specific noise	Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest
Tonal noise	A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is: • The presence in the noise emission of tonal characteristics where the difference between - – The A-weighted sound pressure level in any one-third octave band

	– The arithmetic average of the A-weighted sound pressure levels in the two adjacent one-third octave bands is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ slow}$ levels. This is relatively common in most noise sources.

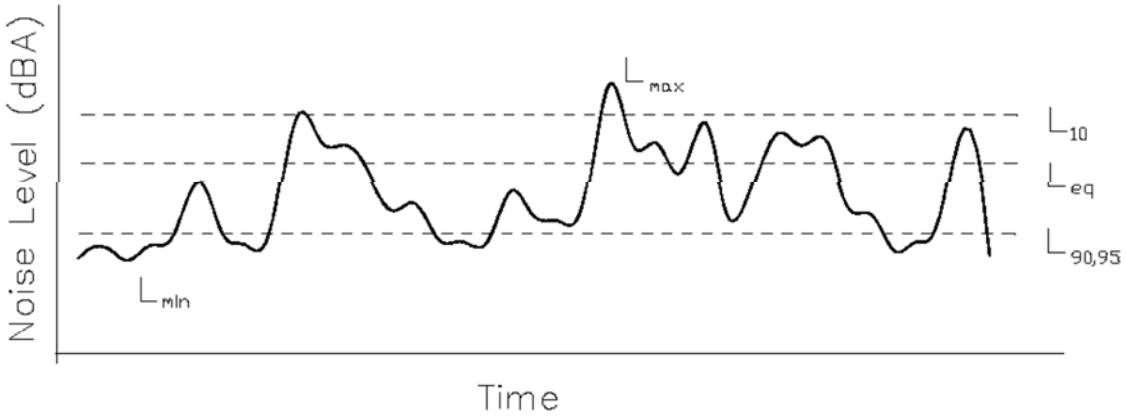
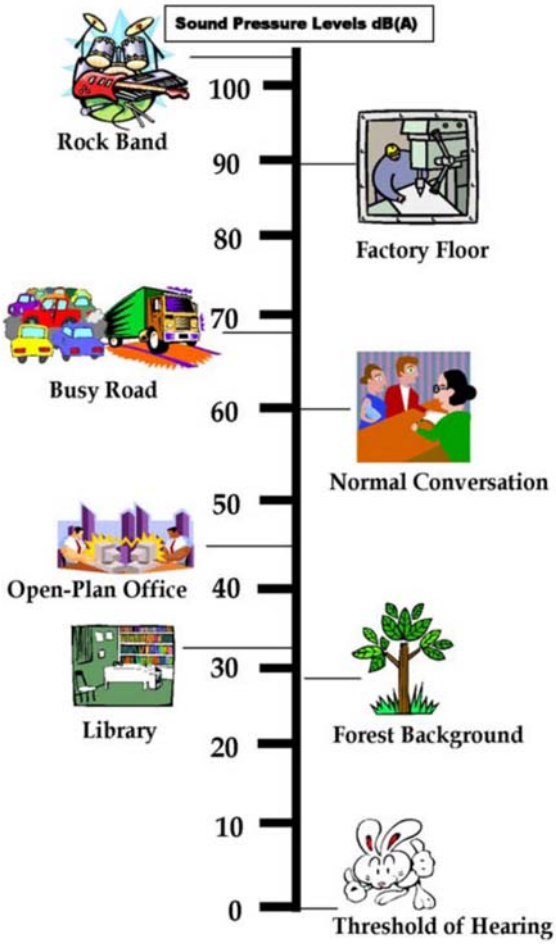


Chart of Noise Level Descriptors



Typical Noise Levels

APPENDIX C MONITORING SITE SUMMARIES

SITE A

(NORTH)

SOUND LEVEL RECORDING FORM

Project No: 61370411 Date 10.09.18

Project Name: BORR Page 1 of 3

Client: MRWA Performed by AST/GF

Site: 662 CLIFTON RD, BRUNSWICK Monitoring Position

SLM Make: SVAN /Model: 955 /Serial N°: 27625

CAL Make: L. DAVIS /Model: 1200 /Serial N°: 10469 /Level 94 (dB) /Frequency: 1000 (Hz)

SLM=Sound Level Meter CAL=Calibrator (pistonphone)

1. Monitoring Interval: 15 (mins)
2. Start Time: 10.45 10.09.18 Finish Time: —
3. Calibration performed before monitoring: 94.0 dB Y/N factor= 0.0 dBA
4. Calibration performed after monitoring: — Y/N factor= dBA

L_{eq} = L1= Lpeak=

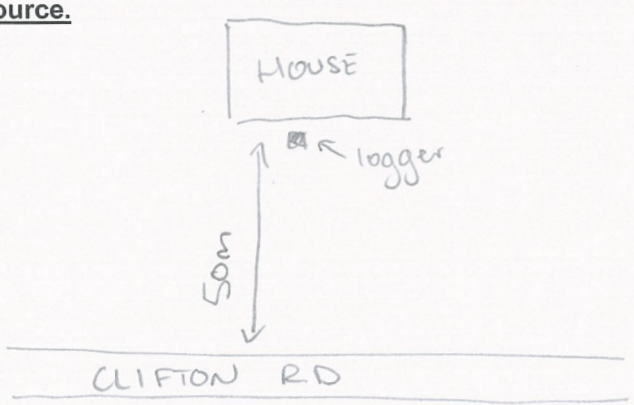
L_{10}= Lmax= L90=

Lmin= Height of meter 1.5m *(1.2m minimum)*

Weather Conditions at time of Monitoring

Wind Speed	m/second
(note: max allowable = 5m/sec)	
Approximate Direction =	
Ambient Temperature =	°C
Relative Humidity	%
Cloud Cover	%
Inversion Layer	Y/N
Others (fog, drizzle)	

Sketch of Monitoring Location and Distance to Noise Source. NTS



DISTINCTIVE NOISE SOURCES Dominant noise source

DROP OFF
56 dB car passing Clifton Rd
61 dB several cars passing
49 dB Wind
46 dB No cars (ambient)
56 dB Birds chirping
65 dB Truck passing

NOISE CHARACTER (broad band , impulsive, tonal)

METER SETTINGS (Linear, exponential:, weightings; a, b, c,: fast, slow, impulsive)

Note: file corrupted giving "FS ERR"
logger recorded for several days only.

log name: 1
start file: 1
last file: -

SITE B

(NORTH)

SOUND LEVEL RECORDING FORM

Project No: 6137041 Date 10.09.18

Project Name: BORR Page 2 of 3

Client: MRWA Performed by AST / GF

Site: 15 BEVAN LOOP, ROELANDS Monitoring Position

SLM Make: SVAN /Model: 955 /Serial Nº: 27621

CAL Make: L. DAVIS /Model: 200 /Serial Nº: 10469 /Level: 94 (dB) /Frequency: 1000 (Hz)

SLM=Sound Level Meter *CAL=Calibrator (pistonphone)*

1. Monitoring Interval: 15 (mins)
2. Start Time: 12.56 10.9.18 Finish Time: 17.09.18
3. Calibration performed before monitoring: 94.0 dB Y/N factor= 0.0 dBA
4. Calibration performed after monitoring: 94.1 dB Y/N factor= +0.1 dBA

L_{eq} = L1= Lpeak=

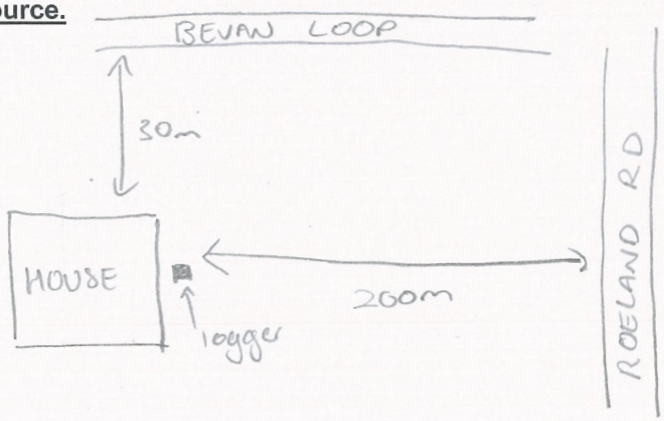
L_{10}= Lmax= L90=

Lmin= Height of meter 1.5m *(1.2m minimum)*

Weather Conditions at time of Monitoring

Wind Speed Still	m/second
(note: max allowable = 5m/sec)	
Approximate Direction =	
Ambient Temperature =	°C
Relative Humidity	%
Cloud Cover	%
Inversion Layer	Y/N
Others (fog, drizzle)	

Sketch of Monitoring Location and Distance to Noise Source. NTS



DROP OFF

DISTINCTIVE NOISE SOURCES

57.5dB cars passing
52.9dB wind

Dominant noise source

PICK UP
55dB Truck passing Roelands Rd
43dB No distinct source (ambient)
55dB lawn mower.

NOISE CHARACTER (broad band , impulsive, tonal)

METER SETTINGS (Linear, exponential:, weightings; a, b, c,: fast, slow, impulsive)

log name: log 2
start file: 3
last file: 660

SITE C

SOUND LEVEL RECORDING FORM

Project No:

Date 13.12.18

Project Name: BOAR

Page 1 of 1

Client: MRWA

Performed by JL & GF

Site: 1441 S.W Highway (Lot 65)

Monitoring Position

SLM Make: RION /Model: U /Serial Nº:

CAL Make: LD /Model: /Serial Nº: /Level : (dB) /Frequency: (Hz)

SLM=Sound Level Meter *CAL=Calibrator (pistonphone)*

1. Monitoring Interval: 15 (mins)

2. Start Time: 15:00 Finish Time: 15:15

3. Calibration performed before monitoring: Y/N factor= 94.2 dBA @14:58 RION

4. Calibration performed after monitoring: Rion: 94.1 Y/N factor= 93.6 dBA @15:02 LD 93.7@14:55

L_{eq} = L1= Lpeak=

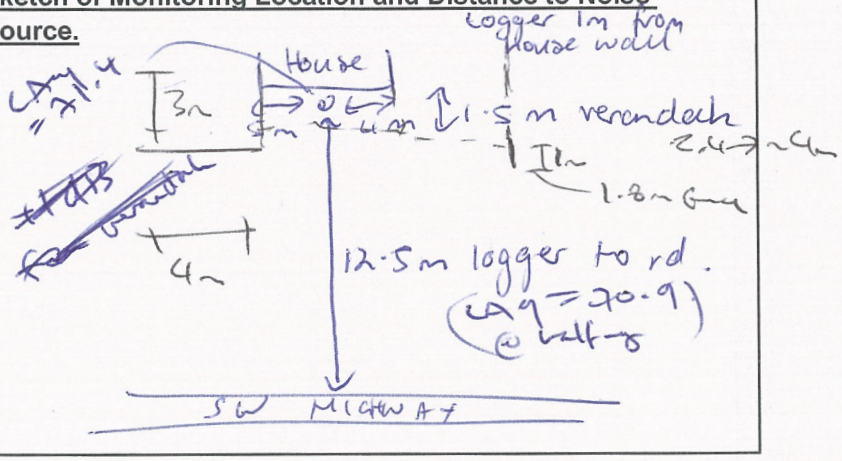
L_{10}= Lmax= L90=

Lmin= Height of meter (1.2m minimum) Locks 244

Weather Conditions at time of Monitoring

Wind Speed	m/second
(note: max allowable = 5m/sec)	
Approximate Direction =	
Ambient Temperature =	°C
Relative Humidity	%
Cloud Cover	%
Inversion Layer	Y/N
Others (fog, drizzle)	

Sketch of Monitoring Location and Distance to Noise Source.



DISTINCTIVE NOISE SOURCES Dominant noise source

LD handheld attended 93.7 cal. m from road.

18/12/13 09

CAR 76 75 79 76 73 75 71 75 76 73 75 75 74 76 75

TRUCK 79 74 83 78 83 82 83 86 83 84 79 80 83 82 78

CAR 76 74 76 77 77 76 73 77 76 79 77 77 77 78 74 76 72

TRUCK 85 83

CAR 71 76 78 78 76 79 74 75 74 77 75 74 76 75 77 76 75

Motorbike 70 81

MULTIPLE CAR 78 78 81 78 80 81 76

NOISE CHARACTER (broad band , impulsive, tonal) 70.9

METER SETTINGS (Linear, exponential:, weightings; a, b, c,: fast, slow, impulsive)

CICADA 46 47 49 50 47

SITE D

(CENTRAL)

SOUND LEVEL RECORDING FORM

Project No: 6137041 Date 17.09.18

Project Name: BORR Page 3 of 3

Client: MRWA Performed by AST / LF

Site: 105 MARTIN-PELUSEY RD, WATERLOO Monitoring Position

SLM Make: SVAN /Model: 955 /Serial Nº: 27625

CAL Make: L. DAVIS /Model: 200 /Serial Nº: 10469 /Level : 94 (dB) /Frequency: 1000 (Hz)

SLM=Sound Level Meter CAL=Calibrator (pistonphone)

1. Monitoring Interval: 15 (mins)
2. Start Time: 13.09 17.09.18 Finish Time: 1023 25.09.18
3. Calibration performed before monitoring: 94 dB Y/N factor= 0.0 dBA
4. Calibration performed after monitoring: 93.8 dB Y/N factor= -0.2 dBA

L_{eq} = L1= Lpeak=

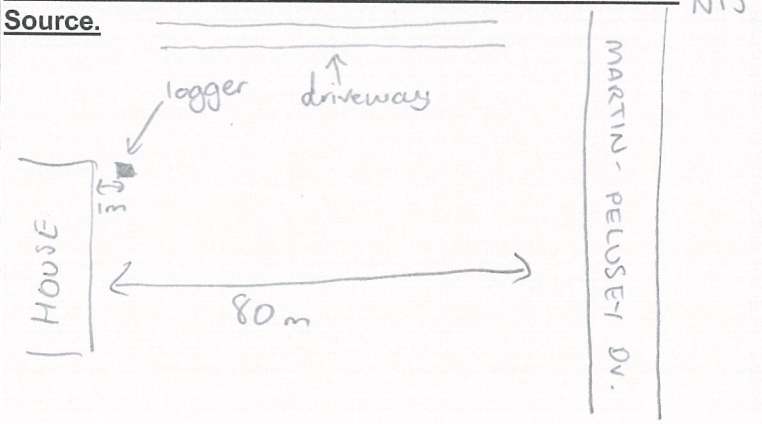
L_{10}= Lmax= L90=

Lmin= Height of meter 1.5m *(1.2m minimum)*

Weather Conditions at time of Monitoring

Wind Speed	m/second
(note: max allowable = 5m/sec)	
Approximate Direction =	
Ambient Temperature =	°C
Relative Humidity	%
Cloud Cover	%
Inversion Layer	Y/N
Others (fog, drizzle)	

Sketch of Monitoring Location and Distance to Noise Source. NTS



DISTINCTIVE NOISE SOURCES Dominant noise source Cars on M-P dr.

DROP OFF	PICK UP
58dB car passing	60.6dB lorry passing
55dB distant horn	60.9dB several cars passing
67.0dB semi-trailer passing	54.2dB distant train horn sounding
64.1dB Ute passing	45.8dB birds
58.5dB car passing	63.4dB small truck passing
70.0dB several trucks	65.5dB FWD passing
71.7dB car backfiring	68.6dB cars + truck
56.0dB car passing / 53.0dB birds	57.9dB car in driveway
	47.9dB birds.

NOISE CHARACTER (broad band , impulsive, tonal)

METER SETTINGS (Linear, exponential:, weightings; a, b, c,: fast, slow, impulsive)

log name: log1
start file: 1
last file : 755

SITE E

(CENTRAL)

SOUND LEVEL RECORDING FORM

Project No: 6137041 Date 17.09.18

Project Name: BORR Page 2 of 3

Client: MRWA Performed by AST / GF

Site: 365 HARRIS RD, PARADISE Monitoring Position

SLM Make: SVAN /Model: 955 /Serial N°: 27621

CAL Make: L. DAVIS /Model: 200 /Serial N°: 10469 /Level : 94 (dB) /Frequency: 1000 (Hz)

SLM=Sound Level Meter CAL=Calibrator (pistonphone)

1. Monitoring Interval: 15 (mins)
2. Start Time: 12:15 17.09.18 Finish Time: –
3. Calibration performed before monitoring: 94 dB Y/N factor= 0.0 dBA
4. Calibration performed after monitoring: – Y/N factor= dBA

L_{eq} = L1= Lpeak=

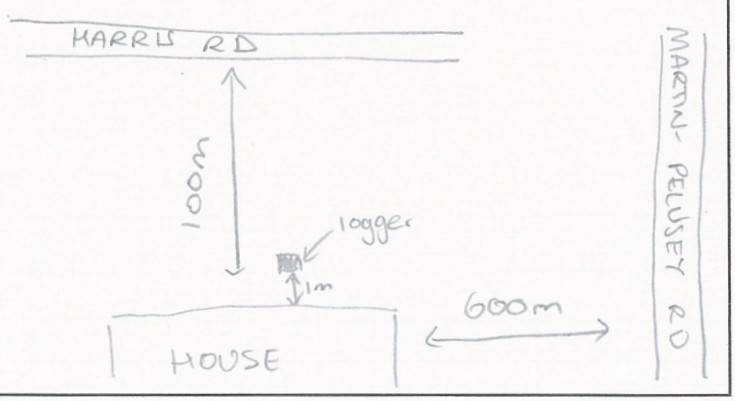
L_{10}= Lmax= L90=

Lmin= Height of meter 1.5m *(1.2m minimum)*

Weather Conditions at time of Monitoring

Wind Speed	m/second
(note: max allowable = 5m/sec)	
Approximate Direction =	
Ambient Temperature =	°C
Relative Humidity	%
Cloud Cover	%
Inversion Layer	Y/N
Others (fog, drizzle)	

Sketch of Monitoring Location and Distance to Noise Source. NTS



DISTINCTIVE NOISE SOURCES Dominant noise source

DROP OFF

44.9 dB lawn mower (distant)

56.8 dB passing car

48.4 dB Wind and birds

37.1 dB no dominant noises (ambience)

59.5 dB passing ute

61.0 dB tractor on Harris Rd

61.4 dB passing car

61.5 dB passing truck

NOISE CHARACTER (broad band , impulsive, tonal)

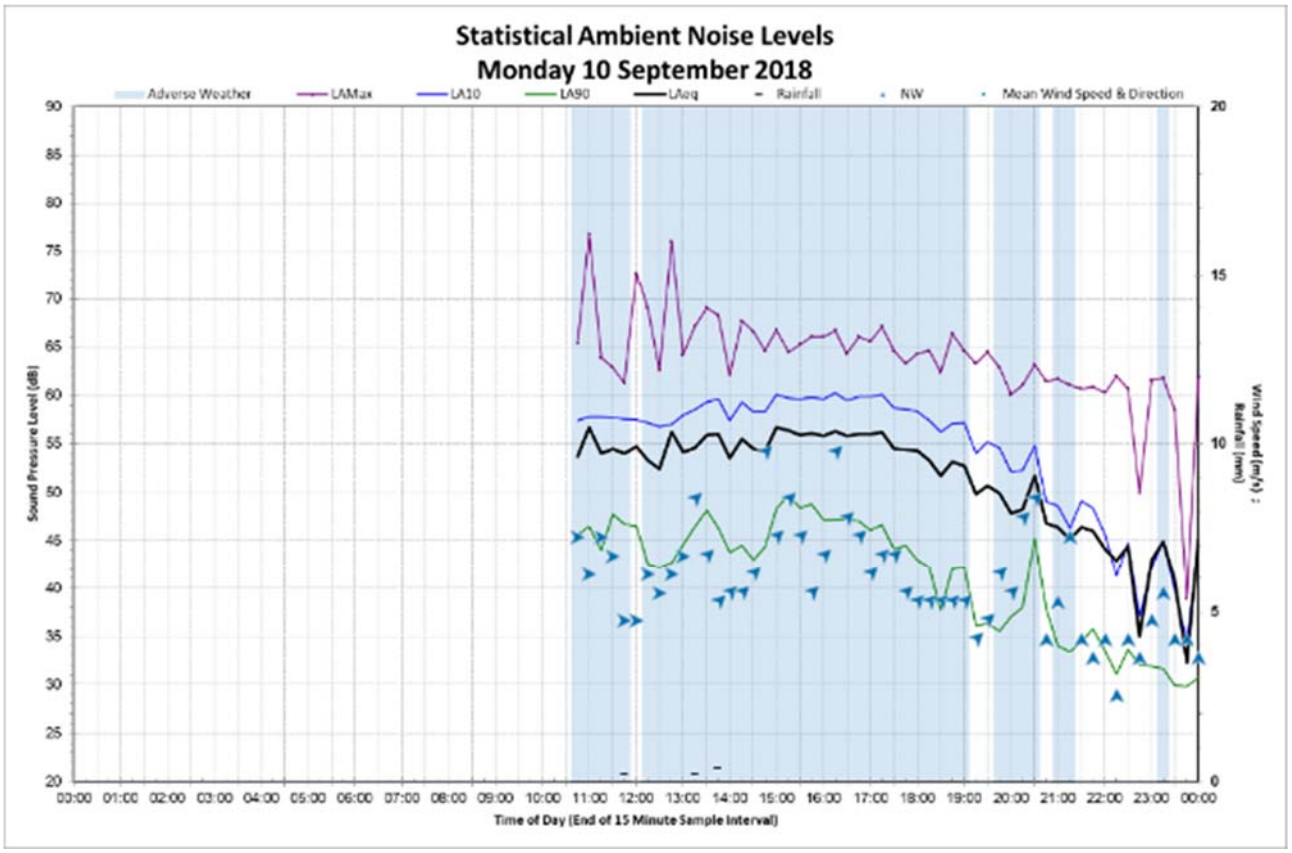
METER SETTINGS (Linear, exponential:, weightings; a, b, c,: fast, slow, impulsive)

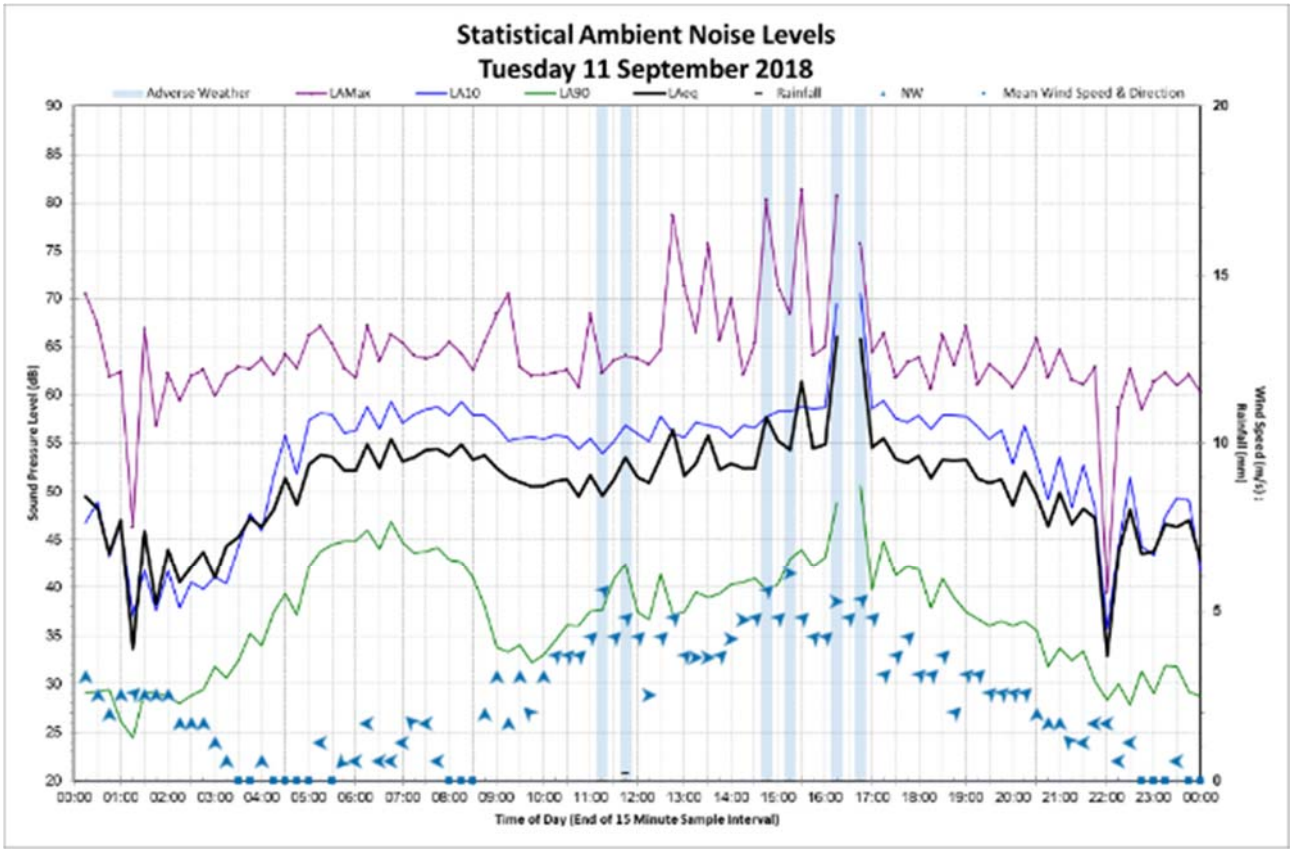
Note: battery dead on arrival to retrieve logger.

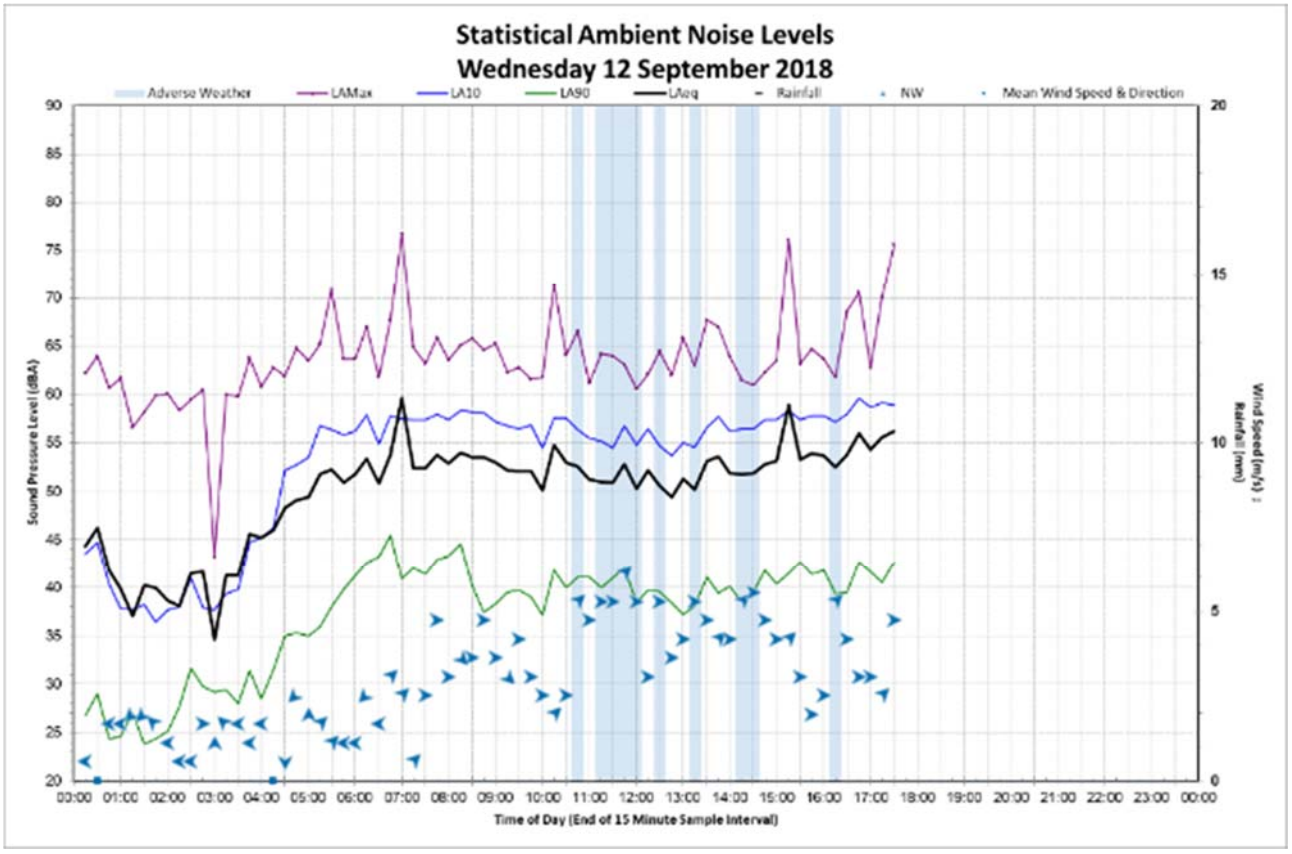
log name: log5
start file : 1
end file: –

APPENDIX D MONITORING RESULTS

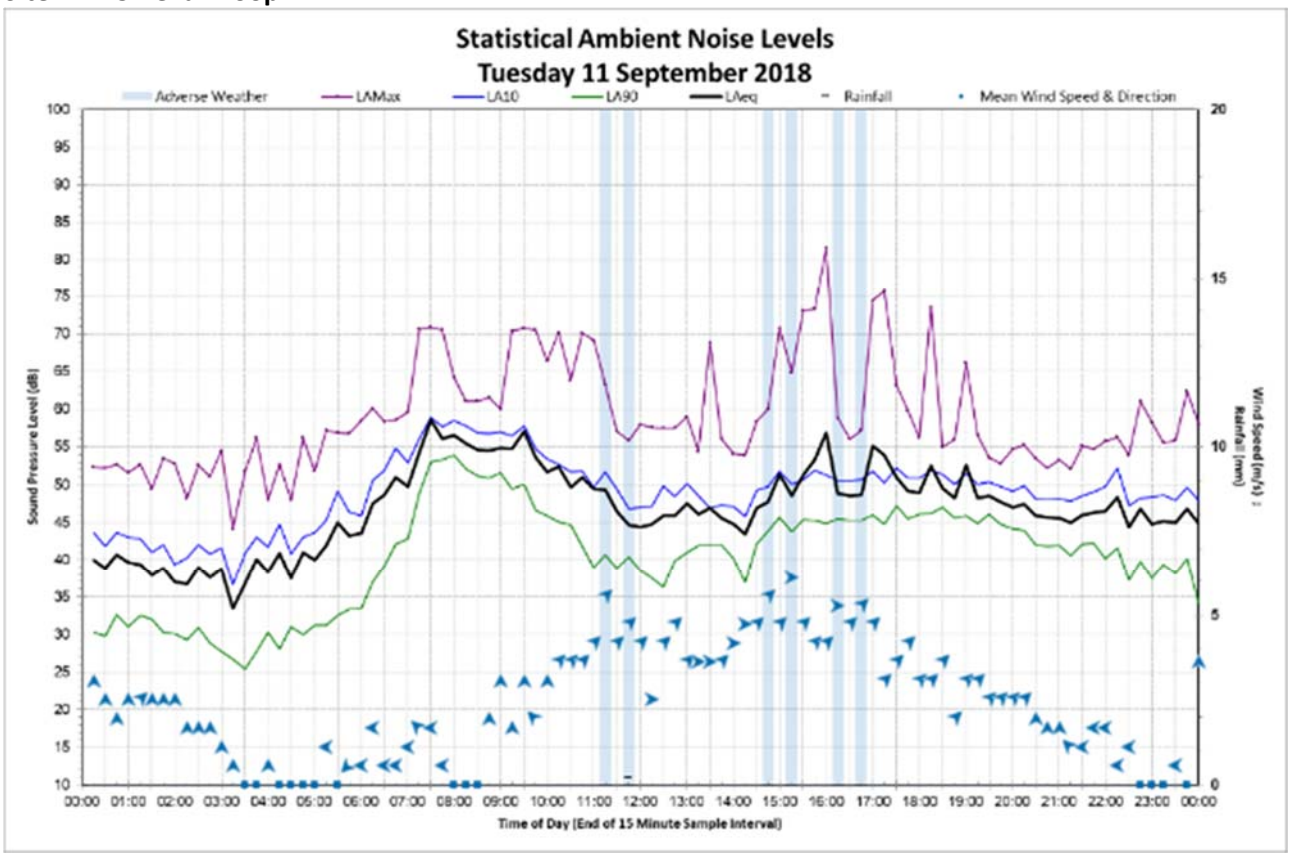
Site A – 662 Clifton Road

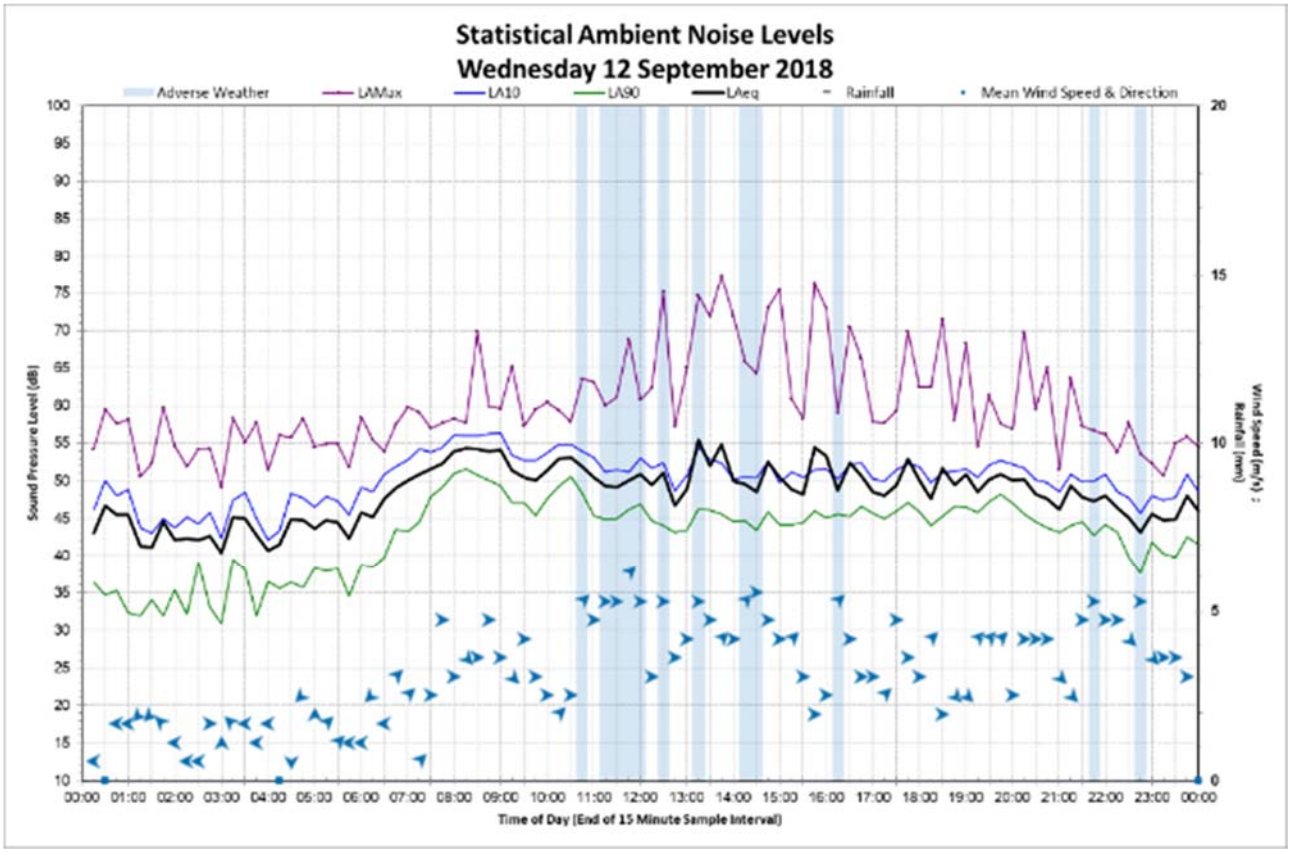


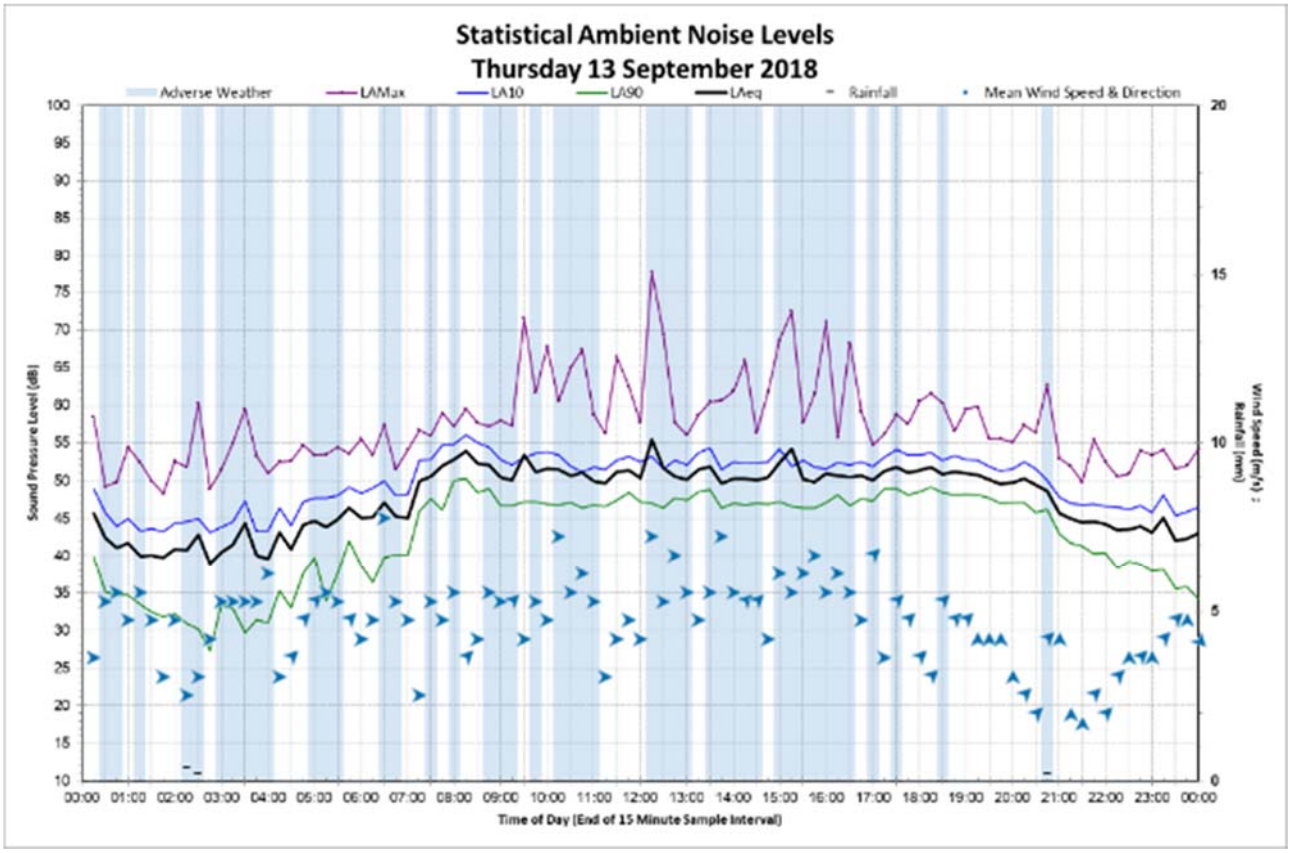


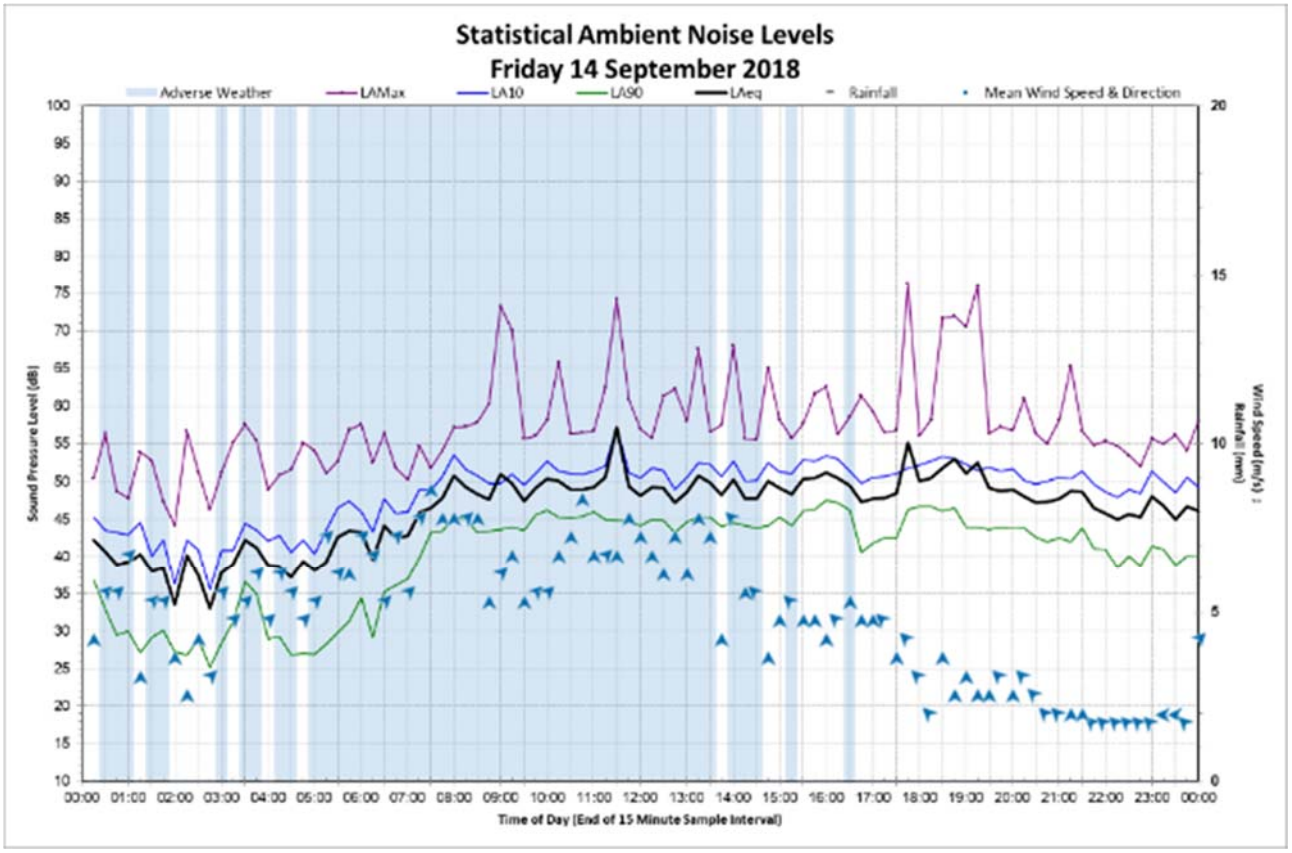

Statistical Ambient Noise Levels
Wednesday 12 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
NW
Mean Wind Speed & Direction
Sound Pressure Level (dBA)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

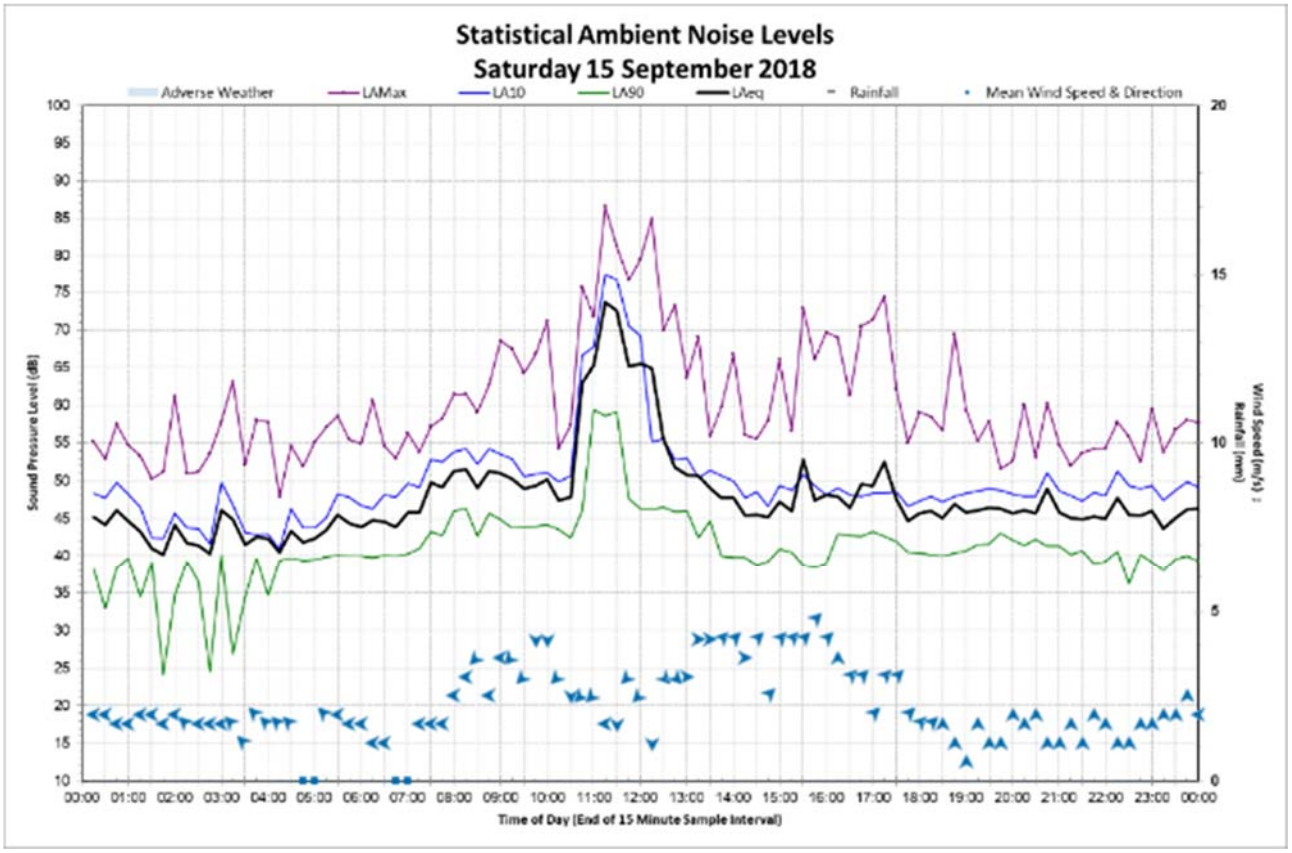
Site B – 15 Bevan Loop

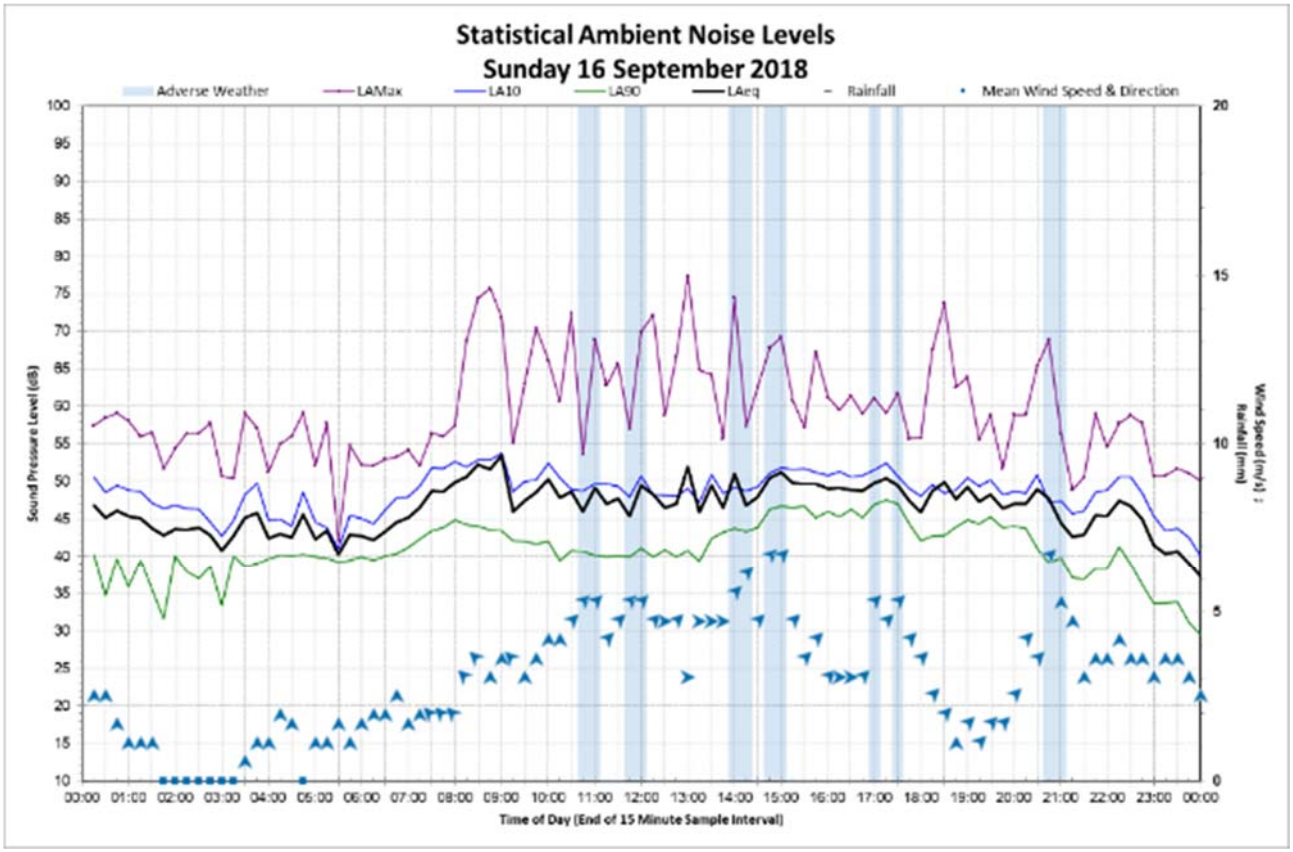




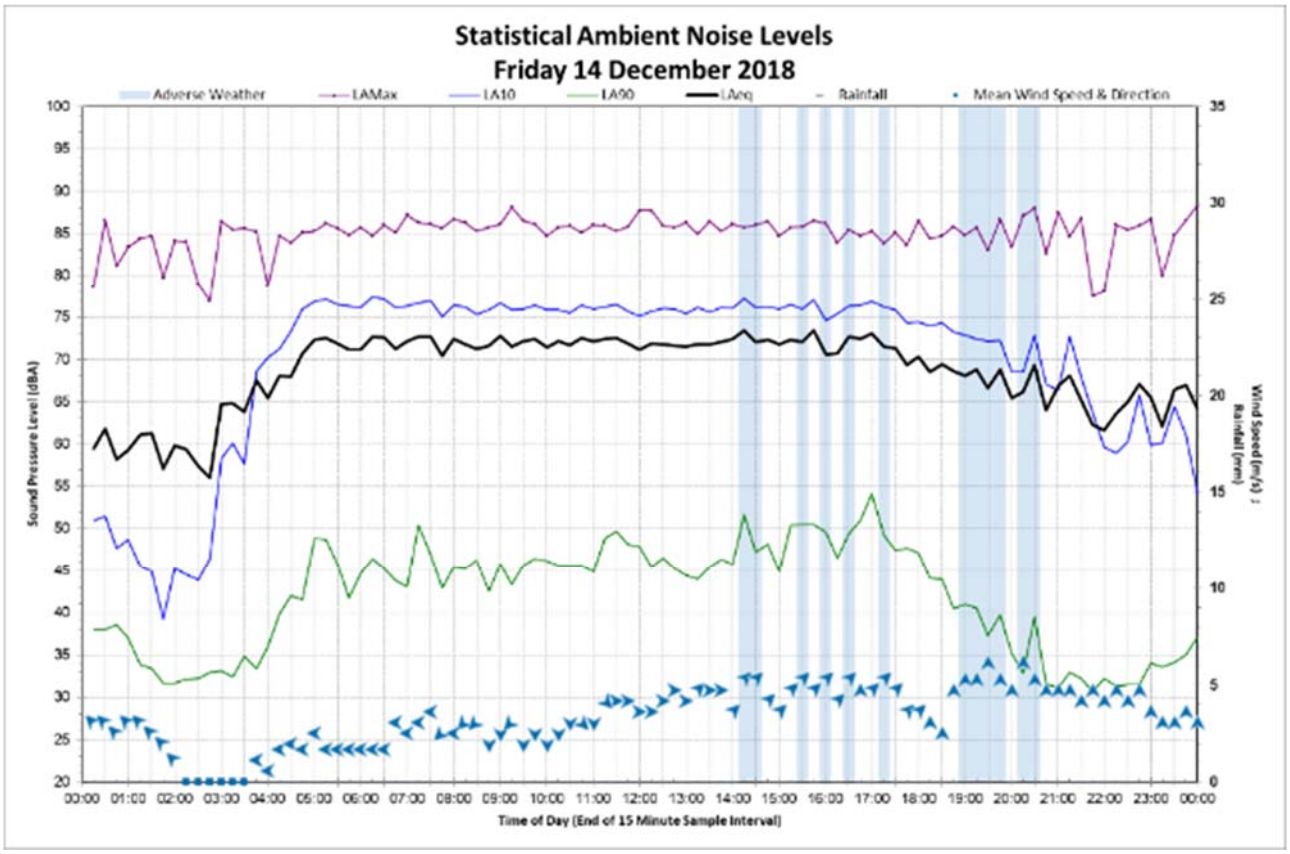

Statistical Ambient Noise Levels
Thursday 13 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

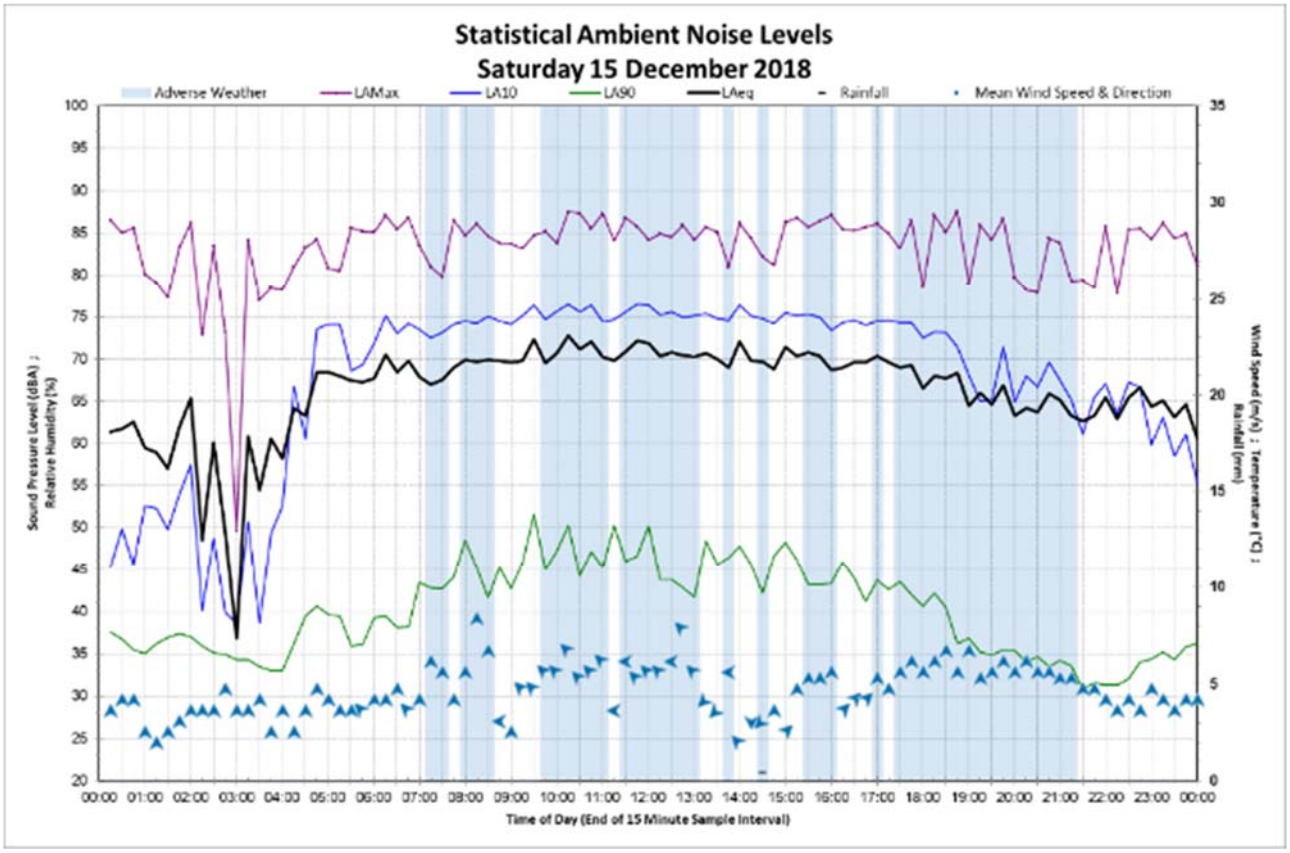

Statistical Ambient Noise Levels
Friday 14 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

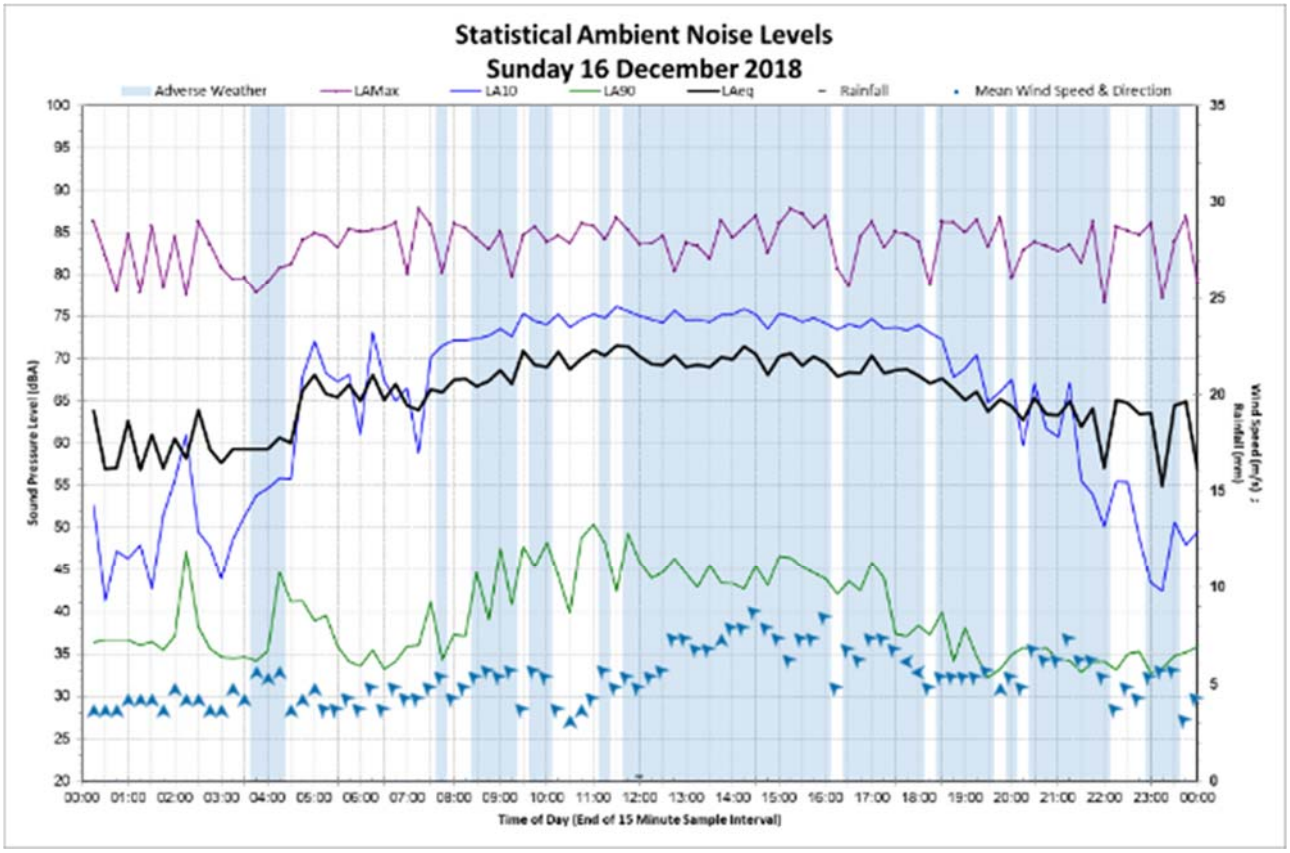

Statistical Ambient Noise Levels
Saturday 15 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

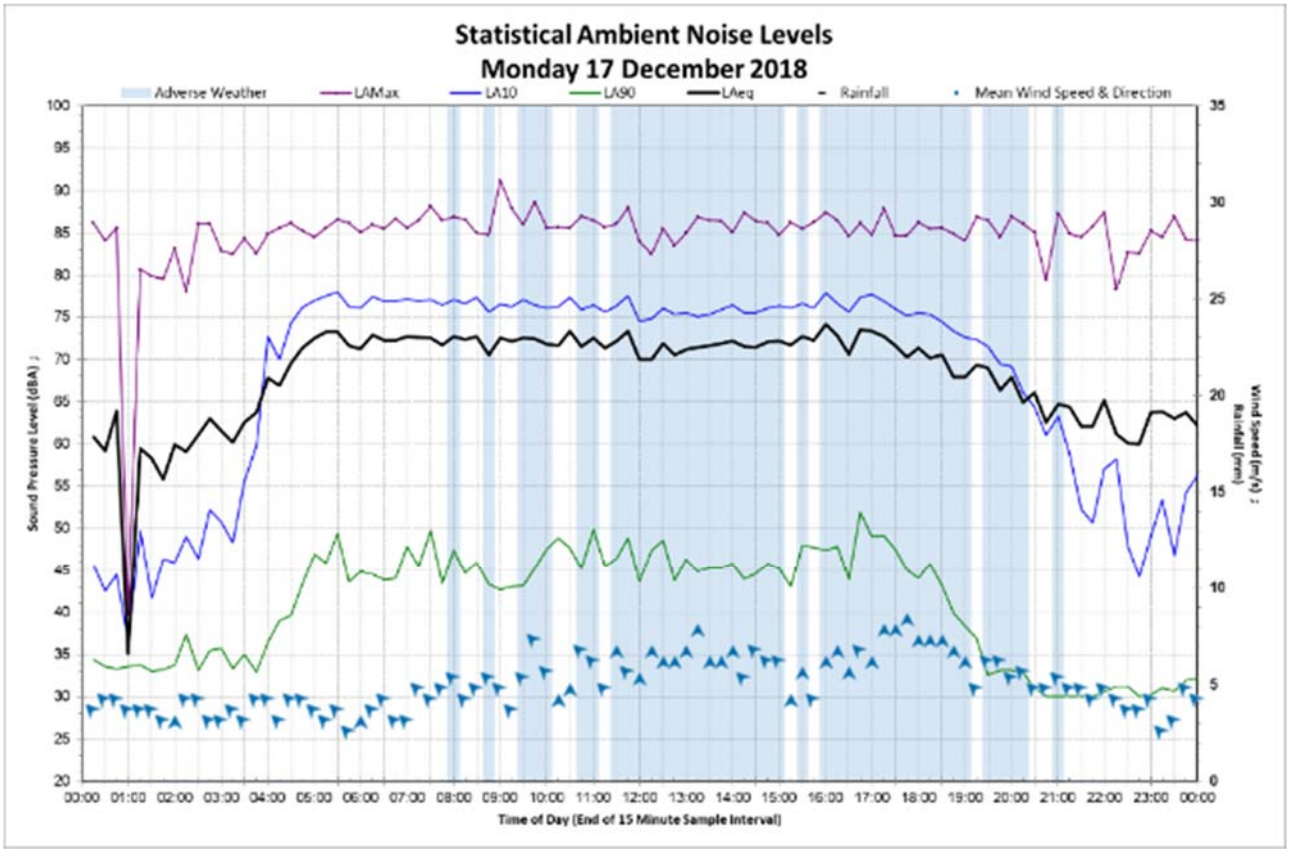

Statistical Ambient Noise Levels
Sunday 16 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

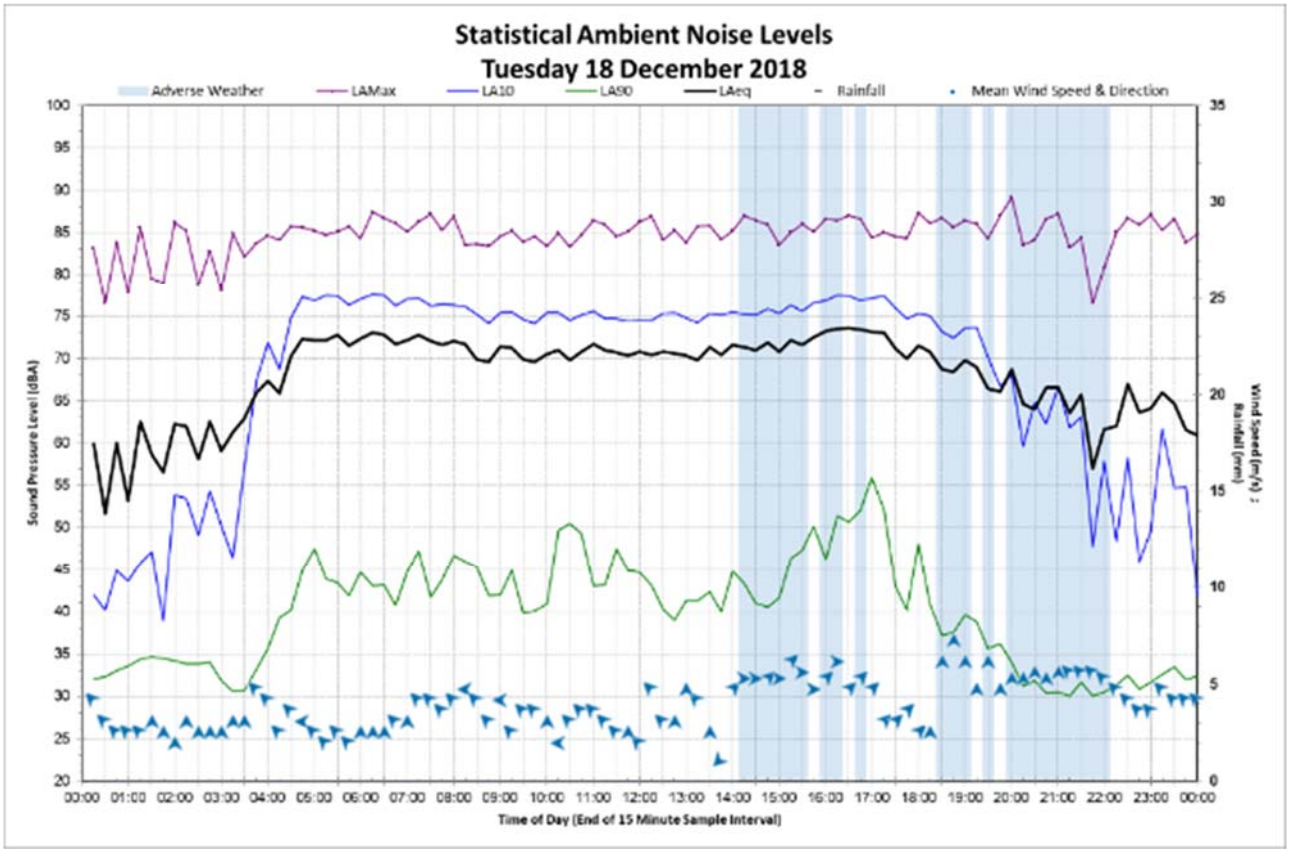
Site C – 14411 South Western Highway

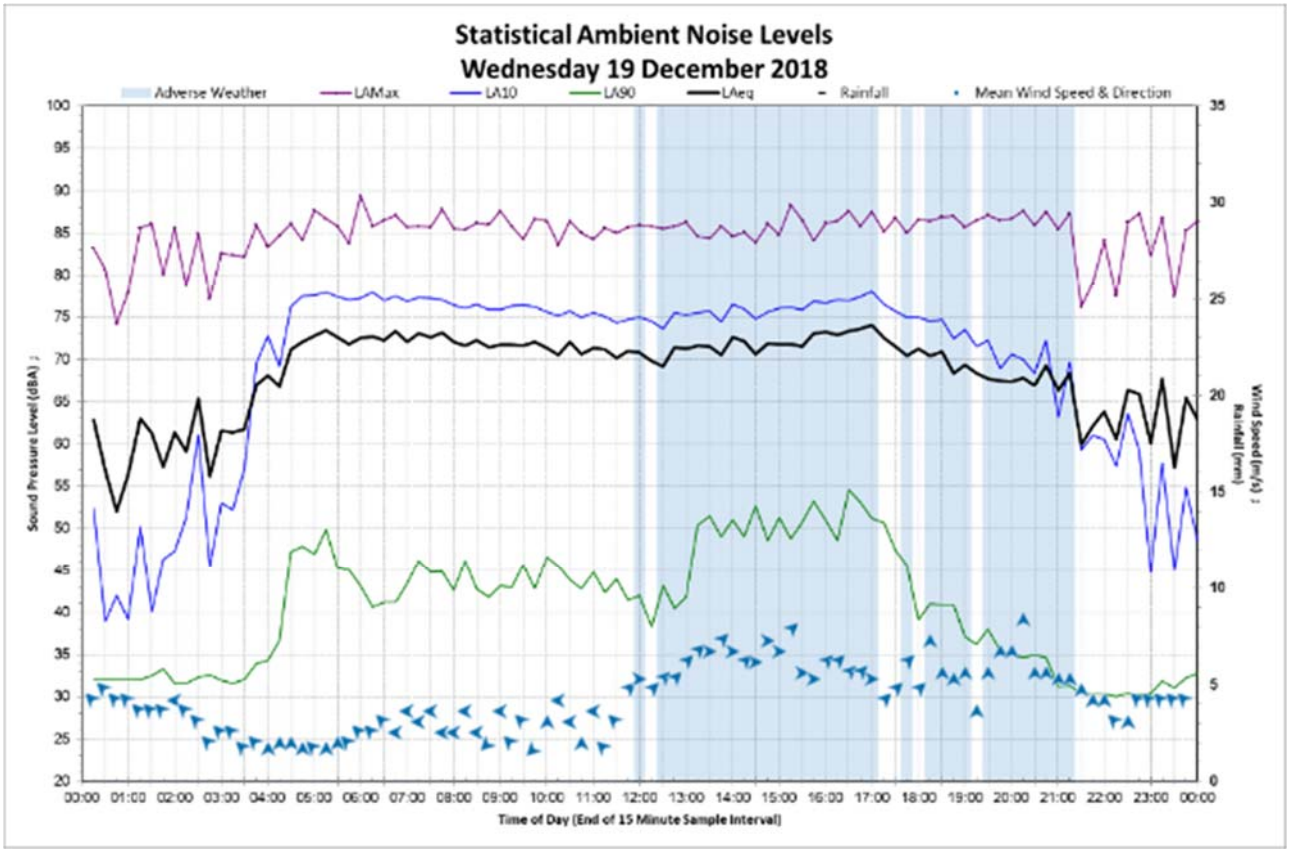




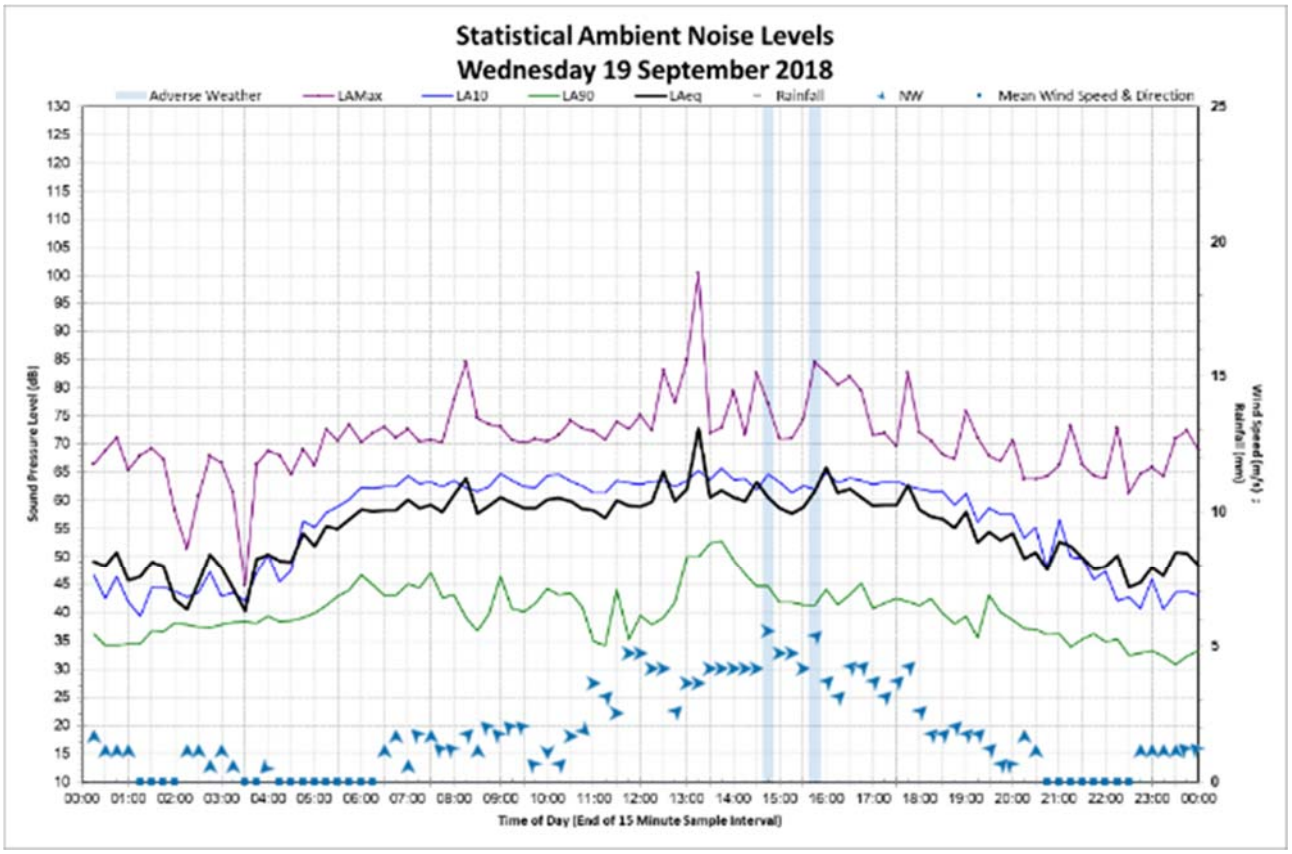

Statistical Ambient Noise Levels
Sunday 16 December 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA)
Wind Speed (m/s) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

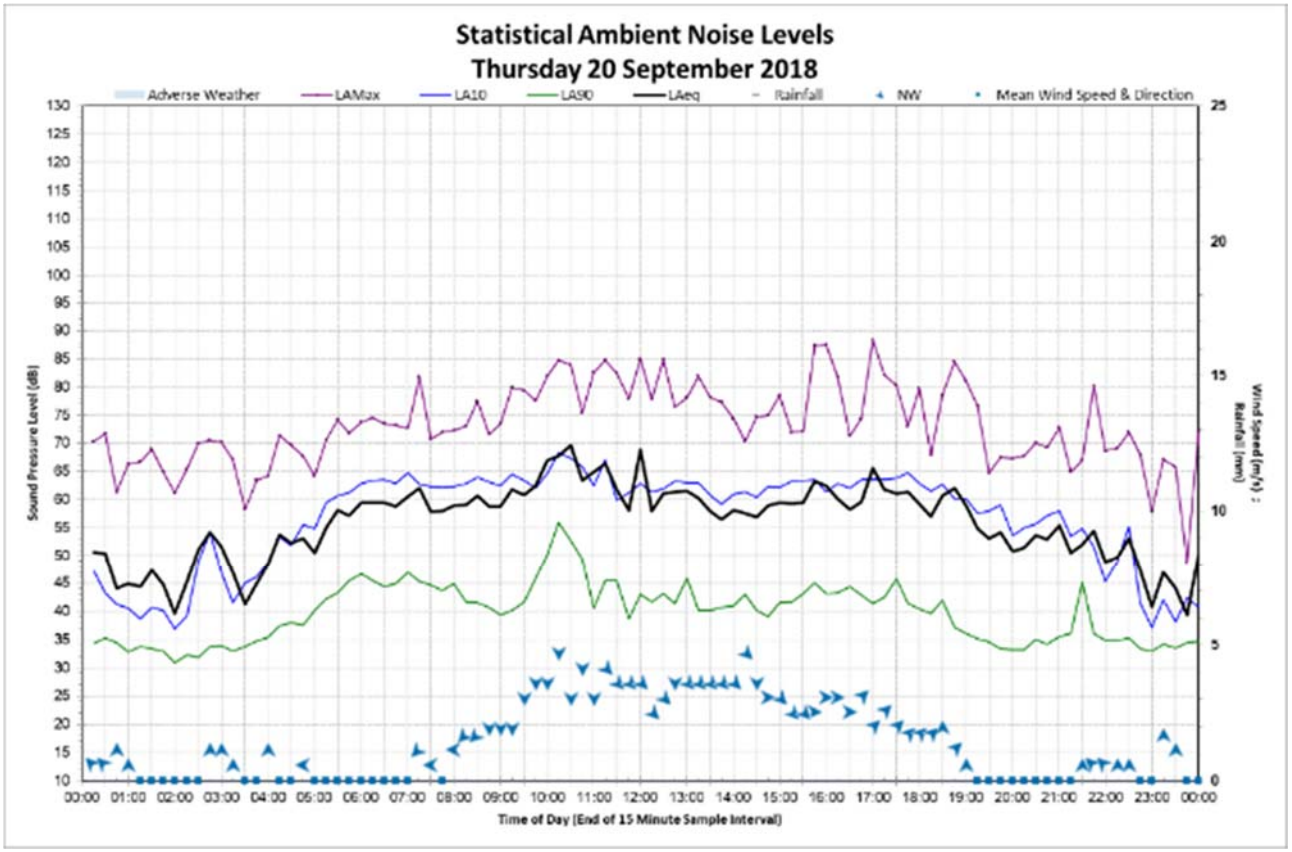

Statistical Ambient Noise Levels
Monday 17 December 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ;
Wind Speed (m/s) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

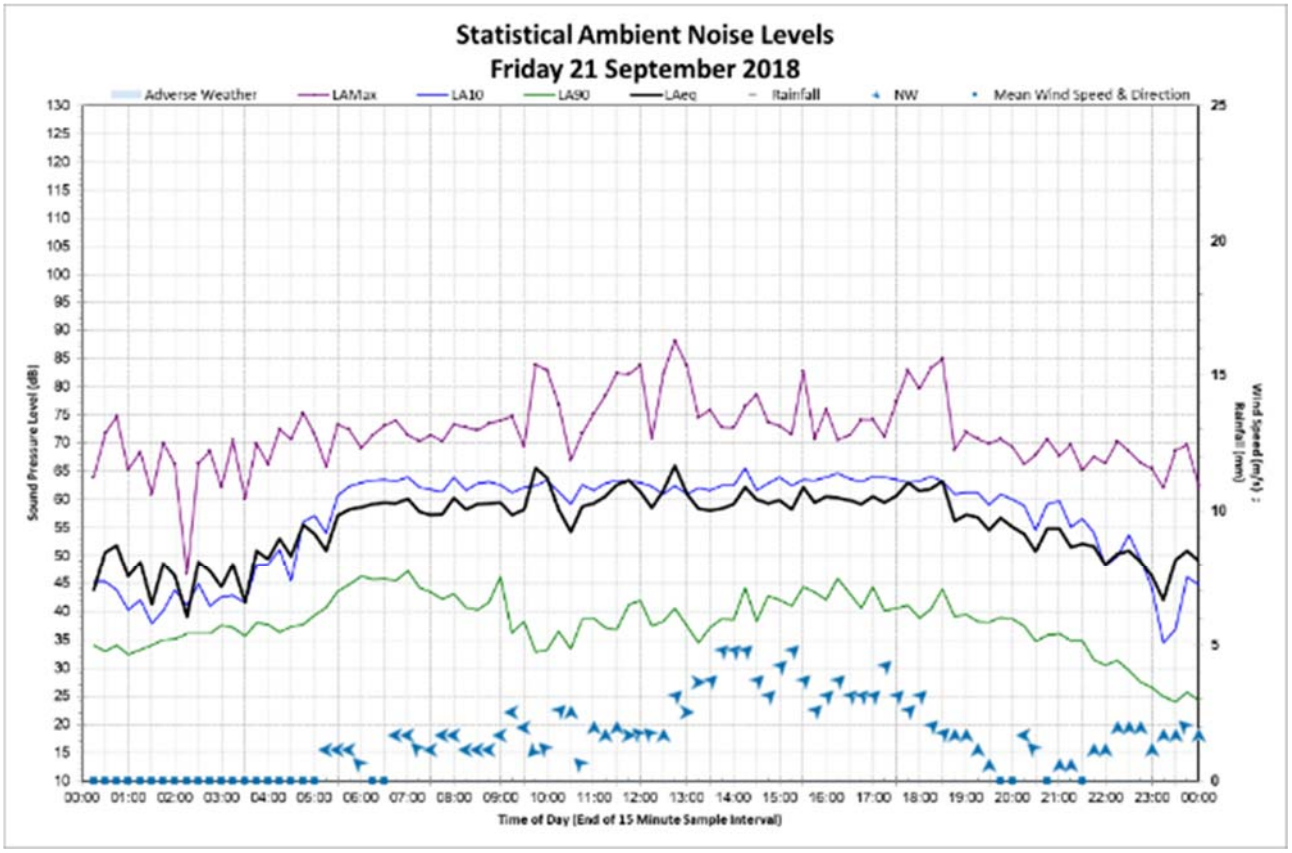

Statistical Ambient Noise Levels
Tuesday 18 December 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA)
Wind Speed (m/s) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

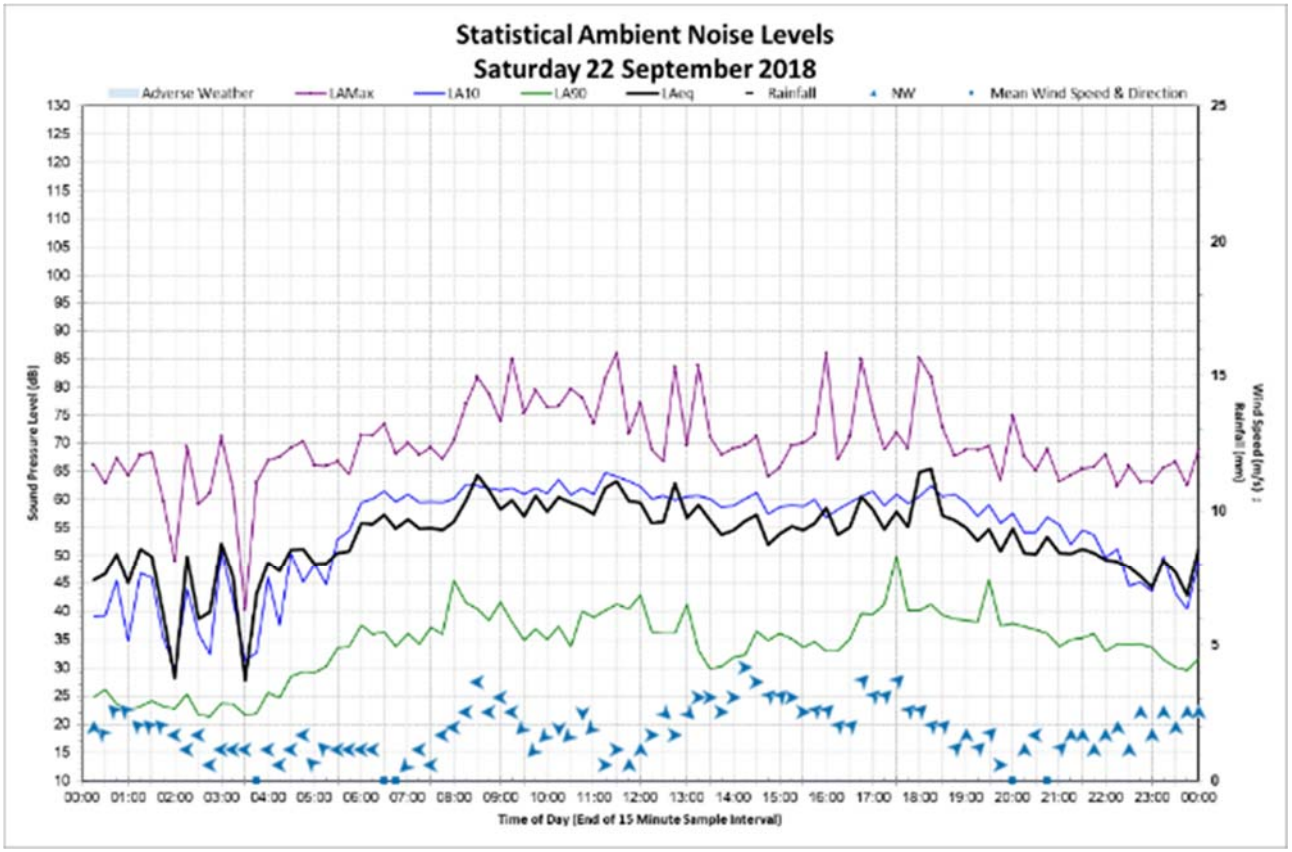

Statistical Ambient Noise Levels
Wednesday 19 December 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA)
Wind Speed (m/s) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

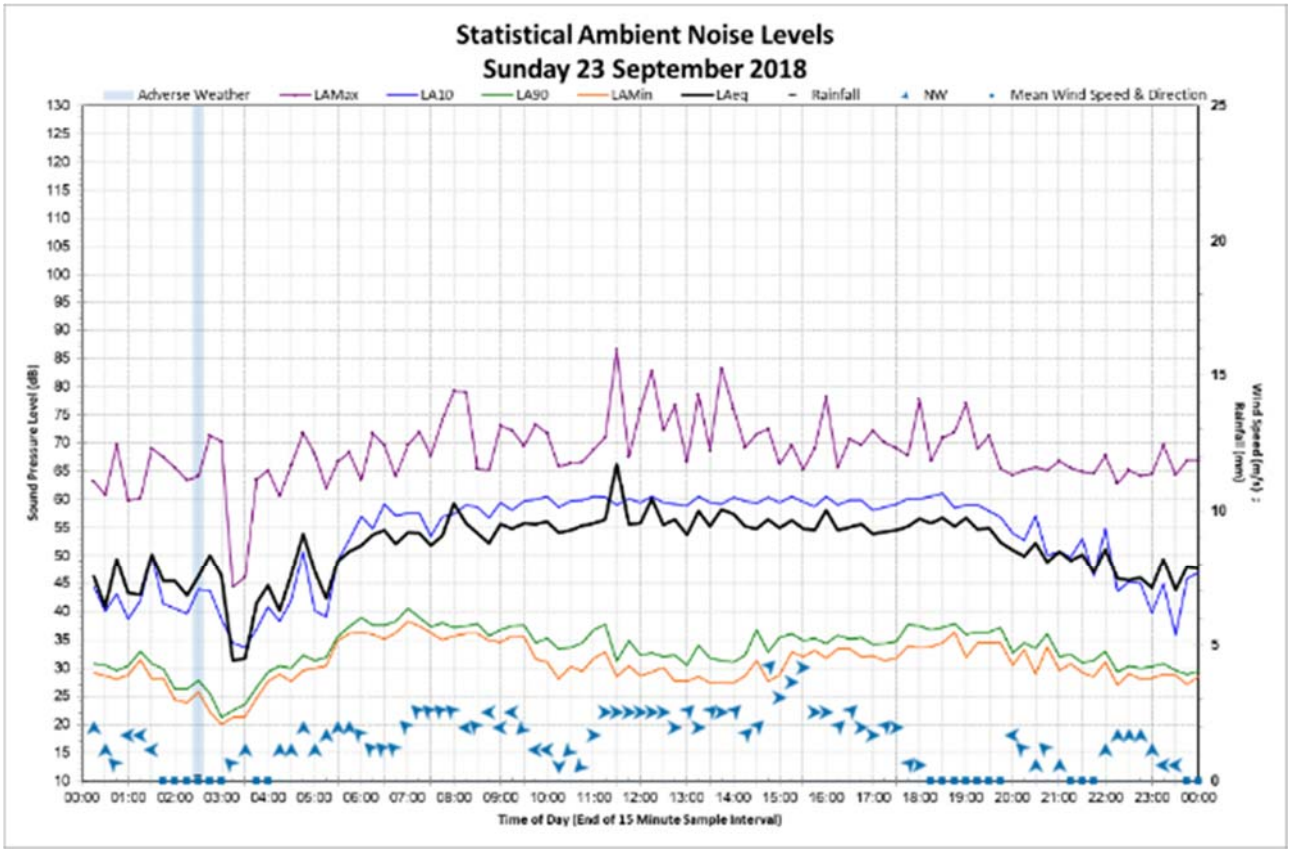
Site D – 105 Martin-Pelusey Road

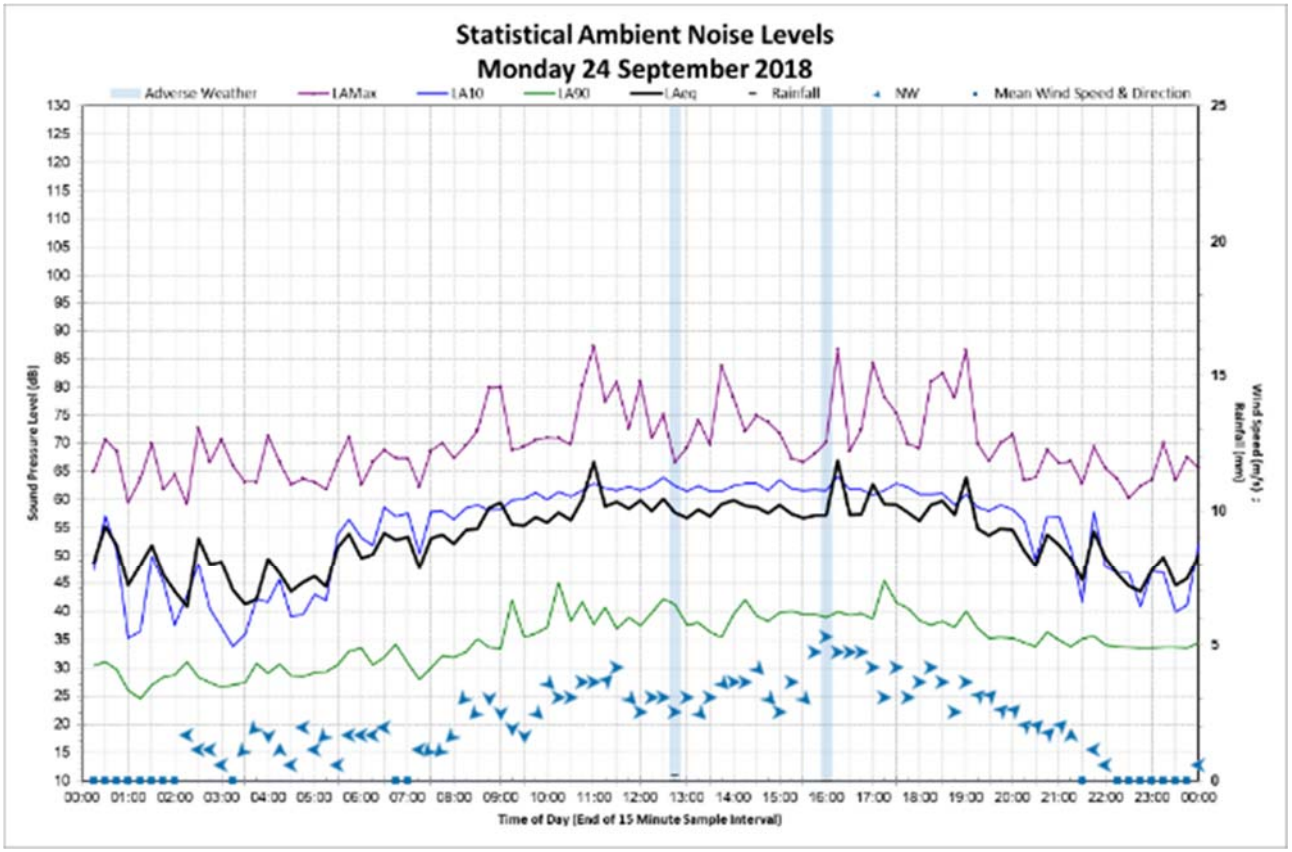




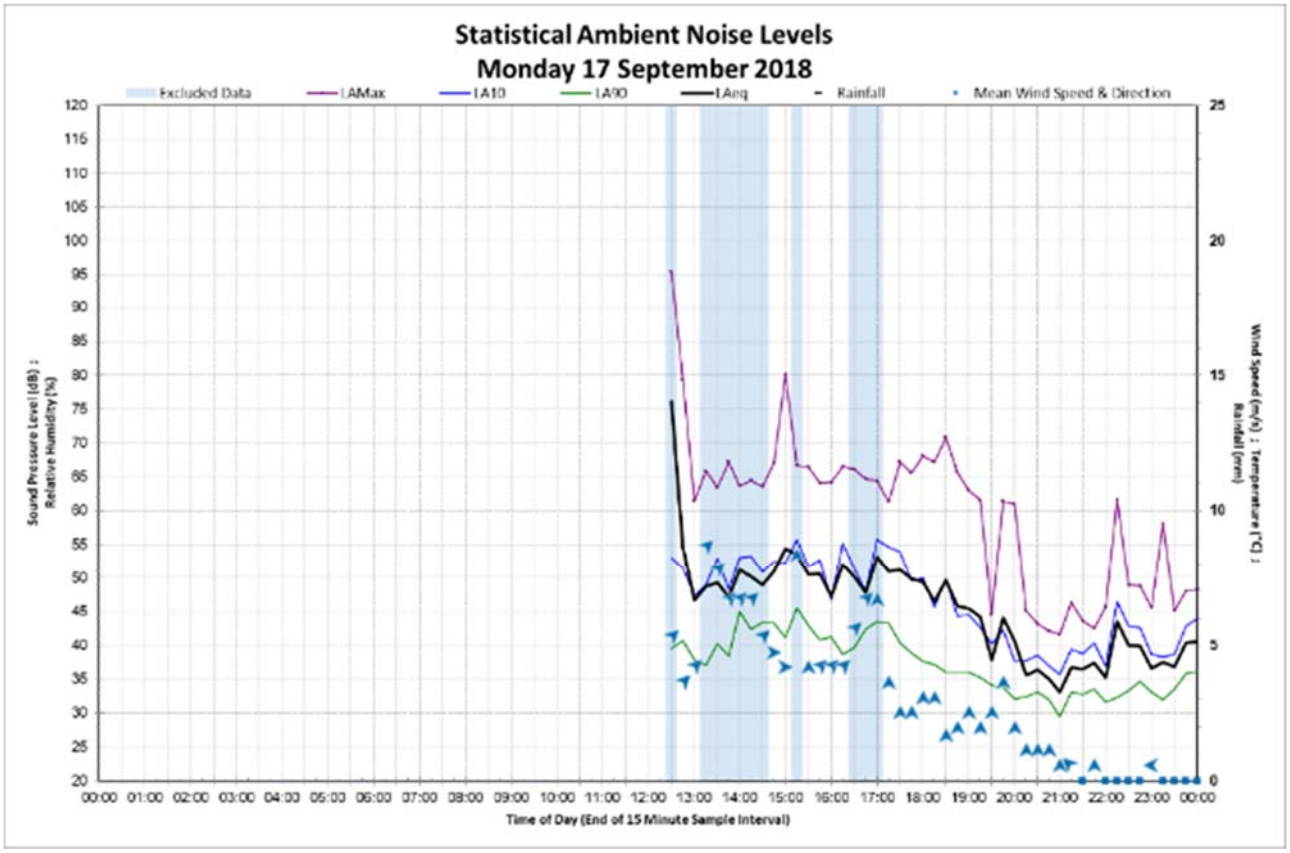

Statistical Ambient Noise Levels
Friday 21 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
NW
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

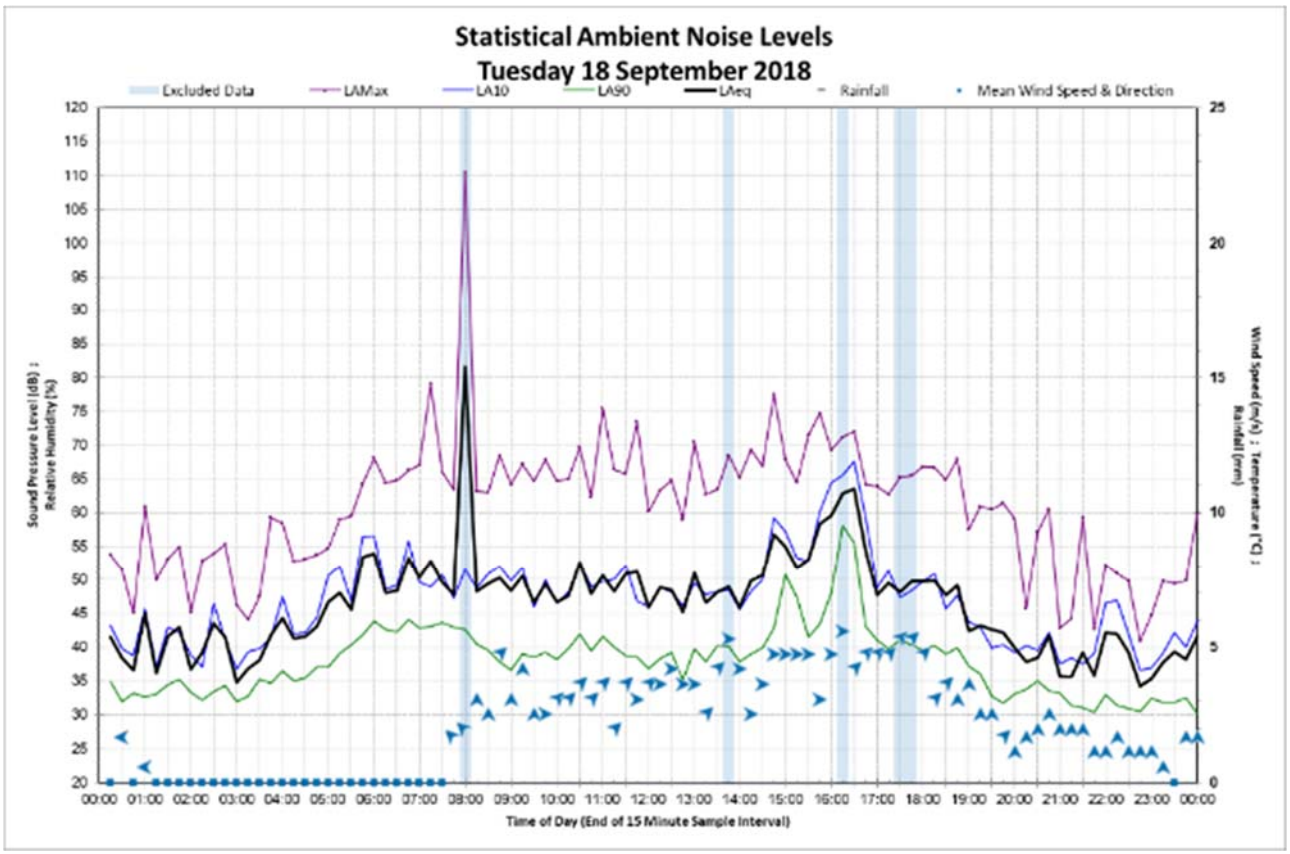

Statistical Ambient Noise Levels
Saturday 22 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
NW
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) & Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

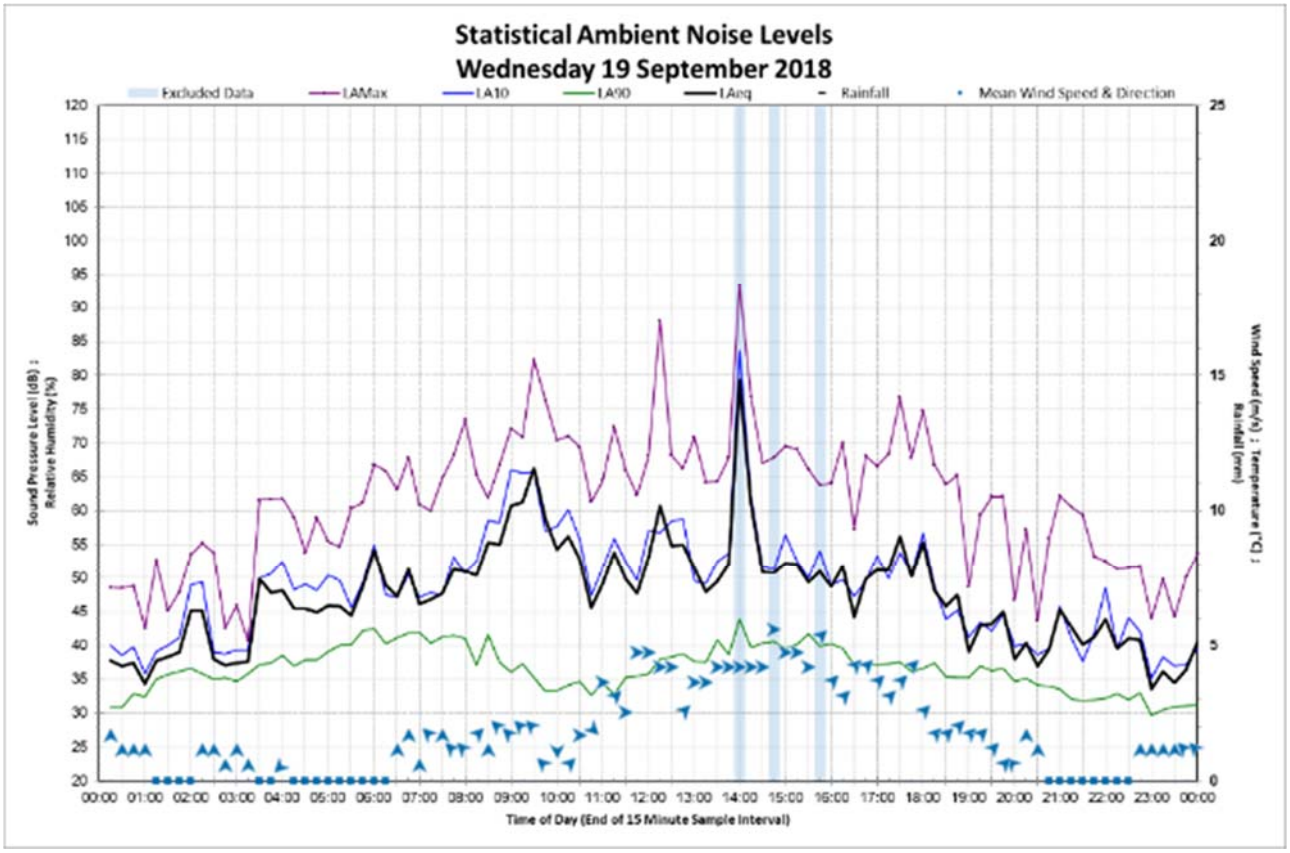

Statistical Ambient Noise Levels
Sunday 23 September 2018
Adverse Weather
LAMax
LA10
LA90
LAMin
LAeq
Rainfall
NW
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

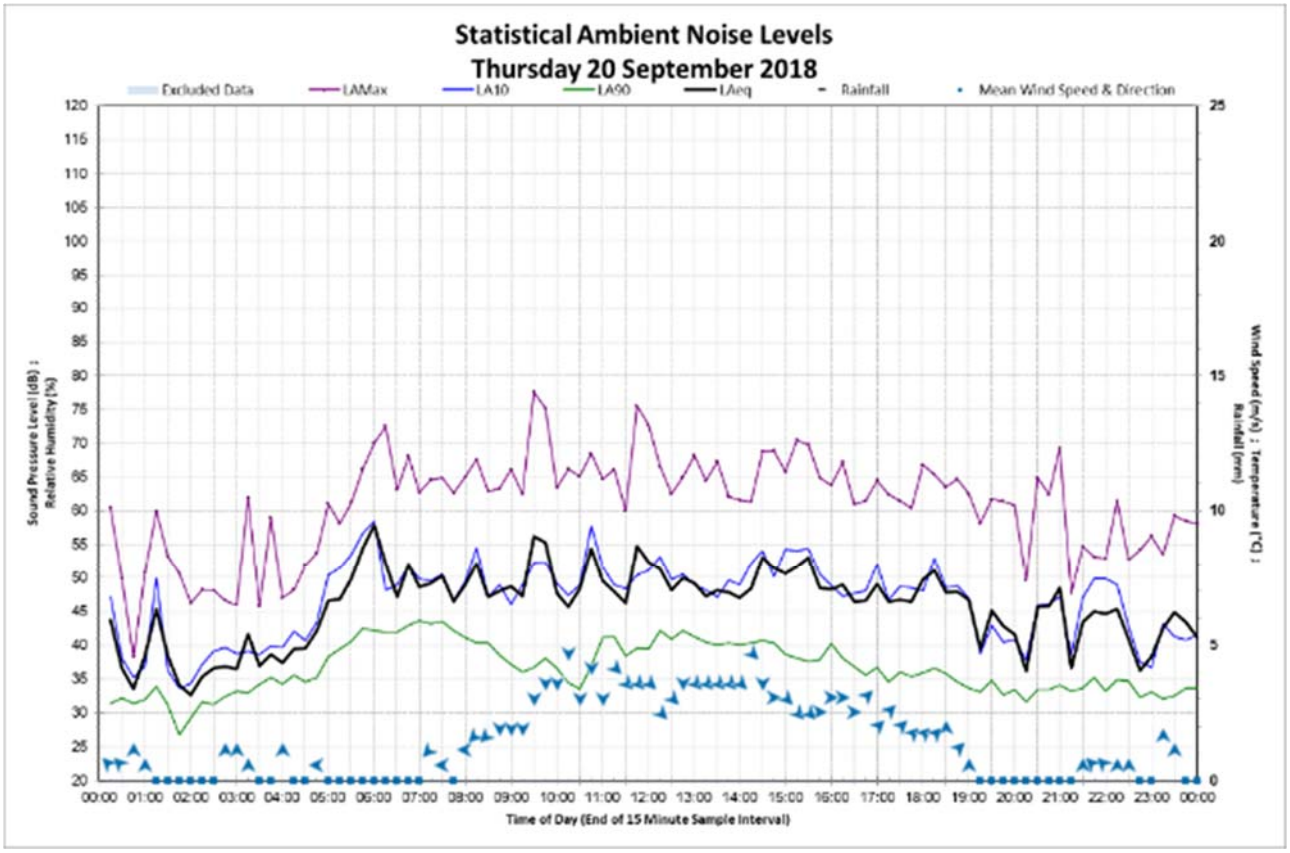

Statistical Ambient Noise Levels
Monday 24 September 2018
Adverse Weather
LAMax
LA10
LA90
LAeq
Rainfall
NW
Mean Wind Speed & Direction
Sound Pressure Level (dB)
Wind Speed (m/s) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

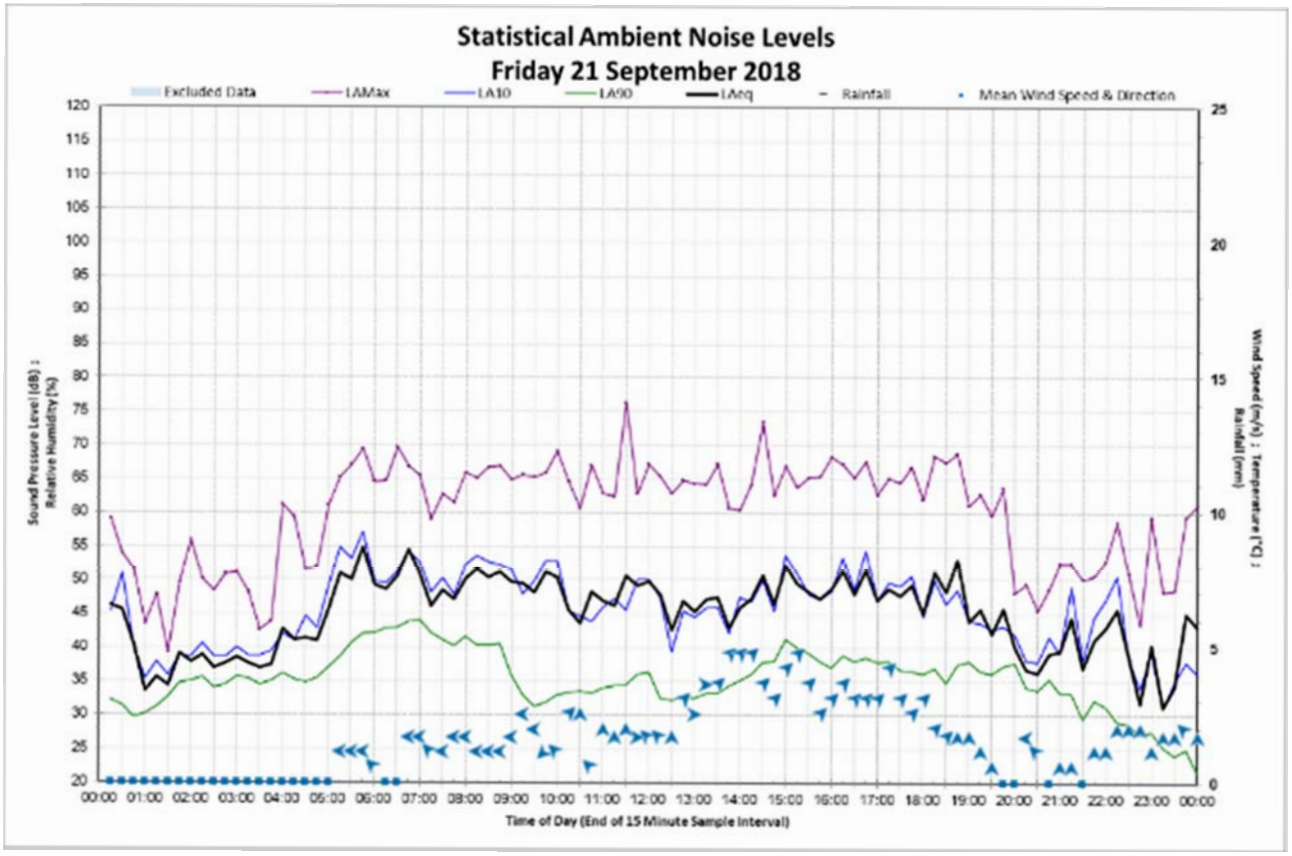
Site E – 365 Harris Road

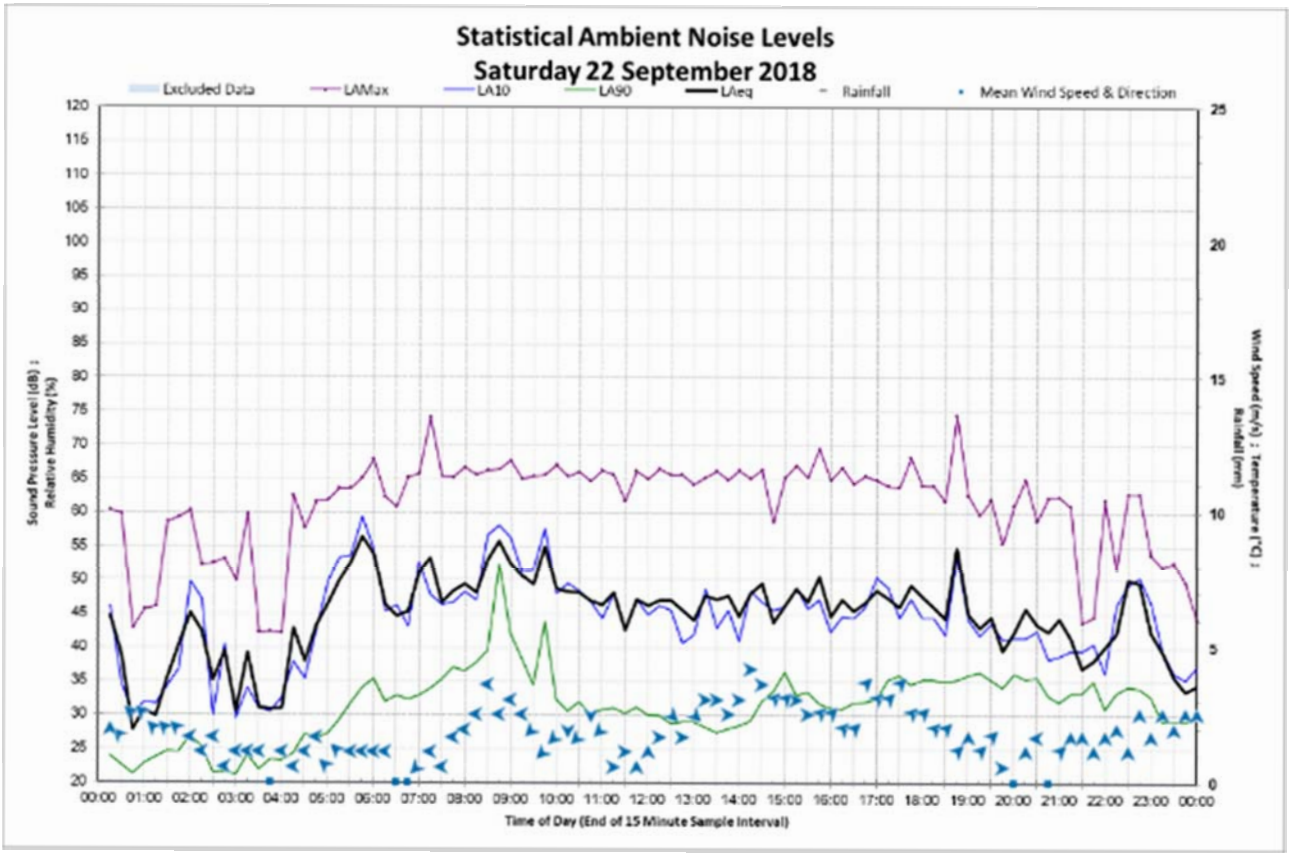





Statistical Ambient Noise Levels
Wednesday 19 September 2018
Excluded Data
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB) : Relative Humidity (%)
Wind speed (m/s) : Temperature (°C) : Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Thursday 20 September 2018
Excluded Data
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB) : Relative Humidity (%)
Wind speed (m/s) : Temperature (°C) : Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Friday 21 September 2018
Excluded Data
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB) : Relative Humidity (%)
Wind Speed (m/s) : Temperature (°C) : Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Saturday 22 September 2018
Excluded Data
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB) : Relative Humidity (%)
Wind Speed (m/s) : Temperature (°C) : Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

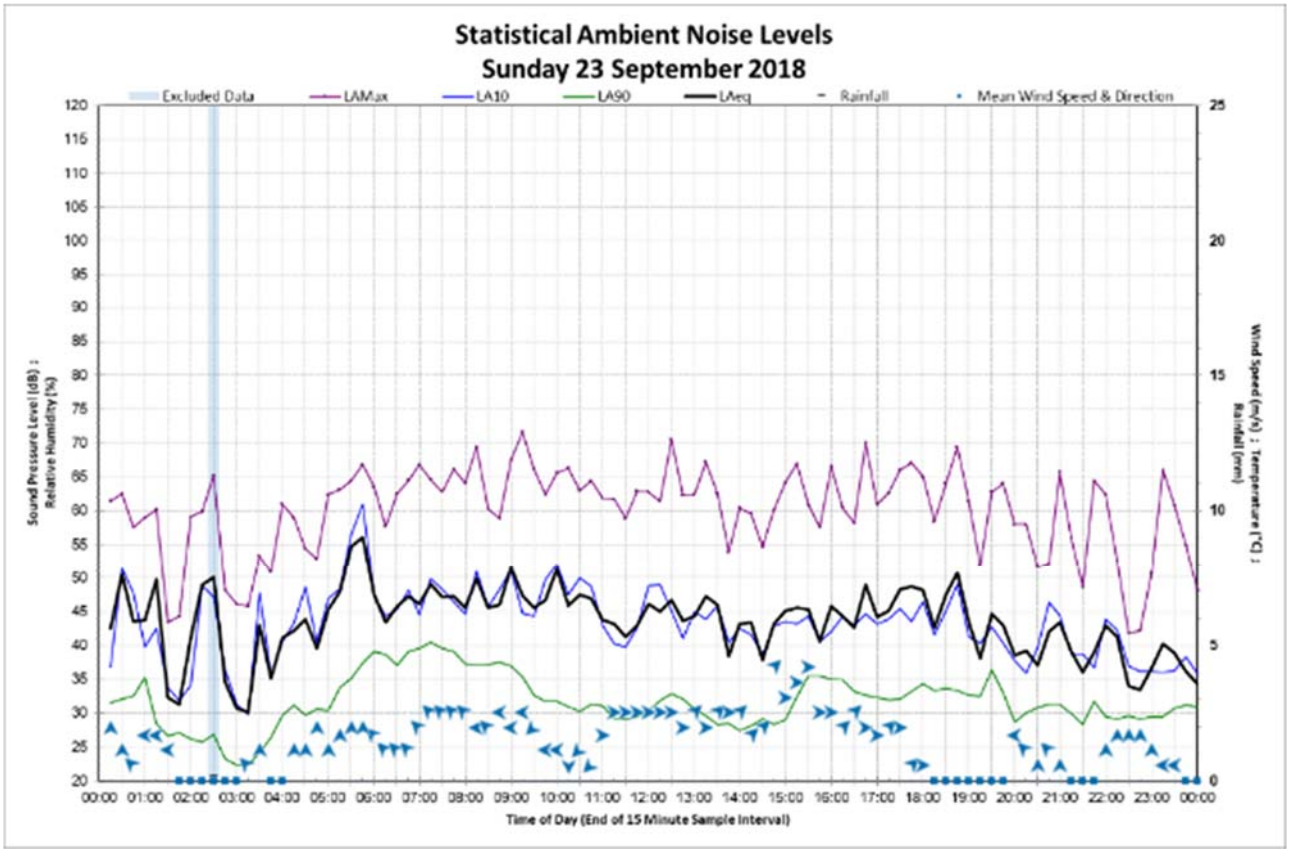

Statistical Ambient Noise Levels
Sunday 23 September 2018
Excluded Data
LAMax
LA10
LA90
LAeq
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dB) : Relative Humidity (%)
Wind speed (m/s) : Temperature (°C) : Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

Table D1 Meteorlogical data for Bunbury[4]

Date	Temperature (°C)		Wind Speed (m/s)		Wind Direction (°)		Rainfall (mm)
	9:00 AM	3:00 PM	9:00 AM	3:00 PM	9:00 AM	3:00 PM	
10/09/2018	16.9	15.3	5.3	7.2	293	248	2.2
11/09/2018	12.7	15.6	3.1	4.7	180	248	0.6
12/09/2018	13.7	15.6	3.6	4.2	270	270	0
13/09/2018	15.3	15.9	5.3	6.1	270	270	0
14/09/2018	13.7	14.4	6.1	4.7	225	180	10
15/09/2018	11.2	14.3	3.6	4.2	90	248	0.2
16/09/2018	12.3	13.2	3.6	6.7	180	248	3.4
17/09/2018	13.2	14.6	3.1	4.2	225	270	0
18/09/2018	14.3	17.1	3.1	4.7	203	270	0.2
19/09/2018	13.9	16.2	1.7	4.7	135	270	0
20/09/2018	15.5	19.6	1.9	3.1	23	315	0
21/09/2018	14.6	17.5	1.7	4.2	113	248	2.8
22/09/2018	17.4	20.6	3.1	3.1	90	248	0.4
23/09/2018	16.2	21.7	1.9	3.1	113	270	0
24/09/2018	15.7	18.2	2.5	2.5	360	293	0
25/09/2018	17.1	18	4.7	5.6	225	248	0
26/09/2018	14.6	17.1	0.6	6.1	45	248	0
13/12/2018	18.5	22.8	3.6	5.6	158	270	0.0
14/12/2018	21.1	22.1	1.7	6.7	90	248	0.2
15/12/2018	21.5	23.3	1.7	6.1	158	248	0.0
16/12/2018	21.8	21.9	1.9	7.8	270	270	0.0
17/12/2018	17.6	16.6	8.6	9.7	270	270	0.8
18/12/2018	17.1	17.8	6.1	6.1	225	225	8.2
19/12/2018	17.3	23.3	4.7	4.2	158	158	2.8

[4] Bureau of Meteorology, (2018). Bunbury Daily Weather Observations. Available online: http://www.bom.gov.au/climate/. Accessed 11 Dec 2018

BORR Team

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BUNBURY OUTER RING ROAD | PLANNING AND DEVELOPMENT

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15 August 2018

Fionnuala Hannon
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Fionnuala:

As requested, a Peer Review was undertaken of *Bunbury Outer Ring Road North Assessment, Rev A*; dated 29 January 2019 by Lloyd George Acoustics and reported in *Peer Review, Bunbury Outer Ring Road*; Reference: 18124767-01 Draft, dated 12 February 2019.

Following the peer review and other updates undertaken by GHD, a new report has been produced being *Bunbury Outer Ring Road Northern and Central Sections, Traffic Noise Assessment, Rev D*, dated 10 May 2019. This report has now been reviewed by Lloyd George Acoustics and we advise it is considered adequate for the purposes of identifying potential noise impacts and potential mitigation for the proposed road project.

We trust this information is acceptable and should you have any queries, please do not hesitate to contact me.

Regards,

Terry George