Appendix G

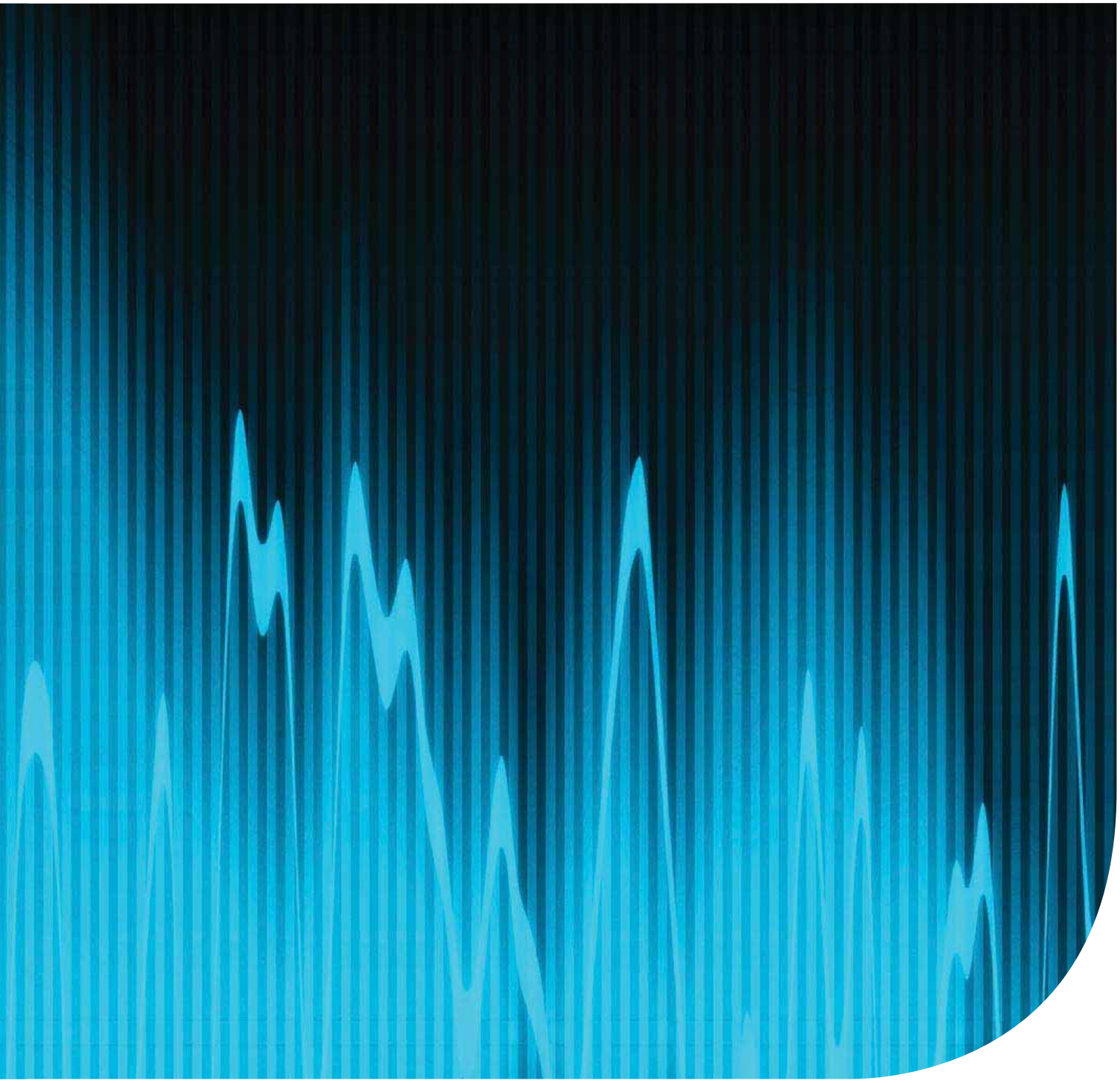
Noise assessment

EMGA Mitchell McLennan

Proposed Georges Cove Marina

Noise impact assessment

Prepared for Benedict Industries Pty Ltd | 21 July 2015



Planning + Environment + Acoustics

Proposed Georges Cove Marina

Noise impact assessment

Prepared for Benedict Industries Pty Ltd | 21 July 2015

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Proposed Georges Cove Marina

Final

Report J14149RP2 | Prepared for Benedict Industries Pty Ltd | 21 July 2015

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Table of Contents

Chapter 1 Introduction 1
1.1 Glossary of acoustic terms 1

Chapter 2 Project description 3
2.1 Overview 3
2.2 Access and parking 5
2.3 Hours of operation 5
2.4 Site preparation and construction 5
2.5 Key noise issues 5

Chapter 3 Existing environment 7
3.1 Noise sensitive receptors 7
3.2 Existing noise levels 7
3.2.1 Unattended noise monitoring 9
3.2.2 Attended noise monitoring 9
3.3 Prevailing meteorology 10
3.3.1 Prevailing winds 10
3.3.2 Temperature inversions 11
3.3.3 Drainage winds 11
3.3.4 Assessed meteorological conditions 11

Chapter 4 Noise criteria 13
4.1 Industrial noise 13
4.1.1 Intrusiveness 13
4.1.2 Amenity 14
4.1.3 Project specific noise level 14
4.2 Sleep disturbance 15
4.3 Music and people noise 16
4.4 Construction noise 17
4.5 Road traffic noise 19

Chapter 5 Noise modelling and assessment 21
5.1 Operations 21
5.1.1 Noise sources and operating assumptions 21
5.1.2 Noise model results and discussion 24
5.2 Construction 28
5.3 Road traffic noise 29
5.3.1 Traffic volume data 30
5.3.2 Predicted traffic noise levels 30

Table of Contents *(Cont'd)*

Chapter 6 Noise management and mitigation 35

6.1 Operations 35

6.2 Construction 35

6.2.1 Noise management plan 35

6.2.2 Community consultation 35

6.2.3 Adoption of general noise management practices (AS 2436-2010) 36

Chapter 7 Conclusion 39

Appendices

A Unattended noise logging charts

B INP wind analysis

Tables

1.1 Glossary of acoustic terms 1

1.2 Perceived change in noise 2

3.1 Noise sensitive assessment locations 7

3.2 Summary of measured background and ambient noise levels 9

3.3 Short-term attended results and correlation with long-term data 10

3.4 Octave band background noise measurement results, 1 June 2015 10

3.5 Weather conditions considered in noise modelling 11

4.1 Intrusive noise criteria 14

4.2 Amenity criteria 14

4.3 Project specific noise levels 15

4.4 Sleep disturbance criteria, residential assessment locations 16

4.5 OLGR music and patron noise criteria 17

4.6 ICNG residential noise management levels 17

4.7 Construction noise management levels 18

4.8 Road traffic noise assessment criteria for residential land uses 19

5.1 Operational noise source quantities and sound power levels 22

5.2 Music and patron octave band centre frequency noise levels 24

5.3 INP and sleep disturbance operational noise level predictions 24

Tables

5.4	Predicted music and patron octave band centre frequency noise levels	27
5.5	Representative equipment sound power levels and quantities	28
5.6	Predicted construction noise levels	29
5.7	Brickmakers Drive traffic count data	30
5.8	Predicted traffic noise modelling results – weekday	31
5.9	Predicted traffic noise modelling results – weekend	31
B.1	Percentage occurrence of 0.5–3 m/s winds	B.1

Figures

1.1	Common noise levels	2
2.1	Marina layout	4
3.1	Assessment and background noise monitoring locations	8
5.1	Acoustic barrier location	23
5.2	Acoustic screening	26
5.3	Predicted marina traffic noise levels - weekday	32
5.4	Predicted marina traffic noise levels - weekend	33

1 Introduction

Benedict Industries Pty Ltd (Benedict) proposes to construct and operate a marina and related facilities on part of Lot 7 DP 1065574 (also known as 146 Newbridge Road, Moorebank) in the Liverpool City Council Local Government Area (LGA). The marina development will utilise approximately 13 ha of the 22 ha site adjoining the Georges River. The portion that will be used to develop the marina is referred to as the 'subject site'. The overall site has been used for sand extraction, dredging and recycling operations.

The development will utilise an existing sand extraction dredge pond (approximately 6 ha) as the basis for forming the final marina basin. This will largely remove the need to import fill to restore the landform following the closure of the quarry as is permitted by the existing quarry planning approval.

The architect-designed marina redevelopment will provide an alternative means to implement the final restoration of the extractive industry activity on the site. It is an innovative proposal which is sensitive to the high value riverine locality and will provide valuable community recreational infrastructure which will reconnect the community with the river foreshore.

The proposed development is classified as local development and Liverpool City Council is the consent authority. Development consent is required under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and pursuant to the provisions of the Liverpool Local Environmental Plan (LEP) 2008 and Development Control Plan (DCP) 2008. The proposal is designated and integrated local development and the Sydney West Joint Regional Planning Panel (JRPP) is the determining authority.

EMGA Mitchell McLennan Pty Limited (EMM) has been commissioned by Benedict to prepare a noise impact assessment for the proposed marina development.

1.1 Glossary of acoustic terms

A number of technical terms are required for the discussion of noise. These are explained in Table 1.1.

Table 1.1 Glossary of acoustic terms

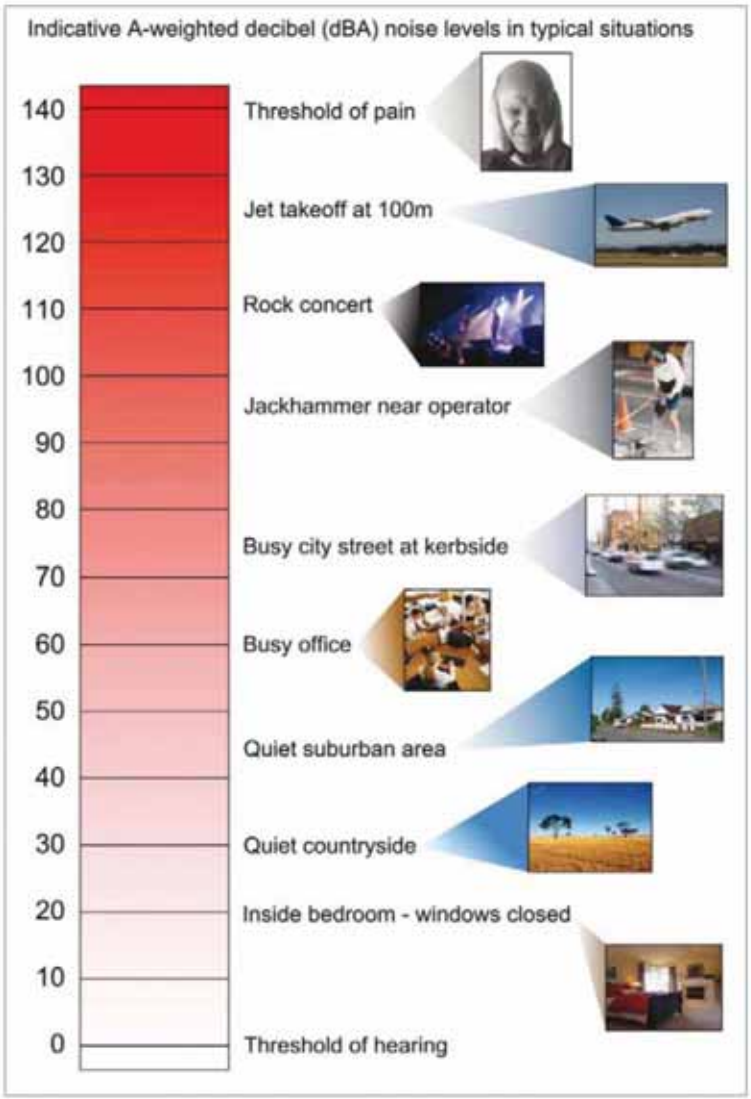
Term	Description
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_1	The noise level exceeded for 1% of a measurement period.
L_{10}	A noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise levels.
L_{90}	Commonly referred to as the background noise, this is the level exceeded 90% of the time.
L_{eq}	It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period. The $L_{eq,15min}$ descriptor refers to an Leq noise level measured over a 15-minute period.
L_{max}	The maximum root mean squared sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period.
Sound power level	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A positive temperature gradient. A meteorological condition where atmospheric temperature increases with altitude.

It is useful to have an appreciation of decibels, the unit of noise measurement. Table 1.2 gives an indication as to what an average person perceives about changes in noise levels:

Table 1.2 Perceived change in noise

Change in sound level (dB)	Perceived change in noise
1 to 2	typically indiscernible
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times as loud (or quarter) as loud

Examples of common noise levels are provided in Figure 1.1.



Source: Road Noise Policy (Department of Environment, Climate Change and Water (DECCW) 2011).

Figure 1.1 Common noise levels

2 Project description

2.1 Overview

The proposed marina development includes the construction and operation of the following main elements:

1. the Maritime Building located near the western boundary of the subject site. This structure will house:
    - a dry berth facility providing 250 berths for small craft;
    - a function centre; and
    - associated kiosks, tourist, entertainment and recreational and club facilities.
2. a wet berth facility for 186 small craft (including casual berths) which will consist of:
    - a marina basin;
    - rock protection of the basin and foreshore including embellishment and revegetation of river foreshore;
    - construction of public recreational facilities on the foreshore including bike paths, barbeque facilities and shelters;
    - floating berths and walkways;
    - a petrol tank (about 60,000 L) and a diesel tank (about 60,000 L) and fuel pumping facilities;
    - sewage pump out facilities; and
    - emergency berth access for Marine Area Command (Water Police), NSW Maritime (RMS), medical evacuation and other emergency services.
3. three external carparking areas and basement carparking providing a total of 637 car spaces;
4. a Private Marina Clubhouse on the northern portion of the RE2 (private recreation) zoned land; and
5. support infrastructure - power, water and sewerage services.

The proposed site layout is provided in Table 2.1.

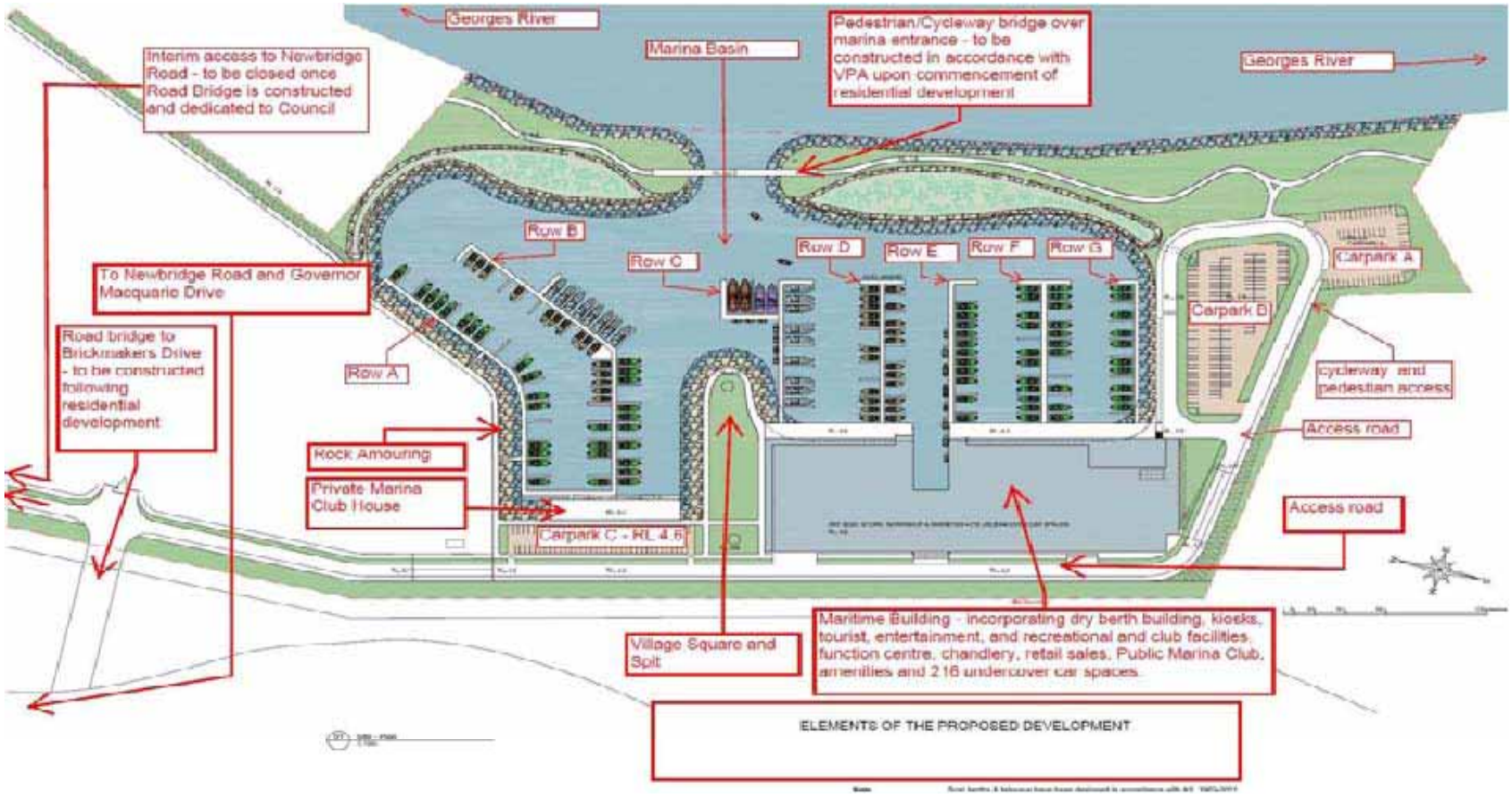


Figure 2.1 Marina layout

2.2 Access and parking

Access to the wet berths will be controlled by access control gates.

Public access to the marina (by car, bicycle and on foot) will be provided during normal operating hours. Equipment and products to the marina will be delivered by road during normal working hours, Monday to Friday.

Vehicular access from Brickmakers Drive to the proposed marina will be provided. The development will incorporate about 637 car spaces. These will be provided in a series of three external parking areas and in basement carparks.

2.3 Hours of operation

The proposed hours of the marina berthing operations are as follows:

- Summer (daylight saving): 7 am to 10 pm seven days a week; and
- Winter (non-daylight saving): 7 am to 10 pm seven days a week.

It is proposed that the private marina clubhouse, marina function centre and associated venues be permitted to operate to 12 midnight as previously approved by the JRPP.

2.4 Site preparation and construction

Construction activities will involve a range of different types of construction methods and equipment. The main activities will be the construction of the hardstands, installation of piling, installation of the pontoon units, and installation of services and access gangways.

Construction will commence once the quarrying activities on the site have been completed. It is expected to take about 22 to 36 weeks.

Construction will be restricted to the following hours:

- Monday to Friday: 7 am to 5 pm; and
- Saturday: 7 am to 1 pm.

No construction will take place on Sundays or public holidays.

There are no existing structures on the site to be removed.

2.5 Key noise issues

The broad potential noise issues for the subject site are:

- noise associated with construction;
- noise associated with the marina operations including boat movements and refuelling;
- music and patron noise from the restaurant and function centre precinct; and

- noise associated with the increased traffic to/from the site during construction and operation.

The noise assessment has focussed on these potential issues and includes noise measurements, derivation of suitable criteria in accordance with government policies and guidelines, and comparison of predicted noise emission levels to noise criteria.

3 Existing environment

3.1 Noise sensitive receptors

The subject site is surrounded by noise sensitive land uses such as existing residential properties and recreational land areas. There is future residential development proposed in areas west of Brickmakers Drive and proposed residential development, Georges Cove residential estate, directly north of the subject site.

Noise has been assessed out representative noise sensitive properties within these areas (referred to herein as assessment locations) to quantify potential noise levels from the site. The representative assessment locations are shown in Figure 3.1 and detailed in Table 3.1.

Table 3.1 Noise sensitive assessment locations

ID	Land use[1]	Approximate distance from site boundary (m)
R1	Residential	310
R2	Residential	170
R3	Residential (future)	60
R4	Residential	120
R5	Residential	210
R6	Residential	330
R7	Residential	410
R8	Active recreation	270
R9	Residential	370
R10	Residential (future)	0

Notes: 1. As defined in the NSW Industrial Noise Policy.

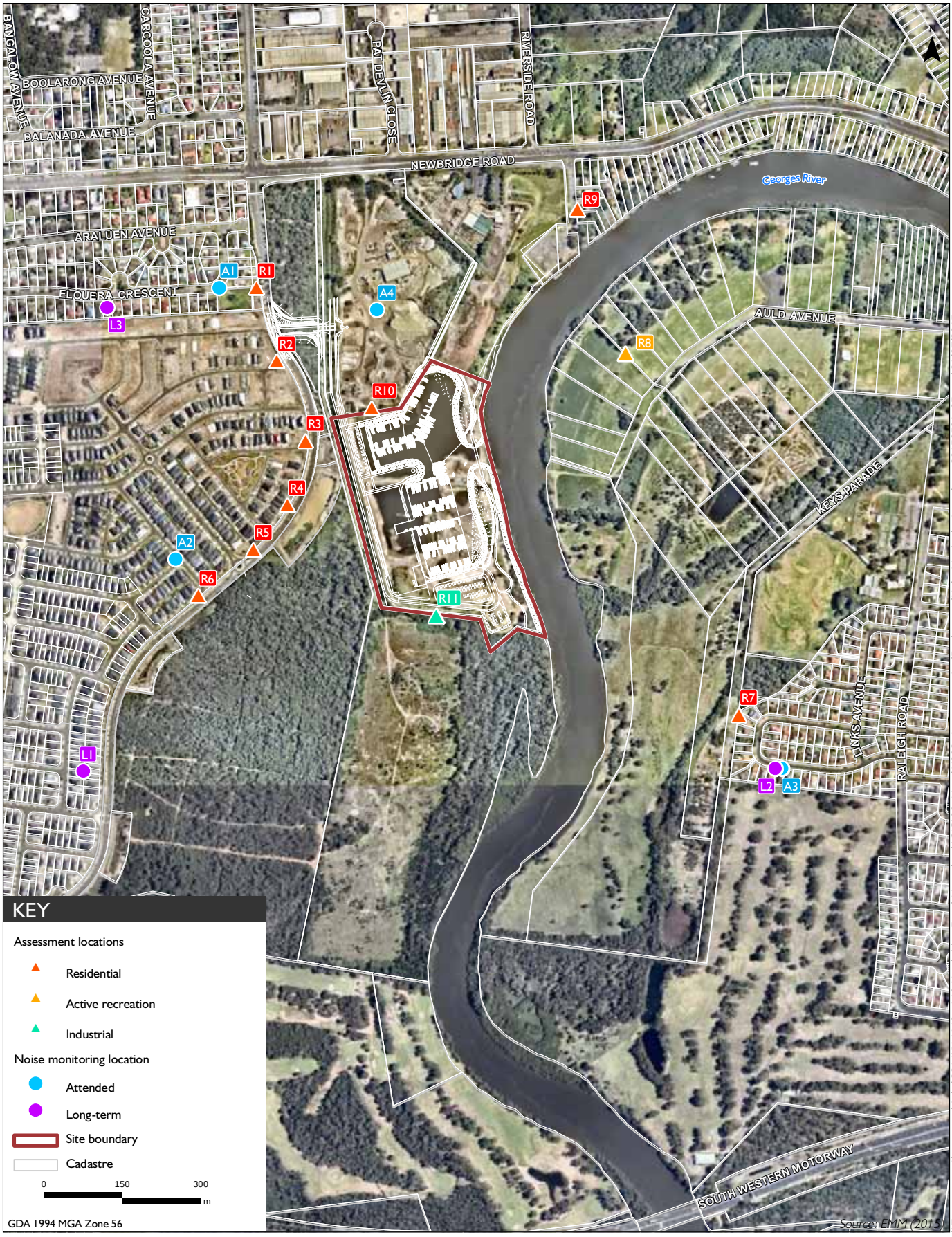
3.2 Existing noise levels

A key element in assessing environmental noise impact is to quantify the ambient and background noise, including any existing industrial noise where present.

Measured background noise levels from Wilkinson Murray (2012) have been adopted for residential areas north of subject site (near and around Elouera Crescent) where the monitoring was undertaken at the potentially most affected locations in accordance with the INP

Additional unattended and short-term operator-attended noise surveys were completed by EMM to validate historic noise monitoring data and to provide additional data at residential locations west of Brickmakers Drive closer to the subject site. The monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055-1997, “Acoustics - Description and Measurement of Environmental Noise”.

The noise monitoring locations were selected after giving due consideration to noise sources influencing the noise levels, the proximity of assessment locations to the subject site; security issues for the noise monitor and gaining permission for access from the residents or landowners. The selected monitoring locations are presented in Figure 3.1.



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EMM

Assessment and background noise monitoring locations

Georges Cove Marina
Noise Impact Assessment
Figure 3.1

3.2.1 Unattended noise monitoring

The unattended noise measurements were carried out using Acoustic Research Laboratories (ARL) EL-316 environmental noise loggers (serial number 16-707-042 and 16-306-036). The loggers were in place from 20 May to 4 June 2015 (16 days).

The noise loggers were programmed to record statistical noise level indices continuously in 15-minute intervals, including the L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}. Calibration was checked prior to, and following, measurements. Drift in calibration did not exceed ±0.5 dB(A). All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Weather data for the survey period was obtained from the nearest Bureau of Meteorology station at Bankstown Airport (station IDN60901). The wind speed and the rainfall data was used to exclude noise data during periods of rainfall and/or wind speed in excess of 5 m/s in accordance with INP methods.

A summary of existing background and ambient noise levels is given in Table 3.2. Results are provided for INP day (7 am to 6 pm), evening (6 pm to 10 pm) and night (10 pm to 7 am) periods and a modified night-time period (10 pm to 12 am) which was adopted for the Office of Liquor, Gaming and Racing (OLGR) music and patron noise assessment. Results from noise monitoring are provided graphically in Appendix A.

Table 3.2 Summary of measured background and ambient noise levels

ID	Location[1]	Date of monitoring	Rating Background Level (RBL), dB(A)				Ambient (L_{Aeq}) noise level, dB		
			Day	Evening	Night	OLGR night[2]	Day	Evening	Night
L1	10 Bushview Lane, Georges Fair	20/6/15 to 4/6/15 (EMM)	32	39	31	38	46	46	44
L2	41 Martin Crescent, Milpera	20/6/15 to 4/6/15 (EMM)	39	40	34	38	53	48	47
L3	28 Elouera Crescent, Moorebank	1/5/13 to 9/5/13 (WM)	42	40	35	n/a	53	48	45

Notes: *1. Levels shown are weather excluded.*

2. RBL from 10 pm to 12 am for OLGR assessment.

3.2.2 Attended noise monitoring

Operator attended measurements were conducted using a SVAN 979 integrating sound level meter (serial number 21095) to both quantify and characterise the existing noise sources. Attended measurements were synchronised with the noise loggers to allow correlation with unattended noise monitoring data. This method was relied on to verify background and ambient noise levels at some locations in the absence of long-term noise logger data, which was difficult to obtain due to property access restrictions in the Georges Cove area, directly west of the subject site.

Noise levels in the area surrounding the site were generally dominated by distant and local traffic, typical suburban noise, occasional aircraft noise and natural noise sources such birds and wind in trees. There was little existing industrial noise noted. Background noise levels were typically controlled by traffic on Newbridge Road in areas north of the subject site or by Brickmakers Drive and surrounding suburban streets in areas further south.

A summary of 15-minute attended noise measurement results along with the time correlated unattended noise logger result are provided in Table 3.3.

Table 3.3 Short-term attended results and correlation with long-term data

ID	Location	Date	Period	Start time	Attended measurement 15-minute noise level, dB		Synchronised measured 15-minute noise level at noise loggers, dB		
					L_{Aeq}	L_{A90}	ID[1]	L_{Aeq}	L_{A90}
A1	Elouera Cr	27/05/15	Day	15:15	54	47	L1/L2	39/53	35/42
		01/06/15	Night	22:30	44	40	L1/L2	55[2]/47	51[2]/38
A2	Speare St	27/05/15	Day	16:45	51	41	L1/L2	43/53	34/43
		01/06/15	Night	22:00	52	42	L1/L2	53[2]/41	45[2]/39
A3	Martin Cr	01/06/15	Night	23:00	43	38	L1/L2	57[2]/41	56[2]/38
A4	Georges Cove residential	27/05/15	Day	16:00	53	46	L1/L2	47/53	35/42

Notes: 1. Refer Table 3.2 and Figure 3.1 for monitoring locations.

2. Noise logger affected by extraneous noise source near the logger location (eg residential air conditioner).

Time correlated attended and unattended measurement results suggest that background noise levels during the day generally decrease as distance from Newbridge Road increases. Background noise levels during the night however generally stay consistent irrespective of the distance from Newbridge Road. Of the two loggers deployed by EMM, it is also evident that short-term attended noise levels at A2 and A4 (nearest to the proposed site) are better represented by the background noise levels recorded at L2, as opposed to L1.

The night-time background noise level spectra (L90) recorded at locations A1, A2 and A3 are presented in Table 3.4. These spectra are used as the basis of noise criteria for music and patron noise provided by Office of Liquor, Gaming and Racing (discussed further in Section 4.1).

Table 3.4 Octave band background noise measurement results, 1 June 2015

ID	Location	Time	Octave band centre frequency (Hz) background noise level ($L_{A90,15minute}$), dB									Overall dBA
			31.5	63	125	250	500	1k	2k	4k	8k	
A1	Eloura Cr (near R1)	10:30 pm	5	24	30	30	34	37	28	15	12	40
A2	Speare St (near R6)	10:00 pm	8	23	31	32	37	38	30	21	19	42
A3	Martin Cr (near R10)	11:00 pm	5	21	28	31	32	33	23	14	13	38

3.3 Prevailing meteorology

Noise propagation over distance can be significantly affected by the prevailing weather conditions. Of most interest are source to receiver winds, the presence of temperature inversions and drainage flow effects, as these conditions can enhance received noise levels. To account for these phenomena, the INP specifies meteorological analysis procedures to determine the prevalent weather conditions.

3.3.1 Prevailing winds

The INP recommends consideration of wind effects if they are a “feature” of the area. The INP defines “feature” as the presence of source-to-receiver wind speed (measured at 10 m above ground level) of 3 m/s or less, occurring for 30% of the time in any assessment period and season.

This is further clarified by defining source-to-receiver wind direction as being the directional component of wind. The INP states that where wind is identified to be a feature of the area then assessment of noise impacts should consider the highest wind speed below 3 m/s, which is considered to prevail for at least 30% of the time.

A thorough review of the vector components of the 15-minute wind data was undertaken for 2010 to 2014 (4 years) from the Holsworthy Control Range (AWS 067117). The wind directions that approach or exceed the 30% threshold are identified in Appendix B.

The results indicate a source to receiver prevailing wind of up to 3 m/s in most directions from site to surrounding assessment locations during the evening and night period (all wind directions in 22.5^{o} clockwise increments from ESE to the NW). Winds from the W and WNW prevail in the winter months during the day.

3.3.2 Temperature inversions

The INP states that the assessment of the impact of temperature inversions be confined to the night-time noise assessment period where temperature inversions occur.

Sigma theta data, which is required to determine the prevalence of temperature inversions, has been reviewed using the Holsworthy Control Range weather data, and have been identified as a feature of the area during the winter months.

3.3.3 Drainage winds

The INP states that a default wind drainage value should be applied where sources are at a higher altitude than the assessment location with no intervening topography. All assessment locations are at a similar or higher elevation than the subject site. Therefore, drainage winds have not been adopted in this assessment.

3.3.4 Assessed meteorological conditions

Predicted noise levels from operation of the subject site at all assessment locations have been calculated based on the meteorological parameters shown in Table 3.5.

Table 3.5 Weather conditions considered in noise modelling

Assessment period	Meteorological condition	Air temperature	Relative humidity	Wind speed	Direction	Stability category (Temperature gradient)
Day	Calm	15^{o}C	70%	0 m/s	n/a	D class
	Prevailing wind	15^{o}C	70%	3 m/s	W, WNW	D class
Evening and night	Calm	10^{o}C	70%	0 m/s	n/a	D class
	Prevailing wind	10^{o}C	70%	3 m/s	Source to receiver	D class
	Temperature inversion	10^{o}C	70%	0 m/s	n/a	F class

4 Noise criteria

4.1 Industrial noise

Noise from industrial sites or processes (eg onsite traffic movements, mechanical plant, refuelling pumps etc) in NSW are regulated by the local council, Department of Planning and Environment (DP&E) and/or the Environmental Planning Association (EPA) and usually have a licence and/or approval conditions stipulating noise limits. These limits are normally derived from operational noise criteria applied at assessment locations. They are based on INP guidelines (EPA 2000) or noise levels that can be achieved at a specific site following the application of all reasonable and feasible noise mitigation.

The INP guidelines for assessing industrial facilities have been used for this assessment. With respect to the criteria, the guidelines state:

> They are not mandatory, and an application for a noise producing development is not determined purely on the basis of compliance or otherwise with the noise criteria. Numerous other factors need to be taken into account in the determination. These factors include economic consequences, other environmental effects and the social worth of the development.

The objectives of noise assessment criteria for industry are to protect the community from excessive intrusive noise and preserve amenity for specific land uses.

To ensure these objectives are met, the EPA provides two separate criteria: intrusiveness criteria and amenity criteria. The fundamental difference being intrusiveness criteria apply over 15 minutes in any period (day, evening or night), whereas the amenity criteria apply to the entire assessment period (day, evening or night).

4.1.1 Intrusiveness

The intrusiveness criteria require that $L_{eq(15\text{-}min)}$ noise levels from the subject site during the relevant operational periods (ie day, evening and night) do not exceed the RBL by more than 5 dB.

The RBL recorded at L3 has been adopted for residential assessment locations R1 and R9 given their proximity to Newbridge Road.

The RBL recorded at L2 has been adopted for residential assessment locations R2 to R7 and R10. This is based on the review of attended and unattended noise data in Section 3.2.2 which demonstrates that, of the data available, the background noise environment at L2 is most representative of attended noise monitoring results near these locations. Applying L2 provides a conservative assessment approach for most assessment locations, as unattended noise logging results were generally lower than time correlated attended measurement results near these assessment locations.

Table 4.1 presents the intrusive noise criteria determined for the site based on the adopted RBLs.

Table 4.1 Intrusive noise criteria

Location	Period[1]	Adopted RBL, dB(A)	Intrusive criteria dB(A), $L_{eq(15\text{-}min)}$
R1, R9	Day	42	47
	Evening	40	45
	Night	35	40
R2-R7, R10	Day	39	44
	Evening	39[2]	44
	Night	34	39

Notes: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; Evening: 6 pm to 10 pm; Night: all remaining periods.

2. In accordance with the INP Application Notes, the RBL for day has been adopted for the evening period since the measured RBL during the evening was higher than that measured for daytime.

4.1.2 Amenity

The assessment of amenity is based on noise criteria specific to the land use. The criteria relate only to industrial noise and exclude road or rail noise. Where the measured existing industrial noise approaches recommended amenity criteria, it needs to be demonstrated that noise levels from new industry will not contribute to existing industrial noise.

Residential assessment locations potentially affected by the subject site have been categorised in the INP suburban amenity category. The corresponding recommended amenity criteria for the subject site are given in Table 4.2. It is noted that no adjustment to the acceptable recommended noise amenity level was necessary during all periods since there was no significant level of existing industrial noise at the assessment locations. It is noted that an application for Moorebank Recycling to the south of the subject site is being determined. However, the only daytime operations are proposed the facility would not influence the acceptable amenity level should the Recycling Facility be approved and developed.

Table 4.2 Amenity criteria

Assessment location	Indicative area	Time period	Recommended noise level dB(A), $L_{eq,period}$	
			Acceptable	Maximum
Residential R1 to R7, R9, R10	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Active recreation	All	When in use	55	60
Industrial	All	When in use	70	75

Source: INP (EPA 2000).

4.1.3 Project specific noise level

The project-specific noise level (PSNL) is the lower of the calculated intrusive or amenity criteria and is provided in Table 4.3 for all assessment locations.

Table 4.3 Project specific noise levels

Location	Period[1]	Intrusive criteria dB(A), $L_{eq(15\text{-}min)}$	Amenity criteria dB(A), $L_{eq,period}$	Project specific noise level (PSNL), dB(A)
R1, R9	Day	47	55	47 $L_{eq(15\text{-}min)}$
	Evening	45	45	45 $L_{eq(15\text{-}min)}$
	Night	40	40	40 $L_{eq(15\text{-}min)}$
R2-R7, R10	Day	44	55	44 $L_{eq(15\text{-}min)}$
	Evening	44	45	44 $L_{eq(15\text{-}min)}$
	Night	39	40	39 $L_{eq(15\text{-}min)}$
Milpera sports fields	When in use	n/a	55	55 $L_{eq,period}$
Future industrial	When in use	n/a	70	70 $L_{eq,period}$

Note: 1. Day: 7 am to 6 pm Monday to Saturday; 8 am to 6 pm Sundays and public holidays; evening: 6 pm to 10 pm; night is the remaining periods.

4.2 Sleep disturbance

It has been assumed that the subject site will operate during the night-time period from 10 pm to 12 am. Therefore assessment of sleep disturbance is required in accordance with the INP and associated application notes.

The operational criteria described in Section 4.1, which consider the average noise emission of a source over 15 minutes, are appropriate for assessing noise from generally steady-state sources, such as roof top mechanical plant noise. However transient noise from sources such as car movements is intermittent (rather than continuous) and needs to be assessed using the L_1 or L_{max} noise metrics.

The INP Application Notes (last updated June 2013) recognise that the current sleep disturbance criteria is not ideal. The assessment of potential sleep disturbance is complex and poorly understood and the EPA believes that there is insufficient information to determine a suitable alternative criteria.

Prior to the EPA determining a standard method to determine potential for sleep disturbance, the INP guideline suggests that $L_{A1(1min)}$ level of 15 dBA above the RBL is a suitable screening criteria for sleep disturbance for the night-time period. Guidance regarding potential for sleep disturbance is also provided in the NSW Road Noise Policy (RNP). The RNP calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

- maximum internal noise levels (L_{max}) below 50 to 55 dBA are unlikely to awaken people from sleep; and
- one or two noise events per night, with maximum internal noise levels (L_{max}) of 65 to 70 dBA, are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB(A). Therefore, external noise levels in the order of 60 to 65 dB(A) calculated at the facade of a residence are unlikely to cause sleep disturbance affects. Similarly, the World Health Organisation *Guidelines for Community Noise* (WHO 1999) suggest that levels below 45 dB(A) inside homes are unlikely to wake sleeping occupants.

The descriptors L_{max} and L_1 may be considered interchangeable which is accepted by the EPA.

If noise levels over the screening criteria were identified, then additional analysis would consider factors such as:

- how often the events would occur;
- the time the events would occur (between 10 pm and 7 am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Table 4.4 provides the sleep disturbance criteria for the residential assessment locations.

Table 4.4 Sleep disturbance criteria, residential assessment locations

Assessment location	Adopted RBL, dB(A)[1]	Sleep disturbance criteria dB(A), L_{max}
R1, R9	35	50
R2-R7, R10	34	49

Notes: 1.Night-time RBLs adopted.

4.3 Music and people noise

Noise from licensed venues is governed by the OLGR. The OLGR noise criteria for music and patron noise that would apply to the member and function centre precinct are as follows:

> The LA10 noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5Hz–8kHz inclusive) by more than 5dB between 7 am and midnight at the boundary of any affected residence.
>
> The LA10 noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5Hz–8kHz inclusive) between midnight and 7 am at the boundary of any affected residence.
>
> Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of midnight and 7 am.
>
> For the purpose of this condition, the LA10 can be taken as the average maximum deflection of the noise emission from the licensed premises.

Noise from music and patron noise at surrounding residences has been assessed during day and evening periods. However reactions will also occur during the most sensitive night-time period (10 pm to 12 am). The OLGR noise criteria for each period has been set by offsetting the measured short term $L_{90,15min}$ spectrum (refer Table 3.4) with the respective adopted RBL derived using the long-term noise monitoring results.

Table 4.5 OLGR music and patron noise criteria

ID	Period	Octave band centre frequency (Hz) noise criteria ($L_{10,15minute}$)								
		31.5	63	125	250	500	1k	2k	4k	8k
R1, R9 (A2 Spectra)	Day	12	31	37	37	41	44	35	22	19
	Evening	10	29	35	35	39	42	33	20	17
	Night	8	27	33	33	37	40	31	18	15
R2-R7, R10 (A3 Spectra)	Day	11	27	34	37	38	39	29	20	19
	Evening	11	27	34	37	38	39	29	20	19
	Night	10	26	33	36	37	38	28	19	18

Notes: *1. For the OLGR assessment, a daytime period of 7 am to 6 pm, evening period of 6 pm to 10 pm and night period of 10 pm to 12 am (midnight) has been adopted.*

2. Night time L90 octave band noise spectra has been adopted for all periods and offset to the respective day, evening and night RBL from Table 3.4. For the night period the RBL from 10 pm to 12 am (midnight) has been adopted to align with the proposed operating hours and the OLGR assessment periods.

4.4 Construction noise

The Department of Environment and Climate Change, *Interim Construction Noise Guidelines* (ICNG) (DECC 2009), provides guidelines for the assessment and management of noise from construction works. This assessment has adopted the ICNG quantitative approach.

i Noise management level

The ICNG suggests the following time restriction for construction activities where the noise is audible at residential premises:

- Monday to Friday 7 am−6 pm;
- Saturday 8 am−1 pm; and
- no construction work is to take place on Sundays or public holidays.

Table 3.5 is an extract from the ICNG and provides noise management levels for residential receivers for day and out of hours periods. These time restrictions are the primary management tool of the ICNG.

Table 4.6 ICNG residential noise management levels

Time of day	Management level $L_{eq,\ 15min}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15\text{-}min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Table 4.6 ICNG residential noise management levels

Time of day	Management level $L_{eq, 15min}$	How to apply
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: i) times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; and ii) if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL +5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see Section 7.2.2.

In summary, the ICNG noise management levels (NMLs) for activities during the standard hours are 10 dB above the existing background levels. For activities outside of the above hours the noise levels should be no more than 5 dB above the existing background levels. It is expected that construction will occur during standard hours only.

The residential construction NMLs and NMLs for other sensitive land uses for the proposal are provided in Table 4.7.

Table 4.7 Construction noise management levels

Location	Day-time RBL, dB(A)	Noise criterion, $L_{Aeq, 15min}$, dB
R1, R9	42	52
R2-R7, R10	39	49
Active recreation	n/a	65

4.5 Road traffic noise

The potential impacts of traffic noise resulting from both the construction and operational related traffic on public roads are assessed against criteria defined in the NSW Department of Climate Change and Water, *Road Noise Policy* (RNP). The application of appropriate criteria for the subject site has followed the two step process identifying the assessment and relative increase criteria as outlined in Section 3.4.1 of the RNP.

Table 4.8 presents the road noise assessment criteria for residential land uses, reproduced from Table 3 of the RNP.

Table 4.8 Road traffic noise assessment criteria for residential land uses

Road Category	Type of project/development	Assessment criteria dB(A)	
		Day (7 am–10 pm)	Night (10 pm–7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors.	$L_{eq,15hr}$ 60 (external)	$L_{eq,9hr}$ 55 (external)
	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors.		
	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.		
Local Roads	Existing residences affected by noise from new local road corridors.	$L_{eq,1hr}$ 55 (external)	$L_{eq,1hr}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing local roads.		
	Existing residences affected by additional traffic on existing local roads generated by land use developments.		

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB.

The $L_{eq,1hr}$ is the traffic noise level associated with the peak one hour traffic period of interest, day or night.

5 Noise modelling and assessment

5.1 Operations

This section presents the methods and assumptions used to model noise levels from the operation of the subject site.

Noise levels from the site's operation was modelled using Brüel and Kjær Predictor software. 'Predictor' calculates total noise levels at assessment locations from the concurrent operation of multiple noise sources. The model considers factors such as:

- the lateral and vertical location of noise sources;
- source to assessment location distances;
- ground effects;
- atmospheric absorption;
- topography of the subject site and surrounding area; and
- applicable meteorological conditions (refer to Section 3.3).

Operational noise sources and activities included in the George Cove Marina model included onsite car and delivery truck movements, boat movements, refuelling and general boat storage and marina operation. Noise levels over a typical worst case 15-minute scenario were modelled and assessed against INP and OLGR noise criteria.

5.1.1 Noise sources and operating assumptions

i INP assessment

Noise sources; quantities over day, evening and night periods and associated sound power levels that were modelled are presented in Table 5.1 These are based on advice from the proponent and benchmarked against similar facilities. Sound power levels have been sourced from an EMM database which has been developed from measurements taken at similar facilities, or where measurement data weren't available, sourced from published sound power level data.

Table 5.1 Operational noise source quantities and sound power levels

Noise source	Quantity over worst case 15-minute period			Individual sound power level, dB(A) re 10^{-12} watts	
	Day	Evening	Night	$L_{eq,15min}$	L_{max1}
Boat idling/slow moving	10	10		95	n/a[2]
Refuelling pump	1	1		94	n/a[2]
Chiller	2	2	2	89	n/a[3]
Car	5	5	5	89	97[4]
Delivery truck	1			102	n/a[2]
Workshop activity	1			98	n/a[2]
Forklift 45t	1	1		104	n/a[2]

Notes: *1. L_{max} sound power level is used for the sleep disturbance assessment during the night period only.*

2. Steady state noise source unlikely to generate sleep disturbance impacts.

3. Day and evening operation only – sleep disturbance assessment not applicable.

4. L_{max} sound power level of a car starting which is representative of the loudest noise event from this noise source.

In addition to the above, the following assumptions have been considered in the operational noise model:

- boats will be spread evenly at worst case operating locations relative to surrounding assessment locations and are assumed to operate for 5 minutes in any 15-minute period;
- workshop activity and the forklift use are assumed in the marina buildings continuously for 15 minutes with all windows and doors (as applicable) closed;
- all other noise sources are assumed to operate continuously for 15 minutes at typical worst case operating locations relative to assessment locations; and
- a two metre acoustic barrier is constructed to the west of the carpark as indicated in Figure 5.1. This is to mitigate carpark activity during the night-time period.

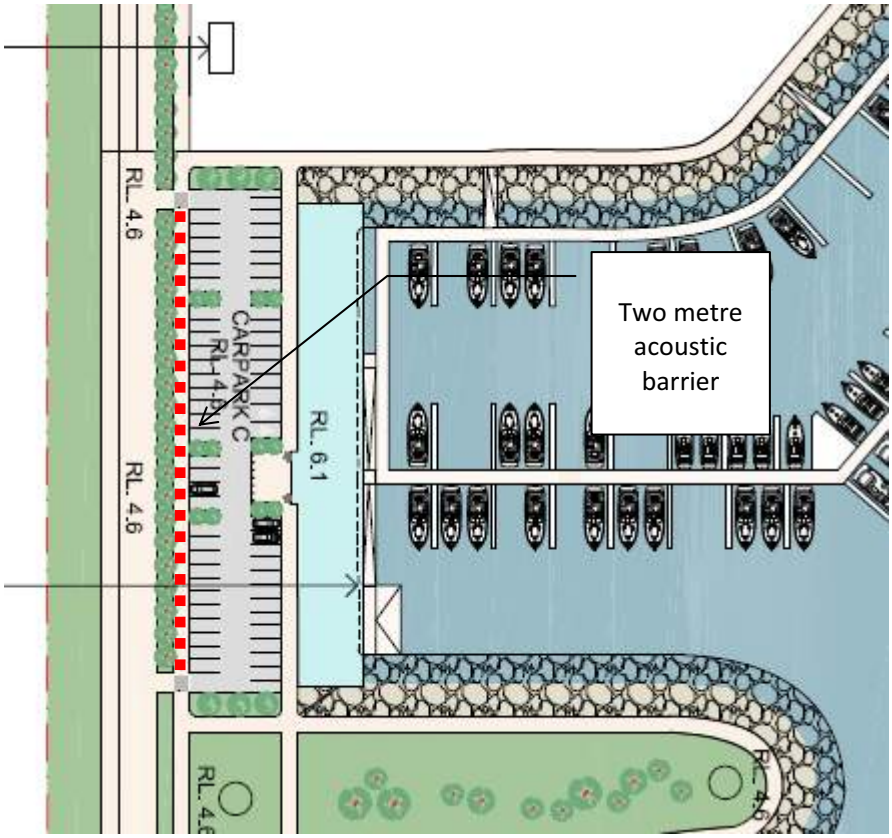


Figure 5.1 Acoustic barrier location

ii OLGR assessment

Source levels adopted for the music and patron noise assessment are presented in Table 5.2. The music source level is based on an internal reverberant sound pressure level measurement of a live band at a private function. The patron noise sound power level has been adopted based on data available in published documents and EMM measurements.

It is worth noting that there are many factors which influence the magnitude of patron noise, including number of people and mix, their behaviour, age, demographic, level of alcohol consumption and the level of background noise, to name a few. Therefore it is difficult to apply a typical sound power level based on number of people alone. Conservative sound power levels have been adopted to account for potential high patron noise levels which are appropriate given the capacity of the marina function and public spaces.

Table 5.2 Music and patron octave band centre frequency noise levels

Description	Assessed music and patron noise levels ($L_{A10,15minute}$), Hz									Overall dBA
	31.5	63	125	250	500	1k	2k	4k	8k	
Music noise, Lp,rev[1]	58	69	76	81	83	86	83	79	75	90
Patron noise sound power level (>20 patrons)	-	70	81	81	87	89	83	75	-	93
Patron noise sound power level (<20 patrons)	-	66	77	77	83	86	80	71	-	89

Notes: 1. Internal reverberant sound pressure level.

5.1.2 Noise model results and discussion

i INP assessment

Predicted $L_{Aeq(15\text{-}min)}$ noise levels from the site at all assessment locations are provided in Table 5.3. Noise levels have been predicted based on the meteorological conditions provided in Table 3.5.

Table 5.3 INP and sleep disturbance operational noise level predictions

Assessment location	Period	Predicted $L_{Aeq,15min}$ noise level, dB		Predicted L_{Amax} noise level, dB		Criteria	
		Calm	Adverse	Calm	Adverse	PSNL, $L_{Aeq,15min}$	Sleep disturbance, L_{Amax}
R1	Day	38	n/a	n/a	n/a	47	n/a
	Evening	37	39	n/a	n/a	45	n/a
	Night	33	35	41	43	40	50
R2	Day	41	n/a	n/a	n/a	44	n/a
	Evening	41	42	n/a	n/a	44	n/a
	Night	38	39	46	47	39	49
R3	Day	43	n/a	n/a	n/a	44	n/a
	Evening	41	42	n/a	n/a	44	n/a
	Night	38	39	45	47	39	49
R4	Day	42	41	n/a	n/a	44	n/a
	Evening	39	41	n/a	n/a	44	n/a
	Night	37	38	44	46	39	49
R5	Day	34	n/a	n/a	n/a	44	n/a
	Evening	32	34	n/a	n/a	44	n/a
	Night	31	33	37	39	39	49
R6	Day	34	32	n/a	n/a	44	n/a
	Evening	31	34	n/a	n/a	44	n/a
	Night	30	33	38	40	39	49

Table 5.3 INP and sleep disturbance operational noise level predictions

Assessment location	Period	Predicted $L_{Aeq,15min}$ noise level, dB		Predicted L_{Amax} noise level, dB		Criteria	
		Calm	Adverse	Calm	Adverse	PSNL, $L_{Aeq,15min}$	Sleep disturbance, L_{Amax}
R7	Day	34	37	n/a	n/a	44	n/a
	Evening	34	37	n/a	n/a	44	n/a
	Night	25	28	33	36	39	49
R8	When in use	39	41	n/a	n/a	55	n/a
R9	Day	36	38	n/a	n/a	47	n/a
	Evening	36	38	n/a	n/a	45	n/a
	Night	24	26	31	34	40	50
R10	Day	**54**	**54**	n/a	n/a	44	n/a
	Evening	**54**	**54**	n/a	n/a	44	n/a
	Night	37	38	45	46	39	49

Notes: 1. Predicted noise level shown in bold with grey shading indicated exceedance of the PSNL.

Predicted noise levels satisfy the sleep disturbance criteria at all assessment locations.

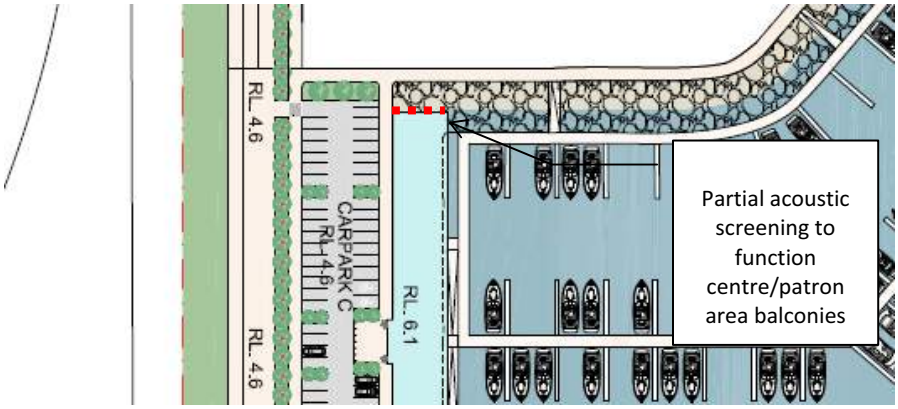
Predicted noise levels satisfy the INP PSNLs at all assessment locations during all periods, with the exception of R10 during the day and evening periods for calm and adverse weather conditions.

The predicted noise level above the PSNL at R10 is caused by boat movements directly south of this assessment location. It is anticipated however that noise controls (eg buffers, architectural noise screening etc) would be incorporated in the future Georges Cove residential development which would mitigate marina noise activity.

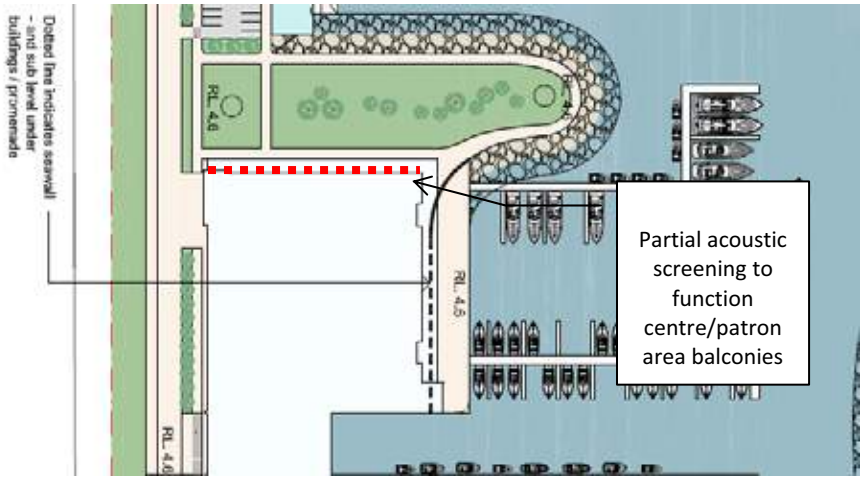
ii Music and patron noise assessment

Predicted music and patron noise levels from the site at the nearest boundary of all assessment locations are provided in Table 5.4. The predictions are based on the following main assumptions:

- a live band (or similar) is located inside each function room generating the sound power level presented in Table 5.2;
- windows are assumed closed with standard 4 mm glazing;
- patrons are located externally on outdoor areas and are at capacity. Outdoor area capacity has been assumed as the total external seating as indicated in DA drawings for each respective outdoor area; and
- the north outdoor areas indicated in Figure 5.2 have the option for partial screening (eg louvres) providing at least 7 dB of patron noise reduction.



Clubhouse



Marina Building

Figure 5.2 Acoustic screening

A comparison of modelled noise levels at each sensitive receptor to OLGR criteria (refer to Table 4.5) is presented in Table 5.2. The results provided in Table 5.4 represent the level of noise above the OLGR criteria. Compliance with the OLGR criteria is therefore indicated by a zero. Noise levels presented are based on the highest predicted noise level from all assessed meteorological conditions provided in Table 3.5.

Table 5.4 Predicted music and patron octave band centre frequency noise levels

Description	Period	Predicted noise level above OLGR criteria ($L_{A10,15minute}$), Hz, dB									Overall dBA
		31.5	63	125	250	500	1k	2k	4k	8k	
R1	Day	2	0	0	0	0	0	0	0	0	31
	Evening	6	0	0	0	0	0	0	0	0	
	Night	8	0	0	0	0	0	0	0	0	
R2	Day	6	0	0	0	0	0	0	0	0	33
	Evening	8	0	0	0	0	0	0	0	0	
	Night	9	0	0	0	0	0	0	0	0	
R3	Day	10	0	0	0	0	0	0	0	0	38
	Evening	11	2	0	0	0	0	0	0	0	
	Night	12	3	0	0	0	0	0	0	0	
R4	Day	10	0	0	0	0	0	0	0	0	35
	Evening	11	1	0	0	0	0	0	0	0	
	Night	12	2	0	0	0	0	0	0	0	
R5	Day	2	0	0	0	0	0	0	0	0	25
	Evening	3	0	0	0	0	0	0	0	0	
	Night	4	0	0	0	0	0	0	0	0	
R6	Day	0	0	0	0	0	0	0	0	0	21
	Evening	1	0	0	0	0	0	0	0	0	
	Night	2	0	0	0	0	0	0	0	0	
R7	Day	8	0	0	0	0	0	0	0	0	36
	Evening	8	0	0	0	0	0	0	0	0	
	Night	9	0	0	0	0	0	0	0	0	
R9	Day	8	0	0	0	0	0	0	0	0	38
	Evening	10	0	0	0	0	0	0	0	0	
	Night	12	0	0	0	0	0	0	0	0	
R10	Day	13	8	8	4	10	12	15	15	0	54
	Evening	13	8	8	4	10	12	15	15	0	
	Night	14	9	9	5	11	13	16	16	0	

Notes: 1.Blue highlight indicates exceedance predominantly generated by music noise; orange highlight indicates exceedance predominately generated by patron noise.

Noise level predictions indicate that energy in 31.5 and 63 Hz octave band centre frequencies will exceed the OLGR criteria at all assessment locations for the majority of periods. This exceedance is generated by music noise in function areas. This can be mitigated/managed by limited the low frequency noise output of the public address system or increasing the glazing thickness, or a combination of both. Such measures should be designed and specified at the project detailed design stage (discussed further in Section 6).

The predicted noise level above the OLGR criteria at R10 is predominantly generated by patron noise at the Marina Clubhouse external balconies. It is noted that the assessment assumes all function centre balconies at capacity and utilises a conservative patron noise sound power level. There is scope to reduce patron noise levels (discussed further in Section 6) with appropriate management. This includes limiting the use or number of patrons at the north balconies, especially during the evening and night, to reduce noise levels to R10.

It is also anticipated that a distance buffer, acoustic screening, or similar would be incorporated in the Georges Cove residential development design to mitigate against noise from this area. Purchasers of dwellings adjacent to the marina will be made aware of the marina development (it will be a selling point) and the associated noise generation. This development of dwellings near entertainment areas is common, and being 'close to the action' is valued by many purchasers, for example in Darling Harbour.

iii Cumulative operations noise

Highest noise levels from industrial and marina based activity that fall under the jurisdiction of the INP are likely to occur during the day and early evening period (ie during daylight hours). Highest noise levels from music and patron noise that fall under the jurisdiction of the OLGR are more likely to occur during the evening and night periods, most likely on Friday and Saturdays.

The likelihood of highest noise levels from the two activities coinciding is therefore low, and on this basis, cumulate noise from the subject site would unlikely be materially above noise already predicted for these activities in isolation.

5.2 Construction

Construction noise levels have been assessed for earthworks, road construction and building construction stages of the project. Noise from construction activity has been predicted at assessment locations using the Predictor noise modelling software.

The plant and equipment quantities and sound power levels considered in each scenario are presented in Table 5.5. All plant and equipment has been conservatively assumed to operate continuously throughout a 15-minute ICNG assessment period.

Table 5.5 Representative equipment sound power levels and quantities

Equipment	$L_{Aeq,15min}$ Sound Power Level, dB re 10^{-12} watts	Quantity per scenario		
		Earthworks	Road construction	Building construction
Front end loader	112	1		
Excavator	104	1		
Backhoe	102		1	1
Dump truck	100	3	1	1
Concrete truck	106		1	1
Crane	105			1
Generator	101	2	1	1
Bored piling rig	108			
Roller	109	1	1	
Asphalt plant	104		1	
Scraper	103	1		
Hand tools (grinder)	98			1

Predicted $L_{Aeq(15\text{-}min)}$ noise levels from the site construction at all assessment locations are provided in Table 5.6. Noise levels have been predicted based on the meteorological conditions provided in Table 3.5.

Table 5.6 Predicted construction noise levels

Assessment location	Predicted $L_{Aeq,15min}$ noise level, dB						NML, dB(A)	Highly affected NML, dB(A)
	Excavation		Road works		Building construction			
	Calm	Adverse	Calm	Adverse	Calm	Adverse		
R1	**55**	n/a	**55**	n/a	43	n/a	52	75
R2	**58**	n/a	**60**	n/a	46	n/a	49	75
R3	**62**	n/a	**61**	n/a	**50**	n/a	49	75
R4	**61**	n/a	**57**	n/a	**51**	n/a	49	75
R5	**57**	n/a	**51**	n/a	46	n/a	49	75
R6	**54**	n/a	48	n/a	46	n/a	49	75
R7	**51**	**54**	48	**50**	40	43	49	75
R8	56	58	50	52	43	45	65	n/a
R9	**53**	**68**	48	51	40	43	52	75

Notes: 1. Predicted noise level shown in bold with grey shading indicated exceedance of the NML.

2. n/a indicates that the calm condition represents the worst case, or adverse, weather condition.

Results are summarised as follows:

- Predicted construction noise levels are below the ICNG highly affected NML at all residential assessment locations for all construction activities.
- Predicted construction noise levels during excavation/earthworks stage are above the ICNG NMLs at all residential assessment locations for calm and adverse weather conditions.
- Predicted construction noise levels during road works are above the ICNG NMLs at all residential assessment locations for calm and adverse weather conditions.
- Predicted construction noise levels during building construction are below the ICNG NMLs at most residential assessment locations for calm and adverse weather conditions, the exception being locations R3, R4 and R10 where marginal noise levels above the NMLs are predicted.
- Predicted construction noise levels are below the ICNG NML for non–residential assessment locations.

Given the above, construction noise will have to be managed. The primary method of managing noise is to limit construction to standard hours which is proposed. Additional noise management and mitigation measures are provided in Section 6.

5.3 Road traffic noise

The Predictor software was used to predict noise levels from the proposed road and determine the effectiveness of mitigation measures. The model uses the accepted Calculation of Road Traffic Noise (CoRTN) algorithm and adds refinements including variable source heights and atmospheric effects and has advantages over the traditional CoRTN methods in the simple handling of complex and extensive road traffic noise modelling. EMM have used this algorithm on a number of projects and it has shown strong correlation with measured data on a number of occasions.

The representative assessment locations used for future dwellings were modelled as single storey (ie 1.5 m above ground level) but the results are also relevant to two-storey homes as there is no ground level acoustic screening.

5.3.1 Traffic volume data

i Marina access road

The key information used for the road model is as follows:

- 197 vehicles accessing the site per hour weekday peaks; and
- 220 vehicles accessing the site per hour for Friday and Saturday evenings.

The results of traffic noise modelling is presented for both weekday and weekend situations. The modelling considered that Friday and Saturday evenings traffic volumes will be higher and that traffic will preferentially use the undercover carpark and carpark C which are closest to the Private Clubhouse and function centre. For weekdays, vehicles could use any of the carparks and therefore it has been conservatively assumed that 197 vehicles per hour will use carparks A and B (ie the southern carparks).

ii Brickmakers Drive

Noise levels on Brickmakers Drive were assessed to determine the traffic noise changes from the marina access road, which is particularly relevant for Georges Fair residences. Table 3.1 presents the traffic volume data for Brickmakers Drive.

Table 5.7 Brickmakers Drive traffic count data

Time	Northbound	Southbound	Two-way
Weekday morning	685	170	855
Weekday afternoon	165	715	880
Friday evening	120	300	420
Saturday evening	105	175	280

Notes: Traffic counts taken from EMM Hourly Site Traffic Generation Calculations, January 2015.

5.3.2 Predicted traffic noise levels

The noise modelling results are summarised in Table 5.9 and Table 5.10 for weekday and weekend traffic volumes respectively. Both daytime and night time traffic noise criteria are shown in the event that peak movements occur from the proposed marina outside of 7 am to 10 pm (ie daytime). The results are displayed as noise contours in Figure 5.3 and Figure 5.4.

The results show the following:

- The proposed marina's weekday peak hour traffic noise contributions are relatively minor in comparison to existing noise levels from Brickmakers Drive for all nominated assessment locations. Total future road traffic noise levels for Georges Fair residences are shown to be similar to existing levels. Predicted traffic noise levels from vehicles accessing the marina will satisfy the RNP allowance criterion of no more than 2 dB increase where existing traffic noise is above acceptable levels.

- The proposed marina's weekend peak hour traffic noise contributions are relatively minor in comparison to existing levels from Brickmakers Drive for all nominated assessment locations. Total future road traffic noise levels for Georges Fair residences are shown to be similar to existing levels. Predicted traffic noise levels from vehicles accessing the marina will satisfy the RNP allowance criterion of no more than 2 dB increase where existing traffic noise is above acceptable levels.

Table 5.8 Predicted traffic noise modelling results – weekday

Receiver		Criteria, dB(A)		Predicted $L_{eq,1\ hour}$, peak traffic noise level dB(A)		
Name	**Number[3]**	**Daytime**	**Night-time**	**Existing[1] (Brickmakers Dr)**	**Marina local road[2]**	**Total (future)**
Georges Fair residences west of Brickmakers Drive (existing and future)	T1	55	50	64	51	64
	T2	55	50	51	47	52
	T3	55	50	64	48	64
	T4	55	50	68	51	68

Notes: 1. Brickmakers Drive existing weekday traffic noise shown.

2. 197 vph for marina to southern carparks.

3. The RNP does not required the assessment if future residences.

The results of noise modelling is summarised in Table 3.3 for weekend volumes.

Table 5.9 Predicted traffic noise modelling results – weekend

Receiver		Criteria, dB(A)		Predicted $L_{eq,1\ hour}$, peak traffic noise level dB(A)		
Name	**Number[3]**	**Daytime**	**Night-time**	**Existing[1] (Brickmakers Dr)**	**Marina local road[2]**	**Total (future)**
Georges Fair residences west of Brickmakers Drive (existing and future)	T1	55	50	61	51	61
				60		60
	T2	55	50	48	44	49
				46		48
	T3	55	50	62	47	62
				60		61
	T4	55	50	65	51	65
				64		64

Notes: 1.Friday and Saturday evening Brickmakers Drive existing traffic noise shown.

2. 220 vph for marina to northern carparks.

3. The RNP does not required the assessment if future residences.

EMM

Predicted marina traffic noise levels - weekday

Georges Cove Marina
Noise Impact Assessment
Figure 5.3

Predicted marina traffic noise levels - weekend

Georges Cove Marina
Noise Impact Assessment
Figure 5.4

6 Noise management and mitigation

6.1 Operations

The following operational noise management and mitigation will be adopted:

- A two metre high acoustic barrier will be constructed to the west of the Marina Clubhouse carpark as indicated in Figure 5.1.
- Partial acoustic screening (eg louvres) will be installed on the north balconies of the marina clubhouse and marina building. The screening will be operable to allow additional acoustic screening during large functions when the respective function centres are in use.
- Music noise from the function centres will be managed and/or mitigated to limit low frequency noise in 31.5 and 63 Hz octave band centre frequencies to the criteria presented in Table 4.5. This can be achieved by fitting the public address system with a noise limiter or increasing the glazing thickness at function centres, or a combination of both measures. This and other alternate measures will be detailed further in the project design stage.
- A noise management plan will be implemented, outlining procedures for patron management, paying attention to more sensitive evening and night-time periods.

6.2 Construction

6.2.1 Noise management plan

Given predicted noise levels are above the NMLs at a number of assessment locations, it is a noise management plan will be prepared which will include:

- identification of nearby residences and sensitive land uses;
- description of approved hours of work and what work will be undertaken;
- description of what work practices will be applied to minimise noise;
- description of the complaints handling process;
- description of monitoring that is required; and
- notification process for nearby properties.

6.2.2 Community consultation

In addition to the above, a programme to engage in active community consultation about the project generally should be implemented to maintain positive relations with local residents.

6.2.3 Adoption of general noise management practices (AS 2436-2010)

Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites (AS 2436-2010) sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject site are listed below.

i Universal work practices

Universal work practices that will be adopted during construction will include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- regular identification of noisy activities and adoption of improvement techniques;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- developing routes for the delivery of materials and parking of vehicles to minimise noise;
- minimising the use of equipment that generates impulsive noise;
- minimising the need for vehicle reversing for example, by arranging for one-way site traffic routes;
- use of broadband audible reverse alarms ("growlers") on vehicles and elevating work platforms used on site;
- minimising the movement of materials and plant and unnecessary metal-on-metal contact;
- minimising truck movements; and
- scheduling respite periods for intensive works.

ii Plant and equipment

Additional noise management measures for plant and equipment will include:

- employing techniques for all high noise activities such as rockbreaking, concrete sawing, and using power and pneumatic tools that minimise noise emissions;
- where possible choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;
- operating plant and equipment in the quietest and most efficient manner; and
- regularly inspecting and maintaining plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.

iii Onsite noise mitigation

Onsite noise mitigation measures will include:

- where possible maximising the distance between noise activities and noise sensitive land uses; and
- where possible using temporary site building and material stockpiles as noise barriers. These can often be created using site earthworks and may be included as a part of final landscape design.

iv Work scheduling

Work scheduling will consider the following:

- scheduling work to coincide with non-sensitive periods;
- scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive;
- planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers;
- optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours;
- designating, designing and maintaining access routes to the site to minimise impacts; and
- including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

7 Conclusion

EMM has completed a noise impact assessment for the George Cove Marina proposed at Moorebank, NSW.

Operational noise levels are predicted to satisfy the INP PSNLs at all assessment locations during calm and worst case meteorological conditions. For the closest residences in the future George Cove residential development, it is anticipated that appropriate noise controls, such as distance buffers and acoustic screening, will be incorporated in the design of the development to provide appropriate noise amenity for occupants. People looking to buy the dwellings adjacent to the marina will be well aware of the Georges Cove Marina development (and associated noise). Those who go on to buy one of these dwellings are expected to see being 'close to the action' as a positive attribute of the location. Notwithstanding, the noise levels at George Cove generally include boat movements. Given the riverside locality and position near the subject site, and that boat movements will be generally short-term in nature, it is anticipated that such noise activity would be largely accepted to a degree by residents.

Maximum noise level events during the night-time period are predicted to satisfy the EPA sleep disturbance criteria at all assessment locations during calm and worst case meteorological conditions.

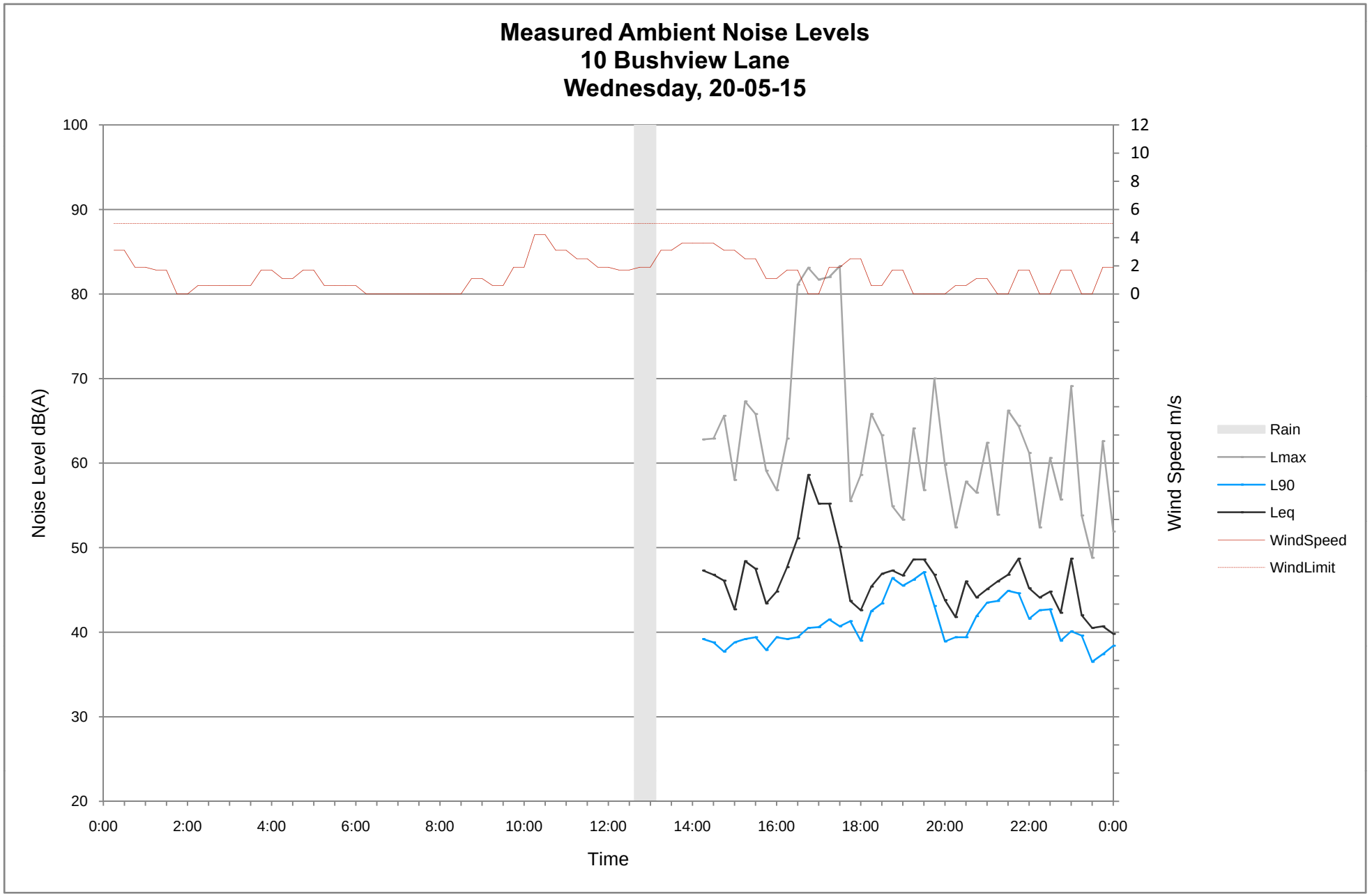
Music and patron noise is predicted to satisfy the OLGR criteria in most octave band centre frequencies at all assessment locations during calm and worst case meteorological conditions. Music noise from function centres has been predicted to generate exceedances at 31.5 and 63 Hz octave band centre frequencies. This can be mitigated by fitting a noise limiter on public address systems or increasing the glazing thickness to function rooms, or a combination of both. Such noise control strategies will be finalised in the project design phase.

Patron noise levels at the closest George Cove residences are predicted to exceed the OLGR criteria in the 125 Hz octave band centre frequency and above. This can be mitigated by the installation of partial acoustic screens at some outdoor patron areas (refer Figure 5.2) to reduce worst-case patron noise levels. A noise management plan will be prepared and implemented that will detail strategies to control patron noise, especially during the night-time period.

Construction noise levels are predicted to satisfy ICNG highly affected NML at all residential assessment locations. Construction noise levels above the NMLs have been predicted at most assessment locations, predominantly during site preparation earthworks and road construction. The proponent will actively manage construction noise, especially when construction equipment is operating relatively close to surrounding receivers. This will primarily be achieved by limiting construction to ICNG standard construction hours. Further management and mitigation measures will be detailed in a construction noise management plan.

Appendix A

Unattended noise logging charts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Wednesday, 20-05-15
Noise Level dB(A)
Wind Speed m/s
Time
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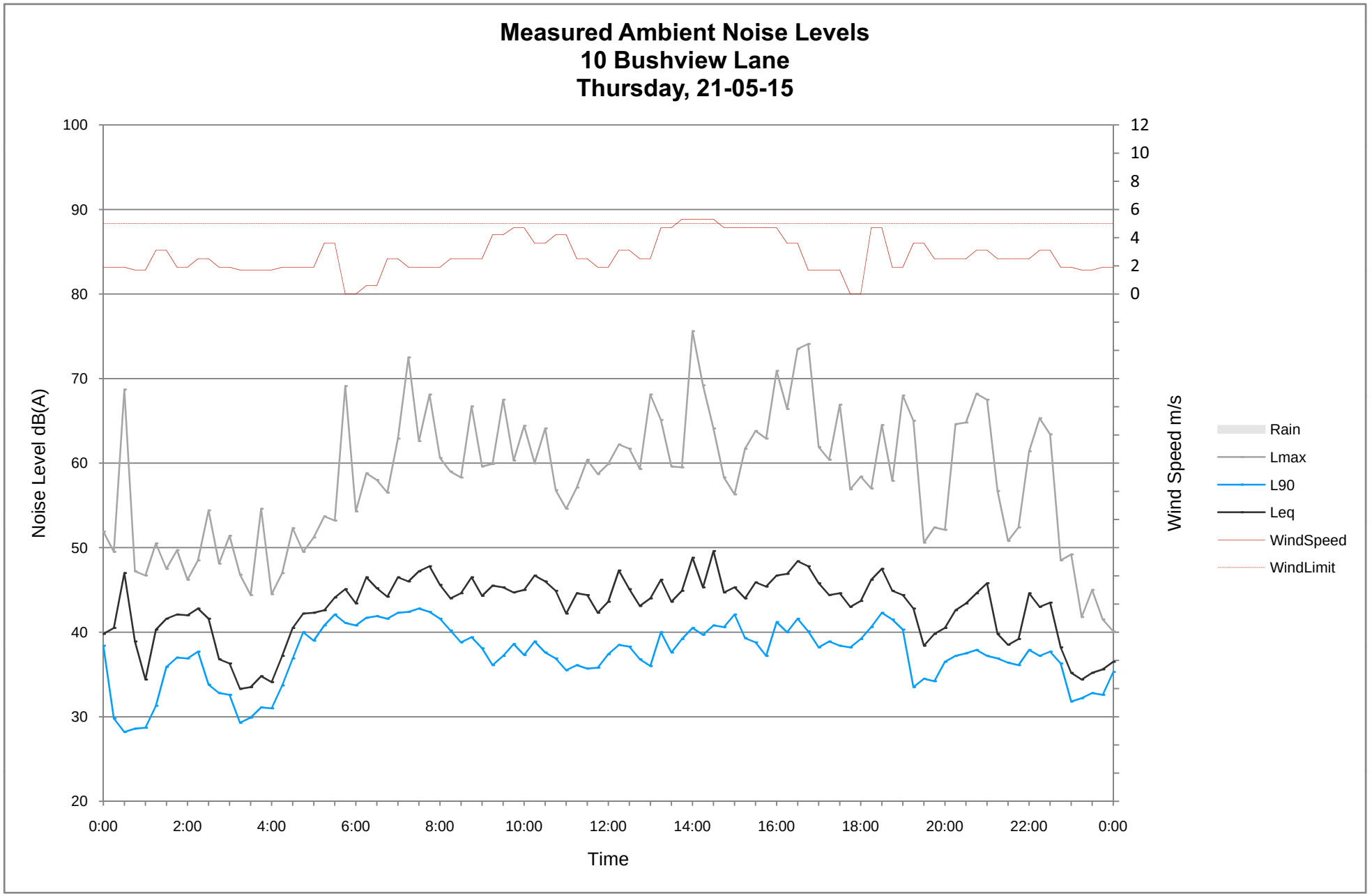
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Thursday, 21-05-15
Noise Level dB(A)
Wind Speed m/s
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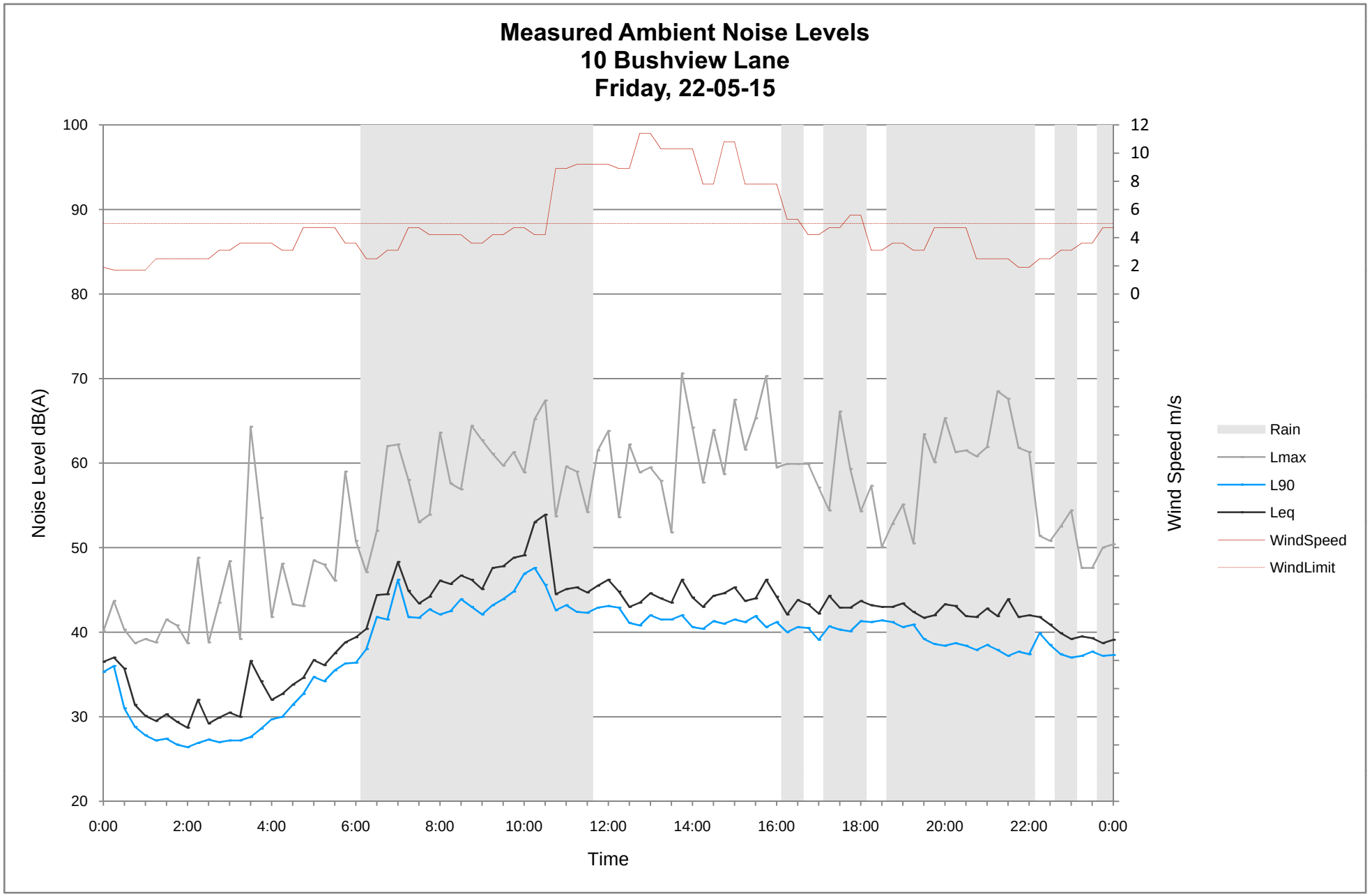
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Friday, 22-05-15
Noise Level dB(A)
Wind Speed m/s
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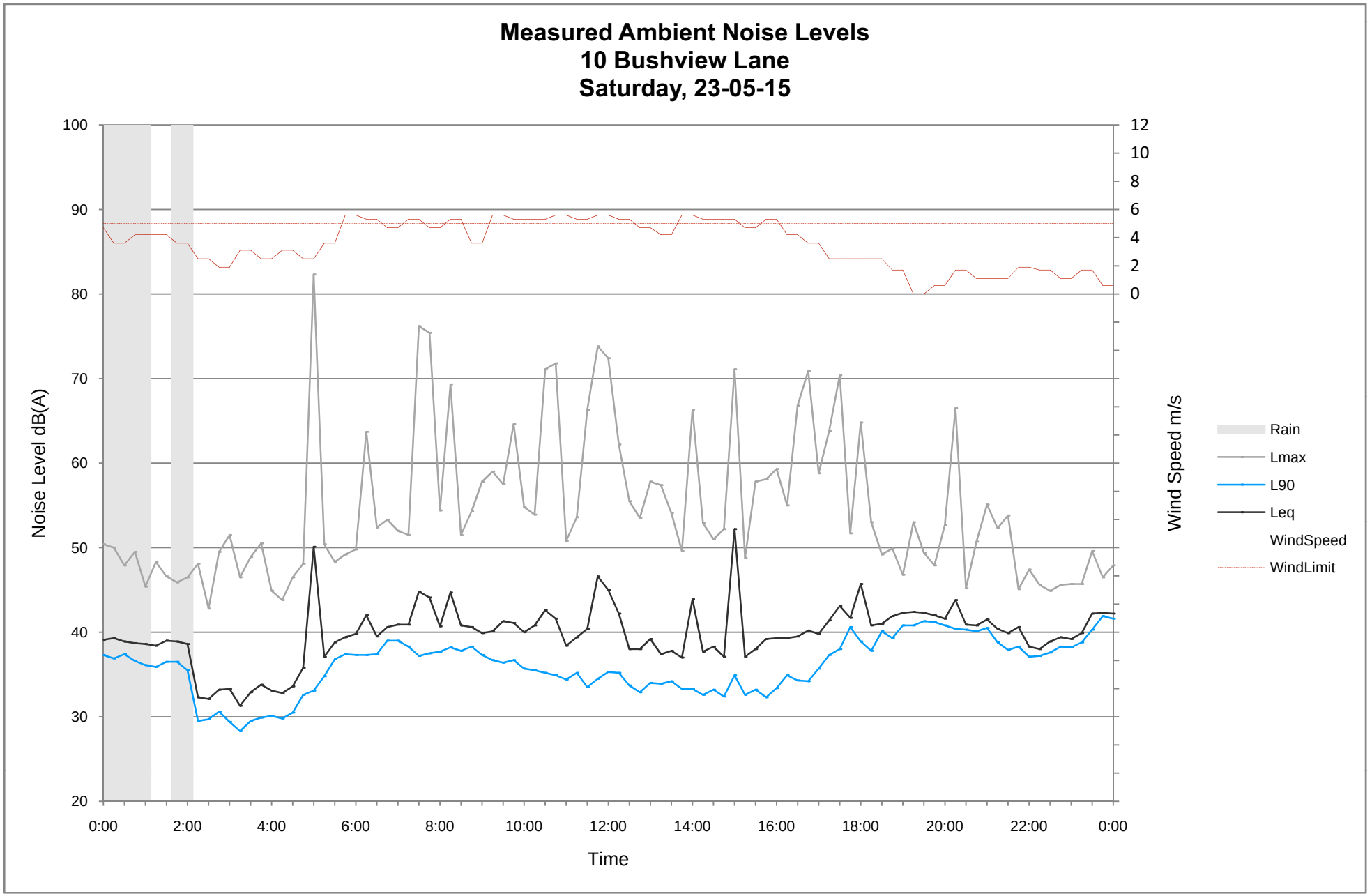
Measured Ambient Noise Levels
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Saturday, 23-05-15
Noise Level dB(A)
Wind Speed m/s
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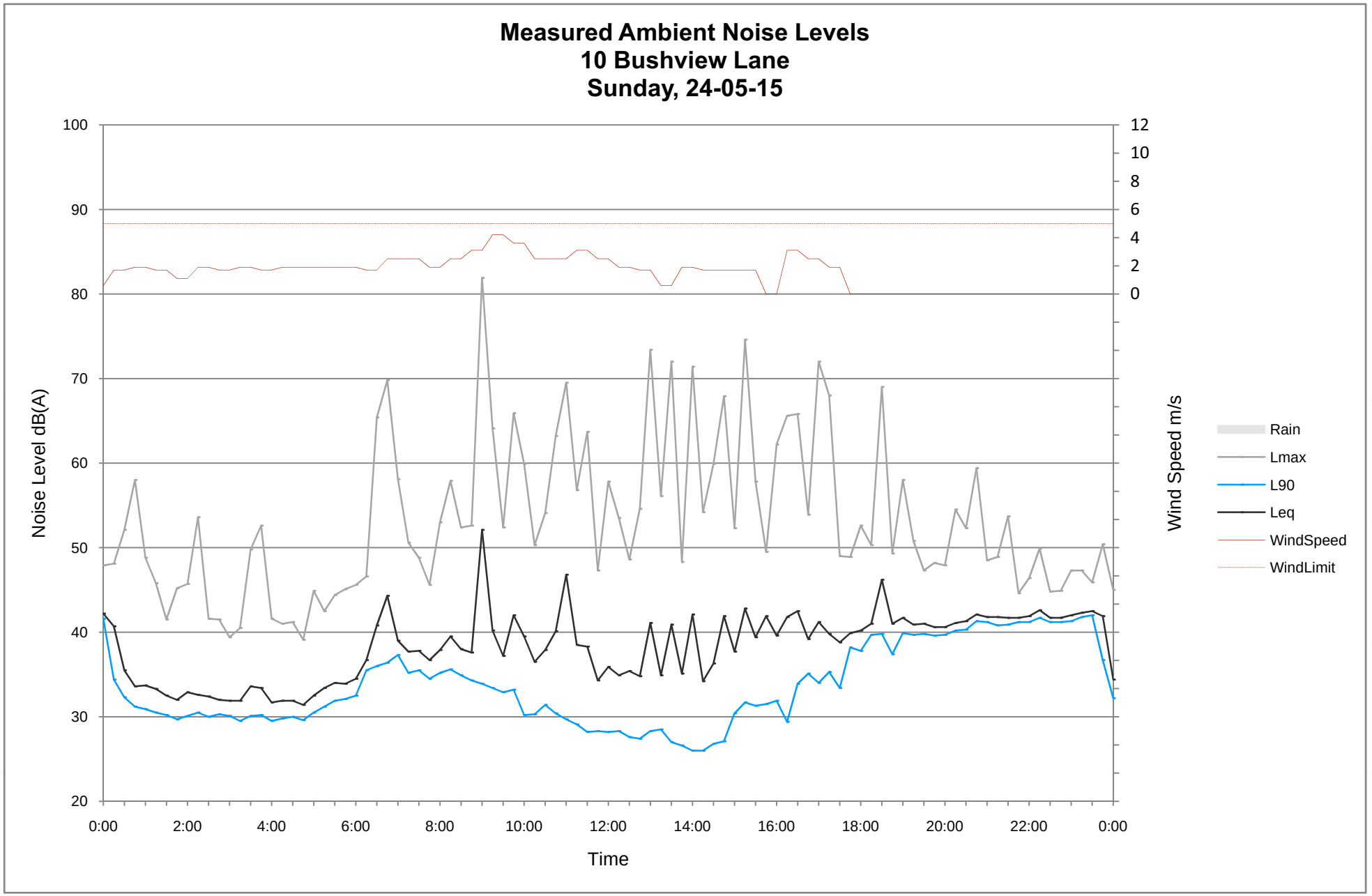
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Noise Level dB(A)
Wind Speed m/s
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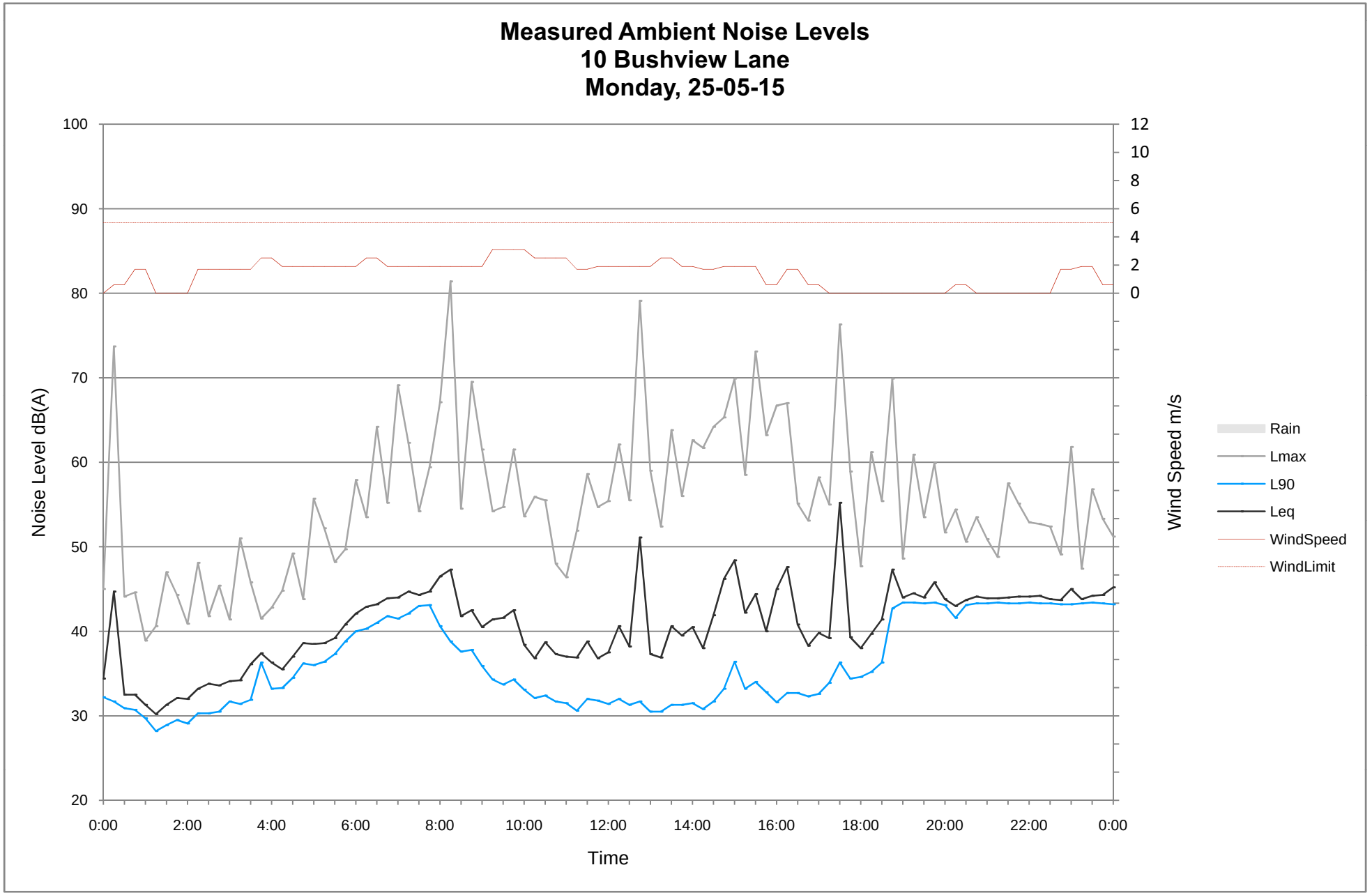
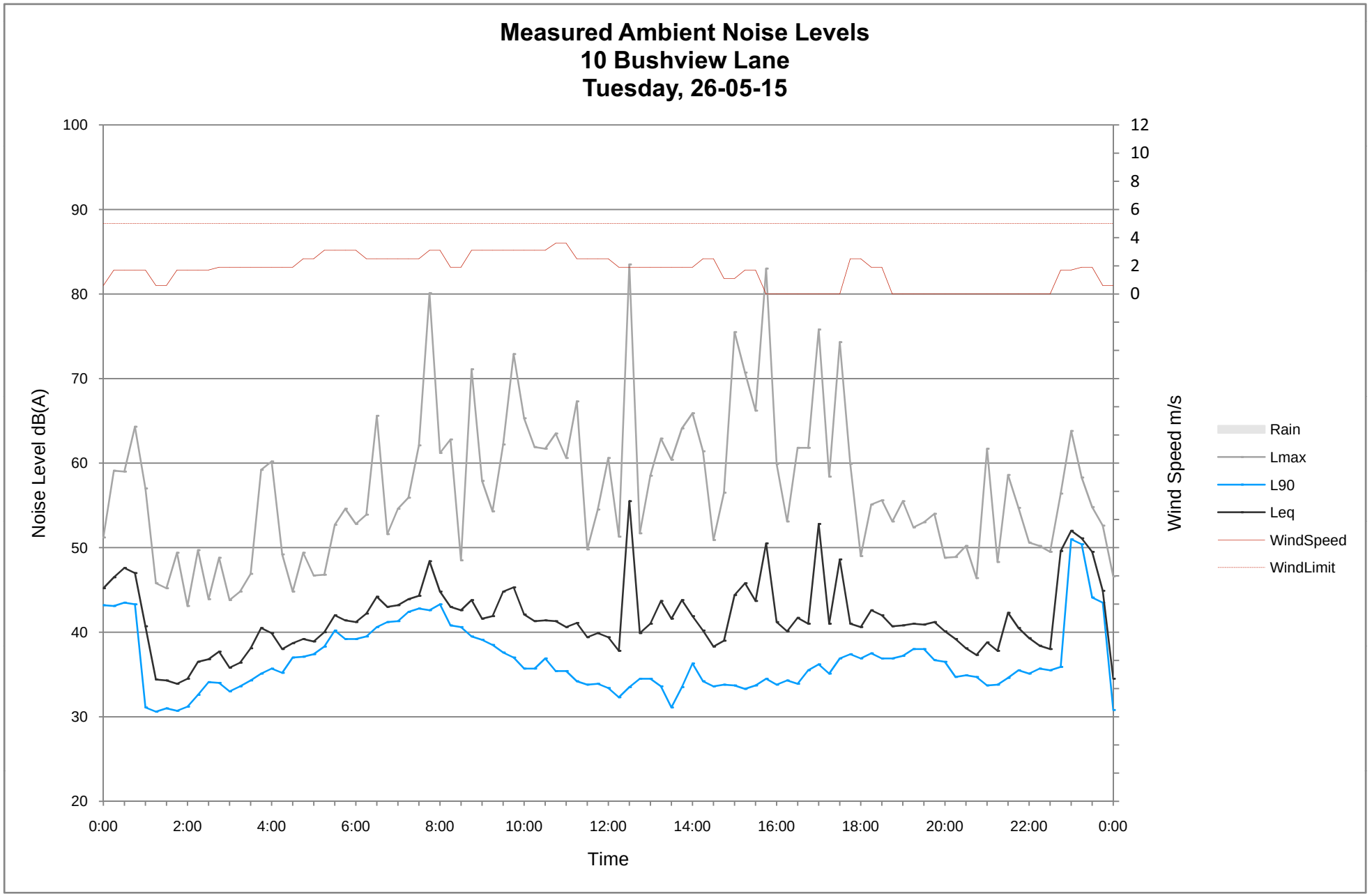
Measured Ambient Noise Levels
10 Bushview Lane
Monday, 25-05-15

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Noise Level dB(A)
Wind Speed m/s
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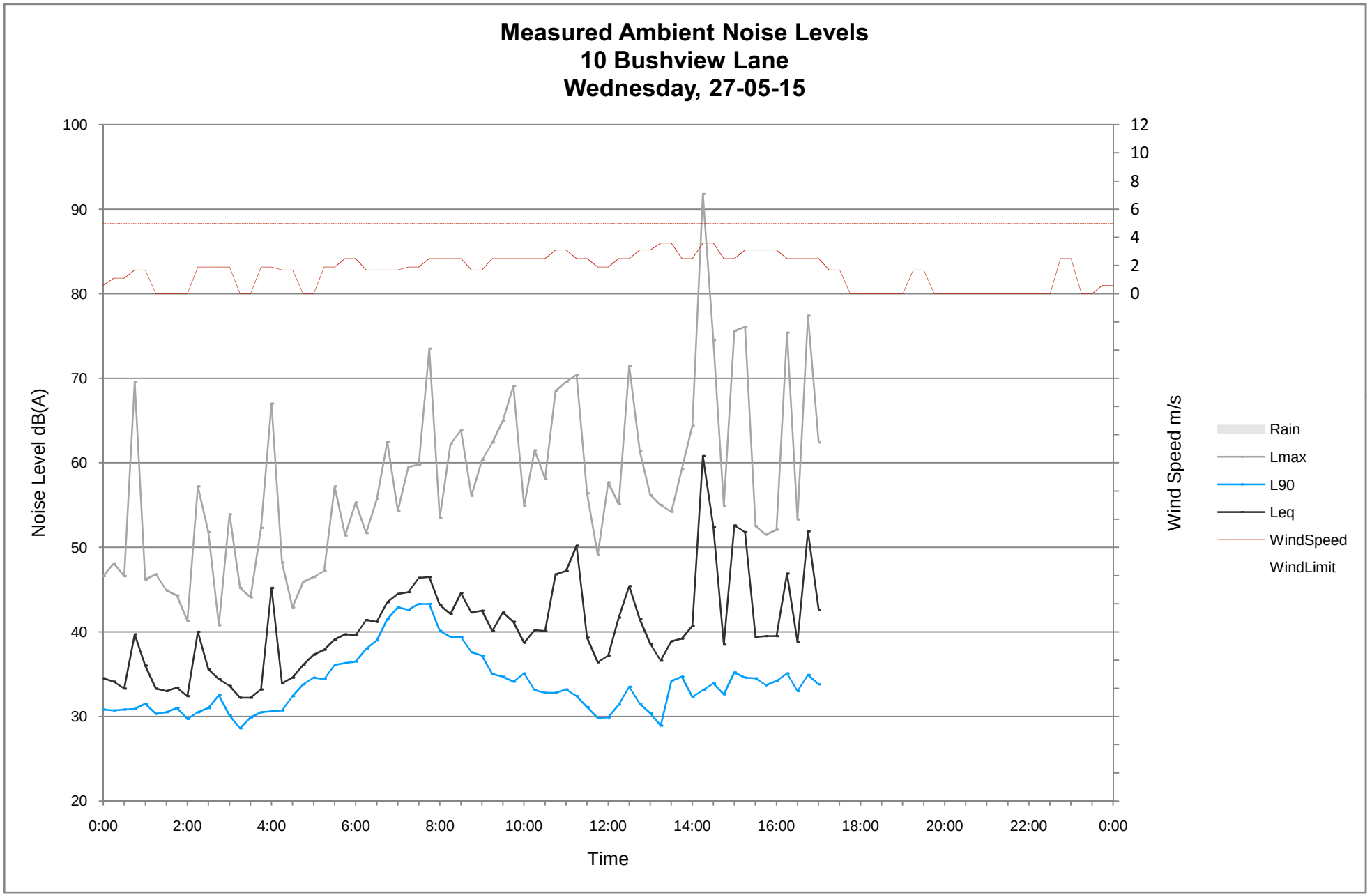
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Noise Level dB(A)
Wind Speed m/s
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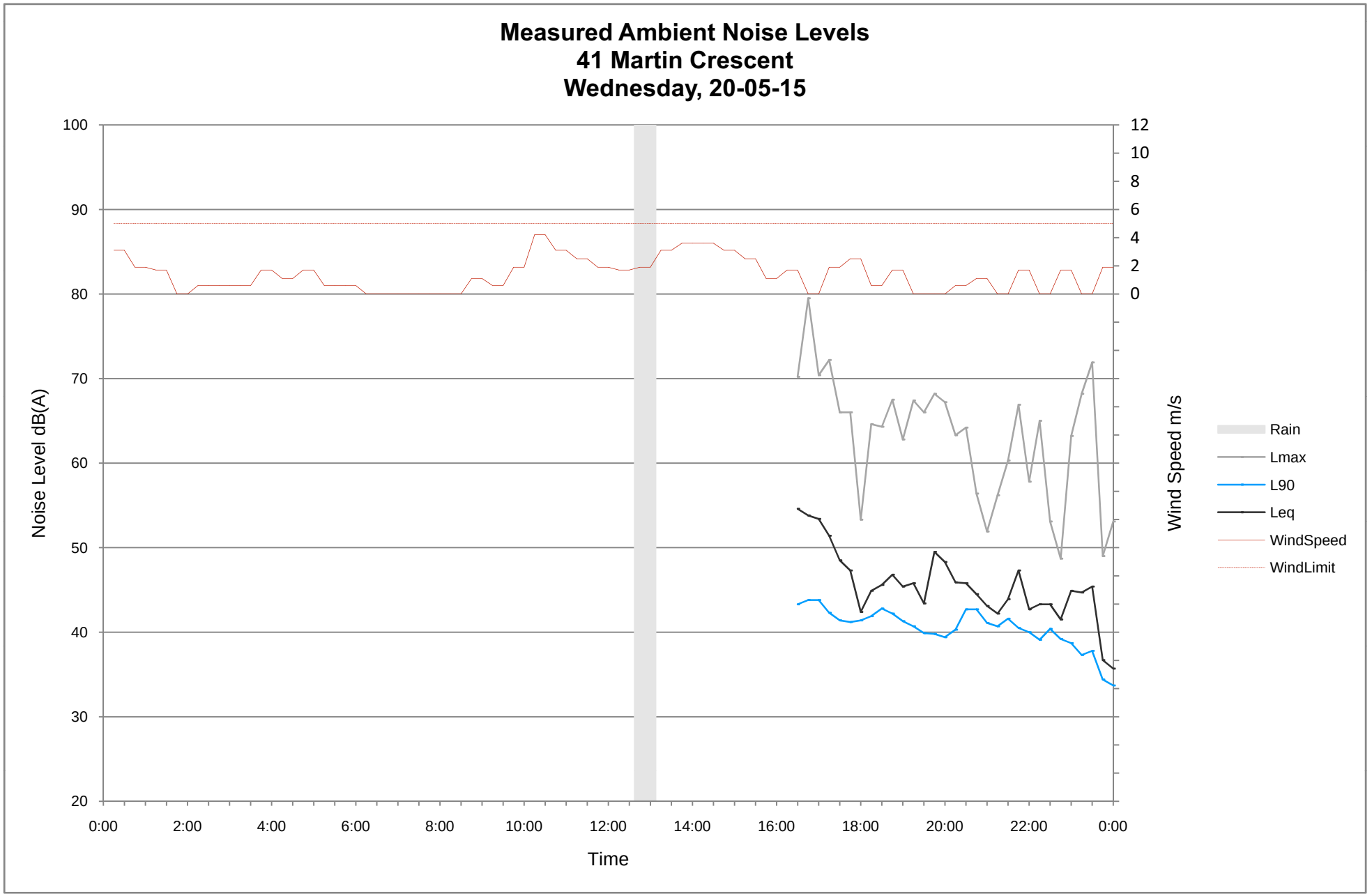
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Wednesday, 20-05-15
Noise Level dB(A)
Wind Speed m/s
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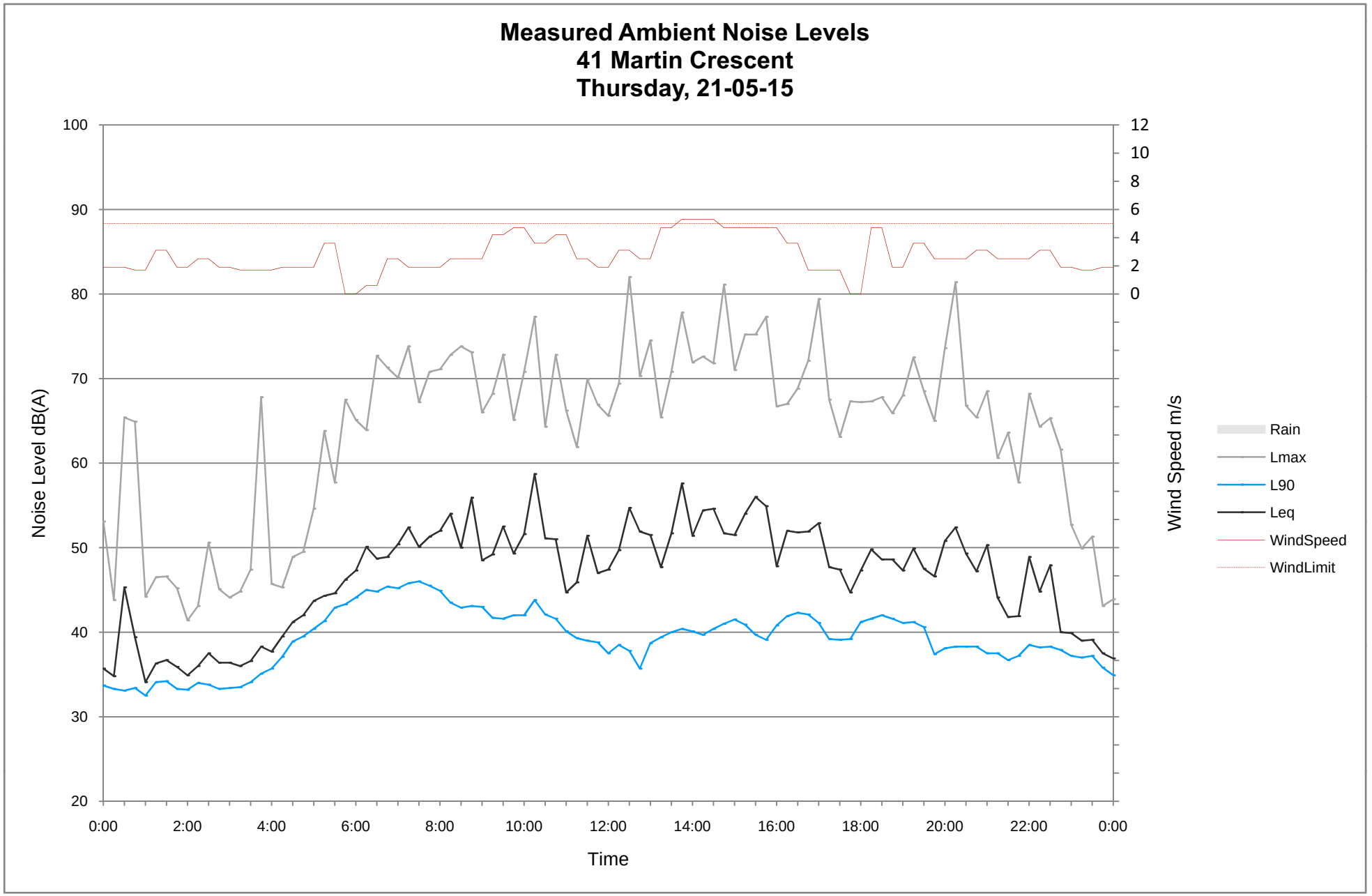
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Noise Level dB(A)
Wind Speed m/s
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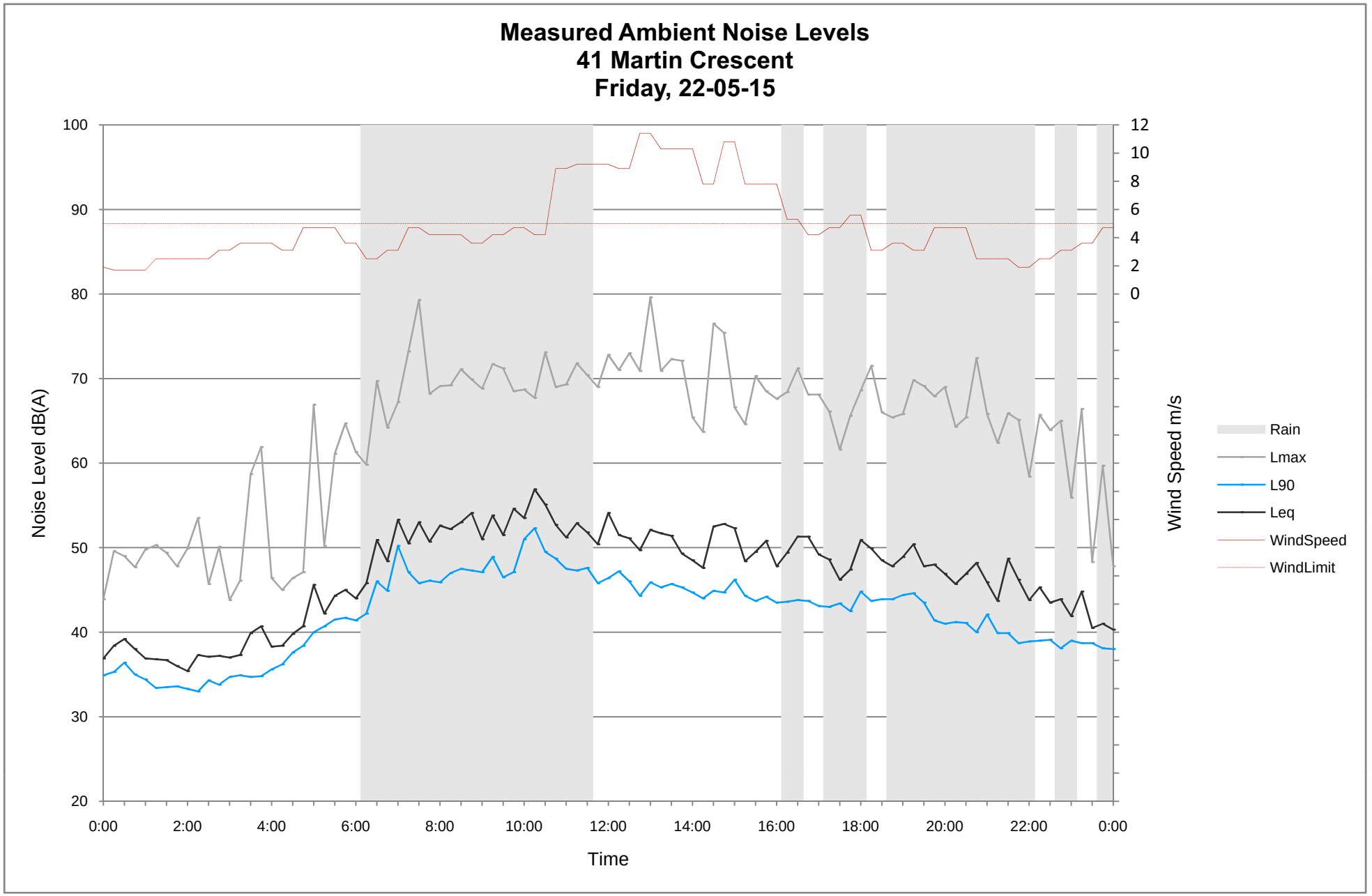
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Noise Level dB(A)
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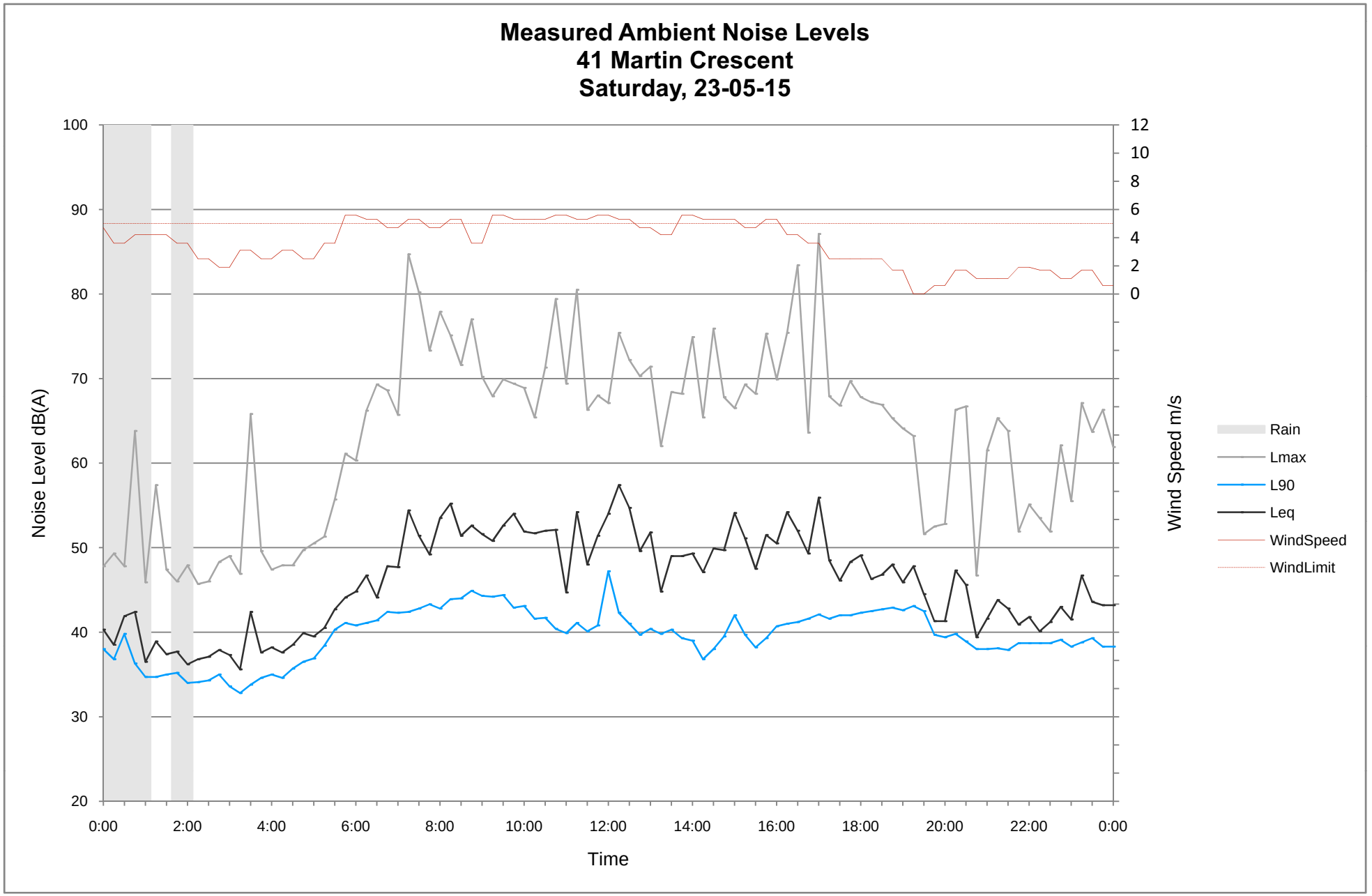
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Saturday, 23-05-15
Noise Level dB(A)
Wind Speed m/s
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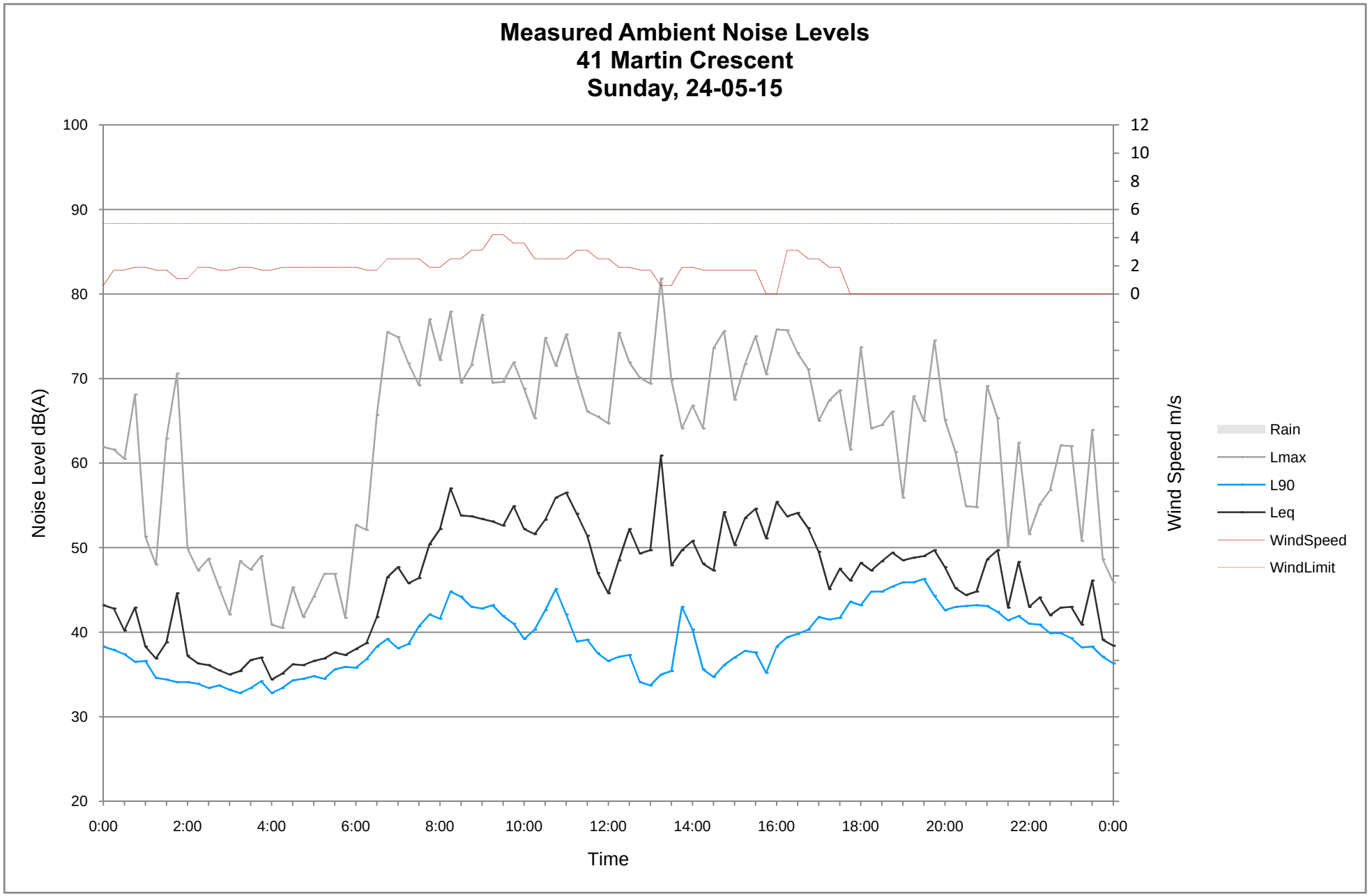
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Noise Level dB(A)
Wind Speed m/s
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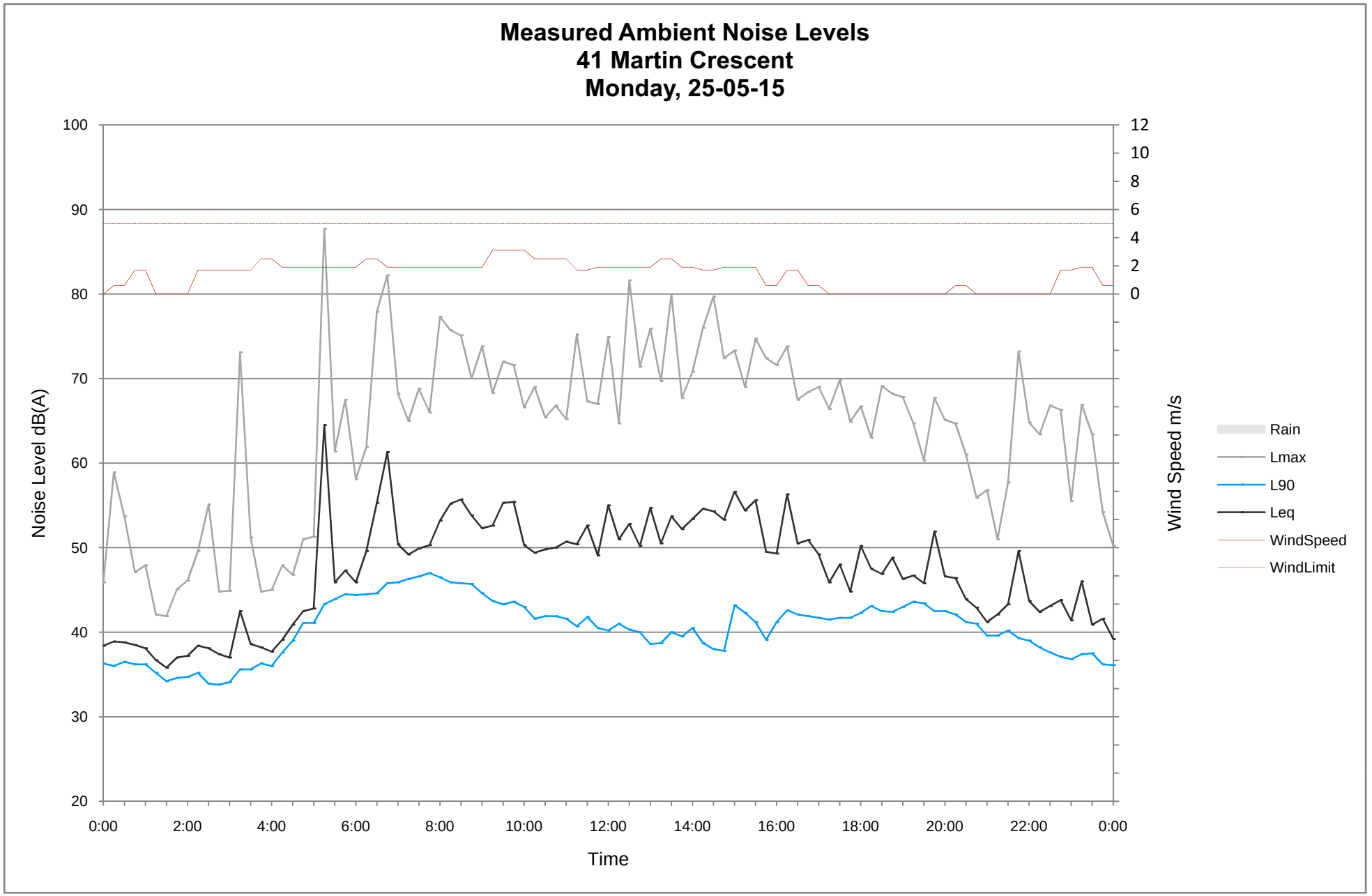
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Monday, 25-05-15
Noise Level dB(A)
Wind Speed m/s
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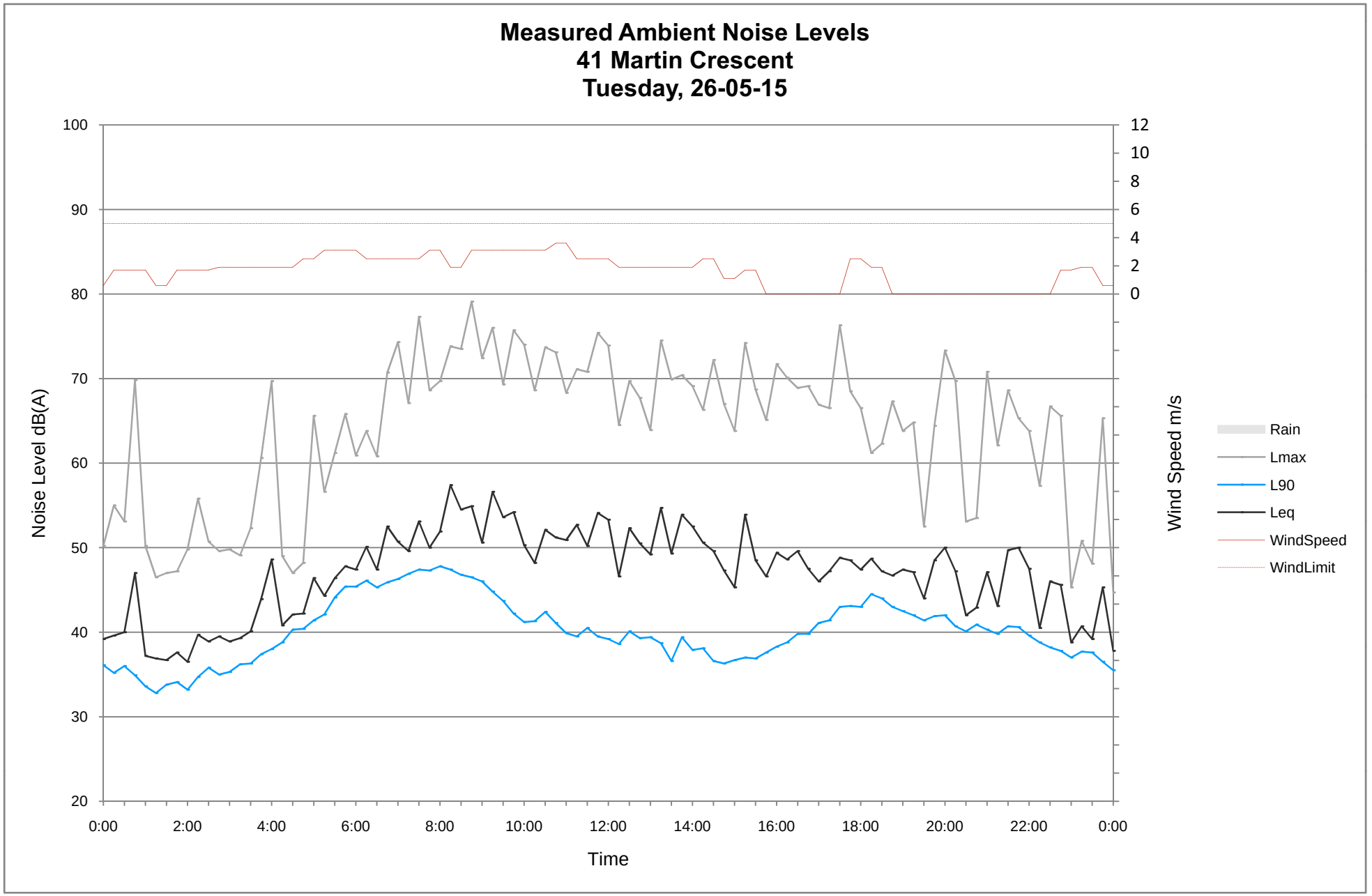
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Tuesday, 26-05-15
Noise Level dB(A)
Wind Speed m/s
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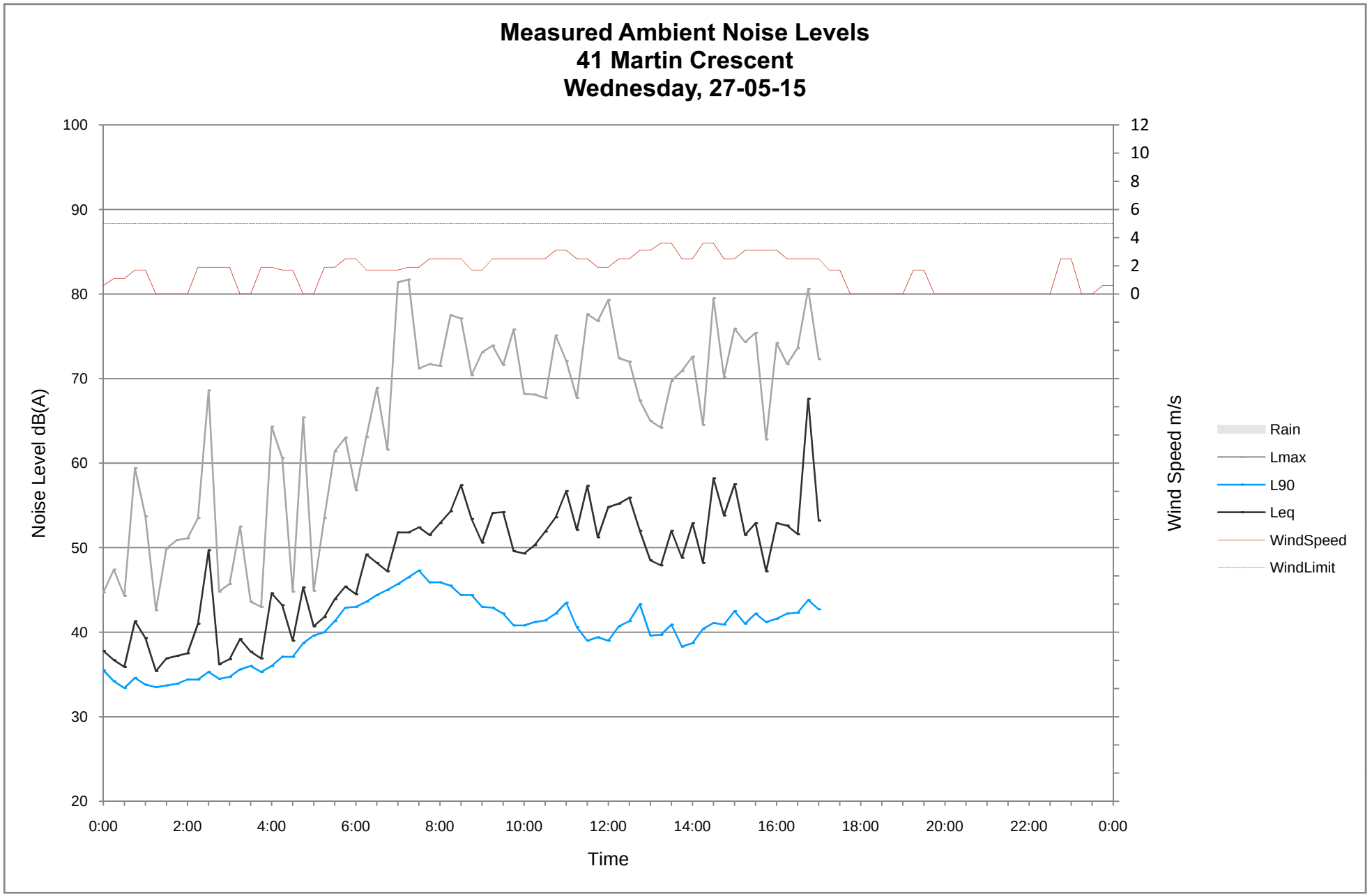
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Noise Level dB(A)
Wind Speed m/s
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Appendix B

INP wind analysis

Table B.1 Percentage occurrence of 0.5–3 m/s winds

Direction	Autumn			Spring			Summer			Winter		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
NNE	14	11	5	12	10	7	11	6	9	12	8	7
NE	13	16	5	10	15	9	11	10	14	10	9	5
ENE	11	19	6	9	21	11	10	14	19	9	11	5
E	10	24	8	8	25	14	10	17	24	8	14	5
ESE	9	27	11	7	29	18	9	20	**30**	8	18	6
SE	10	**30**	15	7	**32**	24	9	21	**37**	8	22	9
SSE	11	**38**	**31**	8	**33**	**38**	10	19	**47**	11	**34**	23
S	16	**42**	**51**	11	**31**	**50**	12	17	**53**	16	**43**	**43**
SSW	21	**41**	**59**	13	27	**55**	12	14	**52**	23	**46**	**53**
SW	24	**37**	**60**	14	22	**54**	12	10	**47**	27	**46**	**56**
WSW	26	**33**	**58**	16	18	**51**	13	7	**42**	29	**44**	**56**
W	28	**30**	**55**	17	13	**45**	13	5	**34**	**30**	**40**	**55**
WNW	28	25	**48**	18	11	**38**	13	3	25	**30**	**35**	**52**
NW	26	15	**30**	17	7	23	12	2	14	28	22	**37**
NNW	21	8	12	15	6	11	10	2	6	22	12	17
N	16	8	5	13	7	6	10	4	6	16	8	9

Notes: 1.Bold and highlighted text indicates percentage occurrence of 30% or greater.

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