106-112 Church Street, Camperdown
Proposed Multistorey Staff Car Park

Acoustic Assessment

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TABLE OF CONTENTS

1 INTRODUCTION

Acoustic Logic Consultancy has been engaged by Health Infrastructure to undertake an assessment of noise and vibration likely to be associated with a proposed multi-storey staff carpark to be located at 106-112 Church Street, Camperdown.

This report has been prepared to address Secretary Environmental Assessment Requirements with respect to acoustics (requirement 9).

In this report, we will:

- Identify nearby noise sensitive receivers and anticipated operational noise sources with the potential to adversely impact nearby development.
- Identify relevant Council and EPA acoustic criteria applicable to the development.
- Predict operational noise emissions and assess them against acoustic criteria.
- If necessary, determine building and/or management controls necessary to ensure ongoing compliance with noise emission goals.

In addition, the report will include an in-principle review of construction noise and vibration.

2 SITE DESCRIPTION AND PROPOSED WORKS

The site is located at 106-112 Church Street, Camperdown.

The proposed development consists of a 9 storey car park building with a capacity of approximately 1000 cars. The car park is proposed to be used by RPA Hospital staff, and will operate twenty four hours per day.

Noise sensitive development in the vicinity of the site consists of:

- Residential development at:
    - The Queen Mary Building (to the south of the site, on the opposite side of Brodie Street).
    - A terrace on Church Street (to the west of the site, on the opposite side of Church Street).
    - Chinese Consulate (to the north of the site, on the opposite side of Lucas Street).
- The Marie Bashir building (mental health) located to the east of the site.

The car park is proposed to be naturally ventilated and as such the external walls to the car park are perforated (and not solid/imperforate sheeting).

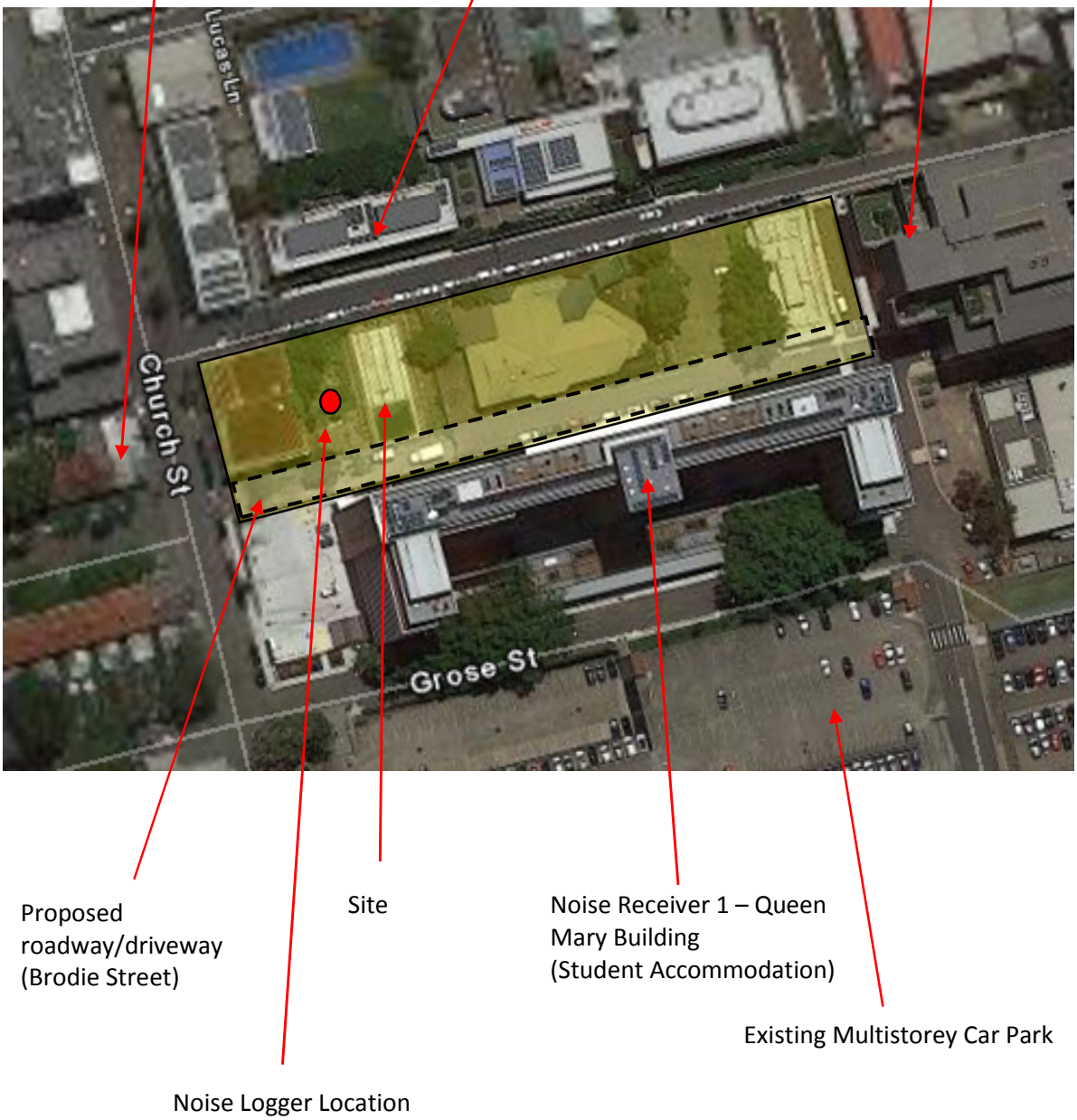
As part of the development, it is proposed to extend the existing roadway (Brodie Street) running along the southern edge of the site (between the site and the Queen Mary Student accommodation building). Although Brodie Street will be on privately owned land (as opposed to being a public road), the road will be free for use by pedestrians and motorists.

Vehicular access to the site will consist of:

- Entry will be via a driveway at the western end of Brodie Street.
- Exit will be via driveways on Church Street and Lucas Street.

We note that there is an existing naturally ventilated car park located to the south of the Queen Mary Building. A survey of operational noise from this car park has been used in conducting this assessment, as detailed in section 6.1.

See aerial photograph below.


Noise Receiver 2 – Church Street Residence
Noise Receiver 3 – Chinese Consultant
Marie Bashir Building
Lucas Ln
Church St
Grose St
Proposed roadway/driveway (Brodie Street)
Site
Noise Receiver 1 – Queen Mary Building (Student Accommodation)
Existing Multistorey Car Park
Noise Logger Location

3 NOISE DESCRIPTORS

Environmental noise constantly varies. Accordingly, it is not possible to accurately determine prevailing environmental noise conditions by measuring a single, instantaneous noise level.

To accurately determine the environmental noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters.

In analysing environmental noise, three-principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the 15 minute period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of environmental noise.

L_1 levels represent is the loudest 1% noise event during a measurement period.

4 SURVEY OF AMBIENT NOISE

Long term unattended noise logging was conducted to quantify the existing acoustic environmental at the site.

Unattended noise monitoring was conducted over an 8 day period between 23 and 31 March 2016 using an Acoustic Research Laboratories monitor set on A-weighted fast response mode. The monitor was calibrated before and after the measurements using a Rion Type NC-73 calibrator. No significant drift was recorded.

The logger position is shown in the aerial photograph in section 2. This location was selected as it was located away from any local noise source (such plant noise from the Marie Bashir or Cyclotron Buildings to the east of the site), and as such, the background noise levels are not impacted by pre-existing plant noise from hospital buildings.

The background noise levels measured by the logger will be representative of the background noise levels at nearby residential land users.

The measured background noise levels have been corrected for meteorological conditions (excessive wind and/or rain), as required by section 3.4 of the EPA Industrial Noise Policy. Exceedances of the 5m/s average wind speed limit of the EPA were noted (as shown in the logging data in Appendix 1) and have been omitted when determining the background noise levels at the site.

Measured noise levels (ambient and the rating background noise level) are presented below.

Table 1 – Long Term Noise Logging Data

Location	Time of Day			
	Daytime (7am-6pm)	**Evening (6pm-10pm)**	**Night (10pm-7am)**	**Morning Shoulder (6am-7am)**
106-112 Church Street, Camperdown	56dB($AL_{eq(15min)}$) 46dB(A)L_{90}	56dB($AL_{eq(15min)}$) 47dB(A)L_{90}	50dB($AL_{eq(15min)}$) 45dB(A)L_{90}	53dB($AL_{eq(15min)}$) 47dB(A)L_{90}

In addition, a survey of operational noise from the existing car park (to the south of the Queen Mary Building) was undertaken in order to assist in prediction of noise emissions from the proposed new car park. This is detailed in section 6.1.

5 NOISE EMISSION CRITERIA

The following noise controls and guidelines are applicable to the site:

- Secretary Environmental Assessment Requirements.
- Environmental Protection Authority (EPA) Industrial Noise Policy.
- EPA Road Noise Policy.
- EPA guidelines for sleep arousal (Application Notes to the Industrial Noise Policy)
- Construction noise and vibration will be reviewed with reference to:
    - EPA Interim Construction Noise Guidelines.
    - Assessing Vibration – A technical guideline.

5.1 SECRETARY ENVIRONMENTAL ASSESSMENT REQUIREMENTS

SEAR Requirement 9 (Noise and Vibration) states:

> *"Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation. Outline measured to minimise and mitigate the potential noise impacts on surrounding occupiers of land".*

Requirement 9 identifies the EPA Industrial Noise Policy, the EPA Interim Construction Guidelines and the document Assessing Vibration: A Technical Guideline as relevant guidelines.

5.2 EPA INDUSTRIAL NOISE POLICY

The EPA Industrial Noise Policy is used in the assessment of operational noise, but not construction noise. The Industrial Noise Policy has two sets of criteria that must be reviewed - the Intrusiveness and the Amenity criteria.

5.2.1 INP - Intrusiveness Assessment

Intrusiveness criteria permit noise generation to be no more than 5dB(A) above existing background noise levels and is used in the assessment of noise impacts on residential noise receivers.

The criteria are as follow:

Table 2 - EPA Intrusiveness Criteria

Location	Time of Day	Background noise Level - dB(A)L_{90}	Intrusiveness Noise Objective dB(A)$L_{eq(15min)}$ (Background + 5dB)
Nearby Residences	Day Time (7am - 6pm)	46	51
	Evening (6pm - 10pm)	47	52
	Night (10pm - 7am)	45	50
	Morning Shoulder Period (6am-7am)	47	52

5.2.2 INP - Amenity Assessment

The Amenity criteria set additional criteria based on the land use of the noise sensitive receivers.

Amenity criteria are as follows:

Table 3 -EPA Amenity Criteria

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A)$L_{eq(Period)}$
All Potentially Affected Residential Properties (Queen Mary, Church Street Residences, Chinese Consulate)	Urban	Day Time (7am – 6pm)	60
		Evening (6pm – 10pm)	50
		Night (10pm-7am)	45
Commercial	All	When in use	65
Hospital Building (Marie Bahir)	Internal Area	When in use	35-40
	External Area	When in use	50-55

5.3 SLEEP AROUSAL ASSESSMENT

Potential sleep arousal impacts should be considered for noise generated before 7am or after 10pm.

Short duration, intermittent noise events (such as cars driving into the car park) are typically assessed for potential sleep disturbance.

Potential impacts are assessed using the recommended procedure in the Application Notes to the EPA Industrial Noise Policy. As recommended in the Application Notes, when assessing potential sleep arousal impacts, a two stage test is carried out:

- Step 1 - An "emergence" test is first carried out. Using this test, the L_1 noise level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15dB(A) when measured outside a resident's bedroom window. If the noise events are less than this level, then sleep arousal impacts are unlikely and no further analysis is needed. This is also consistent with the Noise Guide for Local Government. The "emergence" level is set out below.

Table 4 – Sleep Arousal (Emergence Criteria)

Location	Background Noise Level (10pm-7am) dB(A)L_{90}	Emergence Level dB(A)$L_{1(1min)}$
All Potentially Affected Residential Properties (Queen Mary, Church Street Residences, Chinese Consulate)	45	60

- Step 2 - If there are noise events that could exceed the emergence level, then an assessment of sleep arousal impact is required to be carried out taking into account the level and frequency of noise events during the night. This test takes into account the noise level and number occurrences of each event with the potential to create a noise disturbance. As is recommended in the Application Notes of the EPA Industrial Noise Policy, this more detailed sleep arousal test is conducted using the guidelines in the EPA Road Noise Policy. Most relevantly, the Road Noise Policy states:

  For the research on sleep disturbance to date it can be concluded that:

  - *Maximum internal noise levels below 50-55dB(A) are unlikely to awaken people from sleep.*
  - *One to two noise events per night with maximum internal noise levels of 65-70dB(A) are not likely to affect health and wellbeing significantly.*

The internal noise level guidelines have also been adopted in this assessment.

5.4 NOISE FROM INCREASED TRAFFIC GENERATION ON PUBLIC STREETS

For land use developments with the potential to create additional traffic on public streets the development should comply with the EPA Road Noise Policy.

Noise levels generated by traffic should not exceed the noise levels set out in the table below when measured at a nearby property.

Table 5 - Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Local Road (Lucas Street, Church Street, Brodie Street)	Day (7am to 10pm)	55dB(A)$L_{eq(1hr)}$
	Night (10pm to 7am)	50dB(A)$L_{eq(1hr)}$

However, if existing noise levels exceed those in the table above, section 3.4 of the Road Noise Policy is applicable, which requires noise impacts are reduced through feasible and reasonable measures. However, in determining what is feasible/reasonable, the Policy notes that an increase of less than 2dB(A) is a minor impact and would be barely perceptible.

5.5 CONSTRUCTION NOISE AND VIBRATION IMPACTS

5.5.1 EPA Interim Construction Noise Guidelines

EPA guidelines adopt differing strategies for noise control depending on the predicted noise level at the nearest residences:

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise effected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise effected level". For residential properties, the "noise effected" level occurs when construction noise exceeds ambient levels by more than:
    - 10dB(A)$L_{eq(15min)}$for work during standard construction hours (7am-6pm Monday to Friday and 8am to 1pm on Saturdays) and
    - 5dB(A)$L_{eq(15min)}$for work outside of standard construction hours.
- "*Highly noise affected level".* Where noise emissions are such that nearby properties are "highly noise effected", noise controls such as respite periods should be considered. For residential properties, the "highly noise effected" level occurs when construction noise exceeds 75dB(A)$L_{eq(15min)}$ at nearby residences.

A summary of noise emission goals for both standard hours of construction and outside standard hours are presented.

Table 6 – Construction Noise Emission Goals

Location	"Noise Affected" Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$
Residences (QMB, Chinese Consulate, Church Street)	56 (Standard Construction Hours)	75
Commercial Development	70	N/A
Hospital Wards	45 (internal noise level)	N/A

5.5.2 Construction Vibration

Vibration goals for the amenity of nearby land users are those recommended by the EPA document *Assessing Vibration: A technical guideline.* These levels are presented below:

Table 7 – Construction Vibration Goals

Location	Time	Peak velocity (mm/s)	
		Preferred	Maximum
Continuous Vibration			
Residences	Daytime	0.28	0.56
Hospital – Ward Areas	When in Use	0.28	0.56
Hospital – Operating Theatre/Precision Laboratories	When in Use	0.14	0.28
Commercial	When in Use	0.56	1.1
Impulsive Vibration			
Residences	Daytime	8.6	17
Hospital – Ward Areas	When in Use	2.8	5.6
Hospital – Operating Theatre/Precision Laboratories	When in Use	0.14	0.28
Commercial	When in Use	18	36

6 NOISE EMISSION ASSESSMENT

An assessment of operational noise emissions is presented. The following noise sources are assessed:

- Noise from cars circulating within the car park building (average noise emissions).
- Noise from cars starting/doors closing (peak noise events/sleep disturbance analysis).
- Noise created on public roads and on Brodie Street as a result of traffic generated by the site.
- A preliminary assessment of noise from mechanical plant.
- A discussion of construction noise will be presented.

Given that the predominant noise source in question is from cars driving into the car park (and circulating around it), the dominant noise source will be from passenger vehicles. The noise is more similar to noise generated by a new roadway, as opposed to an industrial noise source (such as mechanical plant and heavy vehicles). As such, both the Industrial Noise Policy and the Road Noise Policy are not entirely appropriate when assessing noise impacts (in that the noise is not industrial in character, yet is located on private land as opposed to a public road). However, to assist in assessment, a discussion of noise emissions with respect to both of these noise criteria is presented.

6.1 NOISE FROM THE CAR PARK BUILDING (AVERAGE NOISE EMISSIONS)

Noise generated within the car park building is assessed with reference to the EPA Industrial Noise Policy.

Noise emission predictions are based on the following data/assumptions:

- The primary noise created by the car park is from cars circulating. The primary means of noise egress is via the building façade, which is open to enable natural ventilation of the car park.
- The number of cars circulating within the car park has been calculated as follows:
    - During a peak period (6.30am-7.30am) there are up to 8-10 cars continuously circulating within the car park. (This number based on 500 movements in a peak hour period, and it typically taking 1-2 minutes for a car to drive from the entry to a parking space).
    - During a typical off-peak period (outside of 6.30am-7.30am peak) there are up to 2-3 cars continuously circulating within the car park. (This number based on a peak period of 100 vehicle movements in an off-peak period, and it typically taking 1-2 minutes for a car to drive from the entry to a parking space).

    Vehicle numbers are based on the traffic report from GTA Consultants.
- Typical sound power of a car circulating within the car park (5-15km/h) is assumed to be 84dB(A)L_{eq}.
- No noise reduction has been assumed for the perforated cladding proposed to the exterior of the building.

Operational noise levels are predicted and assessed against Industrial Noise Policy Intrusiveness criteria, as detailed in section 5.2. Note – the Intrusiveness Criteria (which uses the $L_{eq(15min)}$ time descriptor) addresses short term (15 minute) periods of peak noise generation. The Amenity criteria, by contrast, addresses noise generated over *entire* day time/evening/night time periods (11 hours/4 hours and 9 hour periods respectively), and is not appropriate for assessment of peak hour periods of use of the car park.

Table 8 - Car Circulation Within Car Park – Peak Period (6.30am to 7.30am)

Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Comment
Queen Mary Building (Levels 1-5)	55dB(A)$L_{eq(15min)}$	Exceeds morning shoulder period noise goal by 3dB(A) – (goal of 52dB(A) - refer to table 2).
Queen Mary Building (Levels 6 and above)*	51dB(A)$L_{eq(15min)}$	Complies with morning shoulder period noise goal (goal of 52dB(A) - refer to table 2).
Church Street Residence	52dB(A)$L_{eq(15min)}$	Complies with morning shoulder period noise goal (goal of 52dB(A) - refer to table 2).
Chinese Consulate	53dB(A)$L_{eq(15min)}$	Exceeds morning should period noise goal by 1dB(A) – (goal of 52dB(A) - refer to table 2).

*Early morning peak period would be expected to fill the lower 4 levels of the car park. Remaining levels would be expected to have significantly lower levels of traffic movement.

Further to the noise levels predicted above, the predicted noise levels were further verified by measurement of noise emitted from the existing staff car park (to the south of the Queen Mary Building) on 5 May 2016. The existing car park also contains open sides for natural ventilation. Measurements of noise emitted during the 7.00am-7.30am peak period were as follows:

- Measurement made at 9m from south façade of the existing car park. 9m is the equivalent distance of proposed new car park to Queen Mary Building facade. Measurement was made near the car park entry (the busiest part of the car park). Measured noise level was 53-54dB(A)L_{eq} (compared to 55dB(A) predicted above).

- Measurement made at 9m from north façade of the existing car park. 9m is the equivalent distance of proposed new car park to Queen Mary Building facade. The northern portion of the existing car park is located away from the main vehicle flow. Measurements made to the north of the car park will be indicative of noise level on level 6 and above in the Queen Mary Building, where there would be minimal vehicle movement in the morning peak period. Measured noise level was 50dB(A) (compared to 51dB(A) predicted above).

The predicted noise generation *outside* of peak periods is also presented below:

Table 9 - Car Circulation Within Car Park – Typical One Hour Outside of Morning Peak Period

Noise Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min}$	Comment
Queen Mary Building	50dB(A)$L_{eq(15min)}$	Complies with all times of day – refer to table 2.
Church Street Residence	48dB(A)$L_{eq(15min)}$	Complies with all times of day – refer to table 2.
Chinese Consulate	49dB(A)$L_{eq(15min)}$	Complies with all times of day – refer to table 2.

With respect to the tables above, we note:

- During the morning peak periods (6.30am to 7.30am), noise emissions are predicted to exceed EPA Intrusiveness Criteria by up to 3dB(A) for the lower five levels in the Queen Mary Building. While this exceedance is significant, we note:
    - A 3dB(A) exceedance for a one hour period per day is a relatively small exceedance.
    - Being a car park, the primary noise source will obviously be vehicle noise, as opposed to some industrial noise source.
    - Although not directly applicable in the case of assessing noise generation from a car park, the NSW Planning document *Development Near Rail Corridors and Busy Roads – Interim Guideline* provides guidance on what road traffic noise level is typically acceptable before acoustic treatment of a residence is warranted.
    - The Interim Guidelines permit internal noise levels in bedrooms of up to 45dB(A) in situations where the bedroom windows are left *open*. In the event that this 45dB(A) noise goal cannot be achieve with the window open, then the guideline suggest that an alternative fresh air supply is proposed to enable the window to be closed and the occupant still have fresh air in the bedroom.
    - Given that there is typically a 10dB(A) noise reduction of 10dBA(- between outside and inside (assuming that the bedroom window is left open), this would make a target external noise level of 55dB(A). Above this level, the Interim Guidelines suggest that the external environment is sufficiently loud to required that the windows are closed in order to maintain suitable amenity of the occupant.[1]

[1] NSW Planning document *Development Near Rail Corridors and Busy Roads – Interim Guideline* section 3.6.1.

- At 55dB(A), the noise impact from the site is at a level where even if the windows of a sleeping area are left open, the internal noise level within the sleeping area would still comply with the NSW Planning "windows open" criteria of 45dB(A).

- While obviously this does not make the noise emission EPA compliant in itself, the discussion above is aimed at quantifying the amenity impact of the car park noise generation.

- Outside of the morning peak period, noise emissions are predicted to comply with noise emission criteria.

6.2 NOISE GENERATED BY ADDITIONAL TRAFFIC ON PUBLIC ROADS

Noise created as a result an increase in traffic on public roads is assessed with reference to the EPA Road Noise Policy.

Primary access to the site is via a driveway on Brodie Street, with the morning peak period (between 6.30am and 7.30am) being the busiest period of operation.

Noise generated as a result of vehicle movements on Brodie Street is predicted based on the following:

- An assumed sound power level of a car driving on a public road (at no more than 15km/h) of 84dB(A). (Note – traffic calming will be required to limit vehicle speeds to this speed, as discussed in section 7).

  That the number of vehicle movements on Brodie Street during the morning peak hour period are as follows (vehicle numbers are based on the traffic report from GTA Consultants):

Table 10 – Brodie Street Vehicle Movements

Time of Day	Vehicle Movements on Brodie Street
6.00 – 6.30am	136
6.30 – 7.00am	255
7.00 – 7.30am	165

In the case of traffic generation on Brodie Street, it is the north facing bedrooms on the Queen Mary Building which are the most potentially impacted.

Noise impacts are assessed with the EPA Road Noise Criteria (table 5).

We note that Brodie Street is in fact located on private land, and as such, noise generated would typically be assessed with reference to the Industrial Noise Policy (tables 2 and 3). However, given that the road is publicly accessible for both pedestrian and vehicles, and the only significant noise source will be vehicle noise, it is reasonable to adopt the EPA Road Noise Policy in assessment of noise generation.

Predicted noise levels are as follows:

Table 11 – Noise Generated by Additional Road Traffic (Queen Mary Building)

Time of Day	Vehicle Movements on Brodie Street	Permissible Noise Level dB(A)	Predicted Noise Level – dB(A)L_{eq}	Complies?
5.30 – 6.00am	<75	50dB(A)$L_{eq(1hr)}$	<50dB(A)$L_{eq(1hr)}$	Complies
6.00 – 6.30am	136	50dB(A)$L_{eq(1hr)}$	53dB(A)$L_{eq(1hr)}$	3dB(A) exceedance
6.30 – 7.00am	255	50-55dB(A)$L_{eq(1hr)}$*	56dB(A)$L_{eq(1hr)}$	1-6dB(A) exceedance – see discussion below
7.00 – 7.30am	165	55dB(A)$L_{eq(1hr)}$	53dB(A)$L_{eq(1hr)}$	Complies
7:30 – 8.00am	<100	55dB(A)$L_{eq(1hr)}$	<53dB(A)$L_{eq(1hr)}$	Complies

*50dB(A) goal if deemed "night time", 55dB(A) goal is deemed daytime.

With respect to the above, we note:

- There is a clearly defined peak period between 6am and 7.30am. This is a result of the timing of shifts at the hospital.
- In the 6.00am to 6.30am period, there is a predicted exceedance of the night time criteria of 3dB(A). This would be a just perceptible increase in noise level compared to a fully compliant level (typically, a 1-2 dB(A) exceedance would not be considered perceptible).
- In the 6.30am to 7am period:
    - Noise emissions exceed the night time criteria by 6dB(A).
    - Given that this time period is on the night time/daytime "shoulder", some consideration of the EPA Road Noise Policy discussion regarding shoulder periods is reasonable. In this regard, we note that section 2.5.5 of the Road Noise Policy addresses shoulder periods as follows:

        At times, it may be reasonable to vary the standard time periods applies to the day and night. For example, the noise levels in an area may begin to rise sharply earlier than 7am (the standard time day begins) due to normal early morning activity from the community. In these situations, it is reasonable to consider varying the standard day time and night time periods.

    - Being located in the middle of the RPA hospital precinct where a significant proportion of health care staff have a 7am shift start, an increase in activity in the precinct would typically be expected to begin from 6.30am.
    - On review of the L_{eq} (the energy average) noise levels in the long term noise logging data (appendix 1), there is a clear increase in average noise levels at the site typically beginning from 6am, and is more pronounced still at 6.30am
    - In the event that the daytime period is considered to begin from 6.30am, there is a 1dB(A) exceedance in the 6.30am-7.00am period, as opposed to a 6dB(A) exceedance.

A 1 dB(A) exceedance is typically considered to be imperceptible from a fully compliant noise level.

- After 7am, noise emissions are compliant with EPA Road Noise Policy guidelines.

6.3 TRANSIENT NOISE EVENTS (SLEEP AROUSAL)

Noise events occurring between 10am and 7am should be assessed for potential sleep disturbance impacts on nearby residents.

The primary potential noise source will therefore be from staff passenger vehicles (cars starting/doors closing). Noise from tyre squeal, cars driving over speed bumps, using boom gates and similar is capable of being eliminated through appropriate design and equipment selection, and is discussed in section 7.

The transient noise assessment will be assessed is based on the following assumptions:

- The loudest typical peak noise event from the use of the car park will be from a car door closing or a car starting, both with an approximate sound power level of approximately 95dB(A)$L_{1(1min)}$.
- When predicting noise impacts from the car start/door close, predictions are made of the noise from the parking space closest to each of the respective noise receivers.
- Noise from the car engine as it enters/leaves the site (via driveways on Brodie Street, Church Street or Lucas Street is 84dB(A)).

Noise emissions are assessed against EPA Sleep Disturbance guidelines, as presented below.

Table 12 – Sleep Arousal Assessment

Noise Source	Noise Receiver Location	Predicted Noise Level	Emergence Test Level	Compliance
Car start/door close	Queen Mary Building	64dB(A)$L_{1(1min)}$	60dB(A)$L_{1(1min)}$	Exceeds BG+15 test
	Chinese Consulate	64dB(A)$L_{1(1min)}$	60dB(A)$L_{1(1min)}$	Exceeds BG+15 test
	Church Street Residence	59dB(A)$L_{1(1min)}$	60dB(A)$L_{1(1min)}$	Complies
Engine noise on entry/exit to building	Queen Mary Building	58dB(A)$L_{1(1min)}$	60dB(A)$L_{1(1min)}$	Complies
	Chinese Consulate	53dB(A)$L_{1(1min)}$	60dB(A)$L_{1(1min)}$	Complies
	Church Street Residence	53dB(A)$L_{1(1min)}$	60dB(A)$L_{1(1min)}$	Complies

Noise emissions from cars starting/doors closing are predicted to be more than 15dB(A) above the background noise level at the adjacent windows in the Queen Mary Building an Chinese Consulate, and therefore exceed the initial "emergence" test criteria.

As recommended by in the Application Notes to the Industrial Noise Policy, more detailed assessment is required. In this regard, we note:

- For the worst case noise event (car start/door close as impacting the QMB), the predicted noise level is 64dB(A)$L_{1(1min)}$.

- During a noise event of 64dB(A)$L_{1(1min)}$ *at the window* of a residence the noise level *inside* a bedroom room is predicted to be approximately 54dB(A)L_1 (assuming that the bedroom window is left open to allow for natural ventilation of the room).

- EPA Road Noise Policy notes that internal noise events of 50-55dB(A) are "unlikely to awaken people from sleep". At 54dB(A), predicted noise emissions are within this range.

- In addition, the EPA *Environmental Criteria for Road Traffic Noise* also provides some guidance on this issue. Although the document itself is now superseded by the EPA Road Noise Policy, appendix B of the ECRTN provides a detailed study of sleep disturbance as a result of noise. In particular, tables B3 and B4 show graphs of the probability of sleep disturbance for particular noise events.

- For noise events of 54dB(A)$L_{1(1min)}$, the probability of disturbance 1% in table B3, and 0% in table B4.

6.5 NOISE FROM MECHANICAL PLANT

Detailed acoustic design of mechanical plant cannot be undertaken at project approval stage, as plant selections and locations are not finalised.

Given that the car park is proposed to be natural ventilated, there would be very little by way of mechanical plant that would be anticipated:

- Ventilation equipment would be limited to small toilet exhaust fans which could be acoustically treated, if necessary.

- Appropriate equipment selection with respect to boom gates should be utilised to minimise any motor noise or metal on metal impact noise.

Through appropriate equipment selection and, if necessary acoustic treatment, compliance with EPA Industrial Noise Policy noise emission guidelines can be achieved.

6.6 CONSTRUCTION IMPACTS

6.6.1 Construction Noise

With respect to general construction noise, the impacts on nearby development will be dependent on the activity in question and where on the site the activity is undertaken. Excavation and piling works tend to be the loudest typical construction activity.

Detailed acoustic assessment of individual activities cannot be undertaken prior to knowing the activities/construction methods proposed, their duration and location.

However, based on Initial analysis:

- Excavation/soil retention phase - Primary noise emissions occur during excavation and piling, with some equipment items having sound power levels of approximately 115dB(A)$L_{eq(15min)}$. Noise levels exceeding EPA "Noise Effected" target levels (see table 9) are likely to occur at the QMB, residences on Church Street and Lucas Street.

- Given the proximity of the residential land uses to the site, exceedances of the Highly Nosie Effected level are likely to intermittently occur, particularly during excavation and vibrated piling (however auger piling is unlikely to exceed the 75dB(A) "Highly Noise Effected" level.

- During erection of structure, it is the use of hand tools (saws, angle grinders etc for formwork), concrete pumps and slab finishing equipment which are the loudest typical activity (sound power levels of approximately 105dB(A)$L_{eq(15min)}$). Noise levels exceeding EPA "Noise Effected" levels are likely to occur. Exceedances of the "Highly Noise Effected" level are unlikely for extended periods except in close proximity to concrete trucks.

- Asphalting of the proposed new street (Brodie Street) is likely to exceed the "Highly Noise Effected" level of 75dB(A) at the Queen Mary Building. As Brodie Street is located over a hydraulic easement, we anticipate that soil compaction would not be required for the road construction.

Construction noise impacts can be minimised using the following:

- Use of augured rather than driven or vibratory piling should be considered if feasible.

- Location of static plant (concrete pumps, cranes) as far as practicable away from the western boundaries to maximise the distance to the Church Street residences, the residential areas on the Chinese Consulate and some of the bedrooms on the QMB.

- Use of electric as oppose to diesel cranes should be adopted if practicable. In the event that diesel cranes are proposed, it is likely that acoustic treatment of the crane engine will be required.

- For activities which are extremely close to the QMB (Brodie Street construction), delaying commencement of noisy work (asphalting) until after 7.30am will reduce the chance of sleep disturbance of students.

- Letter box drops or similar to advise residents on activities with the potential to result in noise levels reaching the "Highly Noise Effected" noise level (rock excavation within 20m of northern property boundary). Leaflet should advise of the likely duration of the activity.

In light of the above, we recommend:

- On completion of the construction program, acoustic review of proposed construction activities and plant/methods should be undertaken to identify the extent and duration of potential exceedances of EPA construction noise management levels. While there is certainly risk of exceedances of EPA construction noise guidelines, given the limited extent of demolition and excavation, the degree of noise impact during construction would be less than typical development of similar size that also has a basement.

- Identify feasible acoustic controls or management techniques (for example, selection of plant, use of screens around static plant, notification of adjoining land users, respite periods) when exceedance of management noise levels may occur.

- For activities where acoustic controls and management techniques still cannot guarantee compliant noise levels, implement a notification process whereby nearby development is made aware of the time and duration of noise intensive construction processes.

- Implementation of a noise monitoring program during construction to provide feedback back to the Builder to ascertain whether construction noise goals are being exceeded and determine additional management strategies.

Through adoption of the above, noise impacts on nearby development can be managed to prevent unreasonable impact.

6.6.2 Construction Vibration

Excavation, earth retention works (piling) and soil compaction are the primary vibration generating activities.

Given the distance between the site and the nearest residential and school buildings, it is unlikely that construction vibration will exceed EPA guidelines if piling works are conducted using augured pilings.

In the event that sheet/vibratory piling or vibratory rollers are used, there is a risk that residential amenity vibration criteria will be exceeded (particularly at the Queen Mary Building).

If bulk excavation in rock, driven/vibrated piles or soil compaction works are proposed, we recommend:

- Where practicable, excavation in rock should be done using rock saws as opposed to pneumatic hammers.

- For at least the initial stages of excavation, piling or compaction, vibration monitoring should be conducted to ensure excessive levels of vibration are not achieved.

- Any vibration monitoring system should allow for rapid feedback to the contractor (for example, SMS notification) in the event that excessive levels are reached.

7 RECOMMENDATIONS

We recommend, and note that Health Infrastructure are prepared to adopt the following acoustic treatments/management controls to minimise noise generation:

- Polished concrete surface or similar must be avoided in the car park to prevent tyre squeal. Broom or float finish or other similar finishes should be adopted.

- Speed limit on Brodie Street and in the car park itself to be limited to 15km/h to minimise noise generation. Below 15km/h, the primary noise source will be from the car engine, as opposed to tyre on road noise, and so provided that vehicle speeds are controlled, there will be little additional benefit in selecting road finishes to further reduce noise.

- Speed humps, if used, should either be concrete or plastic type, and should be fixed/installed to avoid any impact noise generated when cars drive over them.

- Use of noise absorptive lining to the underside of the slab soffit over the entry/exit boom gate (and any covered queuing areas) areas should be installed (50mm thick Echosoft or similar material with NRC no less than 0.8).

- Acoustic review of any boom-gate or inter-com system at the car park entry should be conducted at detailed design stage.

- A detailed construction noise and vibration management plan should be undertaken following preparation of the construction program. Review of the mitigation techniques outlined in section 6.8 of this report should be done, and implemented where feasible.

- Detailed acoustic review of all external plant items should be undertaken following equipment selection and duct layout design.

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8 CONCLUSION

Noise emissions associated with the proposed multi-storey staff car park at 106-112 Church Street Camperdown have been assessed with reference to relevant EPA and Council acoustic guidelines in order to comply with Director General Requirement 9.

An analysis of typical operational noise (vehicle noise both within the car park in in the surrounding road network) indicate that there is a risk of exceedance of typically adopted noise emission guidelines, particularly in the 6.30-7.30am peak period of use of the car park. Outside of this period, noise emissions are predicted to generally be compliant with noise emission goals.

Where possible, acoustic treatments and noise management has been recommended, as detailed in section 7. However even with these acoustic treatments in place, exceedances of commonly adopted EPA guidelines are predicted (with exceedances of between 1-6dB(A), depending on how noise emission guidelines are adopted, as discussed in sections 6.1 and 6.2).

Justification of the noise impact is discussed in sections 6.1, 6.2, 6.3. These exceedances should be considered when balancing the merits of the proposal. In short:

- There are limited periods when vehicle noise will exceed EPA Industrial Noise Policy guidelines. This is primarily in a clearly defined one hour peak period between 6.30am and 7.30am.

- Given that the noise from the site consists of cars using the entry driveways and circulating within the car park, the noise emitted would be similar in nature to that created by a local road, and therefore it is not unreasonable to consider the site with respect to emission guidelines for new local roads (the EPA Road Noise Policy), as opposed to the Industrial Noise Policy.

- When considered in this regard, the noise emitted from the site is generally consistent with EPA Road Noise Policy guidelines:

    - There is some exceedance of the guidelines in the 6.30am -7.30am peak period of use of the car park, however being located within the RPA hospital precinct where majority of healthcare worker shifts start between 7am and 7.30am, there is merit in treating this 6.30-7.00am period as a “daytime” period, as opposed to the night time period, as this is reflective of the activity/use in the area (as is consistent with clause 2.5.5 of the Road Noise Policy with expect to “shoulder” periods between day and night).

    - Considered in this way, any remaining exceedances of criteria are less than 2-3dB(A), which is typically considered insignificant as it would be barely perceptibly louder than a compliant noise level.

In addition, further noise mitigation is not feasible or practical:

- Vehicle calming to reduce tyre on road noise is already recommended.

- We are instructed that it is not feasible to relocate the car park entry to the eastern end of Brodie Street (away from the residential land use and avoiding queuing on Brodie Street) as this would cause queuing within the hospital precinct road network adjacent to the QMB and Marie Bashir building in any case.

- Enclosure of Brodie Street is not feasible, as Brodie Street is subject to an easement given there are hydraulic services below (making construction of a permanent enclosing structure not feasible).

- Given the noise generated on Brodie Street, there would be little perceptible improvement in enclosing the southern façade of the lower levels of the car park itself to reduce noise impacts on the Queen Mary Building (given the Brodie Street noise is a more significant impact).

With respect to construction noise, detailed noise management practices should be implemented. In principal acoustic review indicates that earthworks, piling and erection of structure all have the potential to exceed EPA Interim Construction Noise Policy guidelines, however the construction noise is not out of keeping with moderate/large scale development in residential areas. Noise mitigation through work scheduling and equipment selection should be considered. This should be implemented via a Noise/Vibration Construction Management Plan, which should be determined once a construction program is complete.

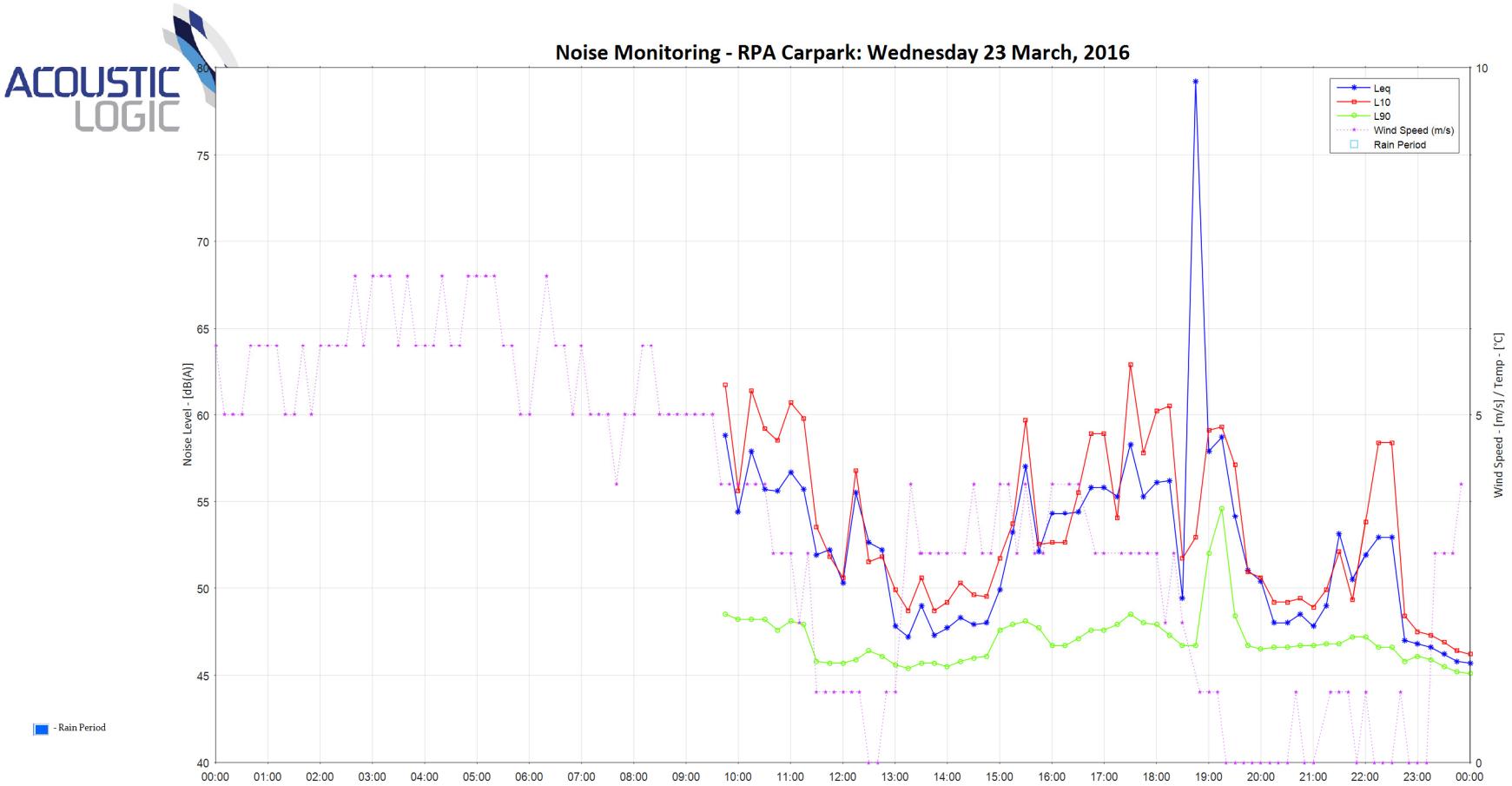
Please contact us if you have any queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Thomas Taylor

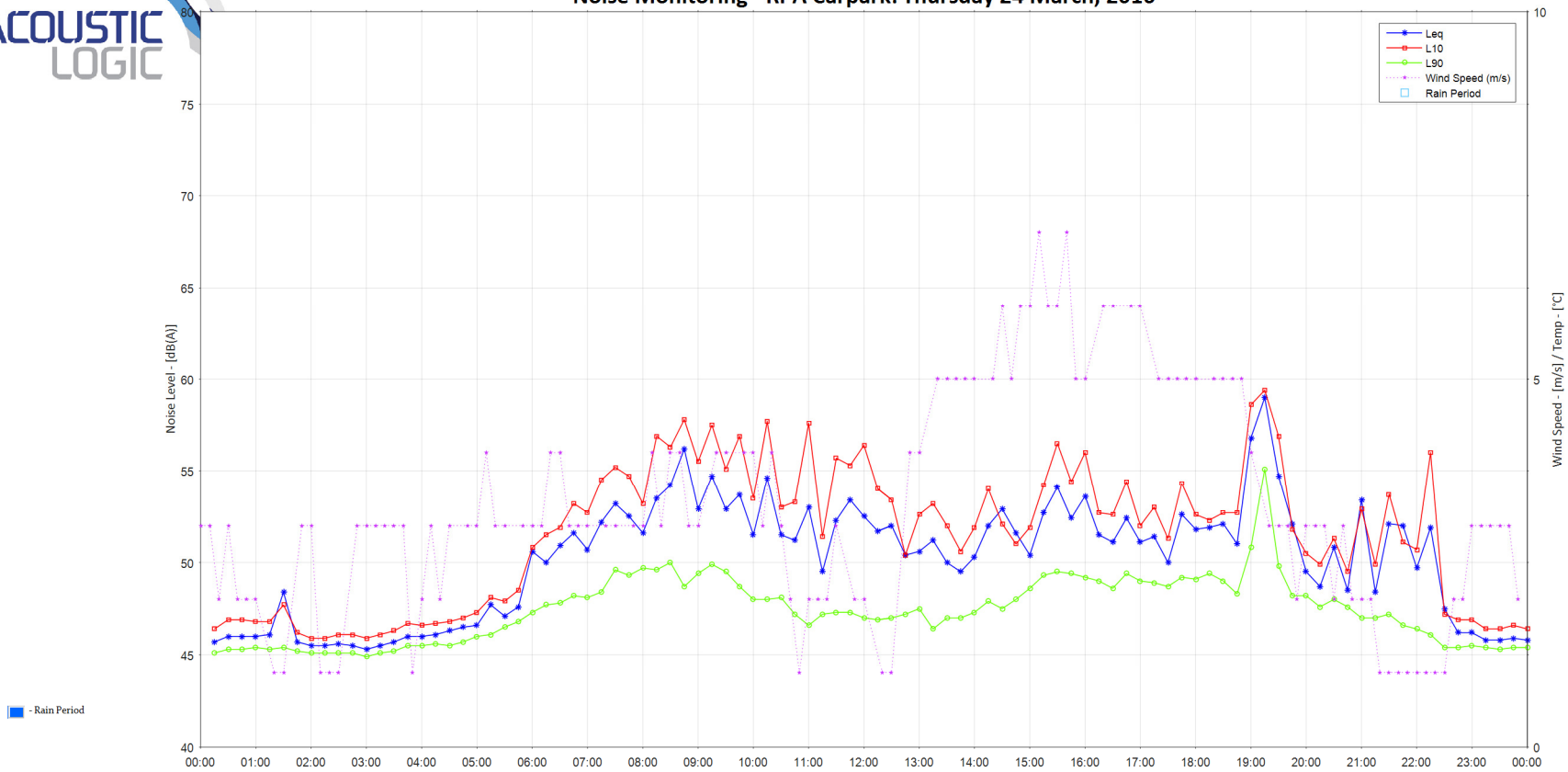
Appendix 1

Background Noise Logging Results


Noise Monitoring - RPA Carpark: Wednesday 23 March, 2016
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Rain Period

ACOUSTIC LOGIC

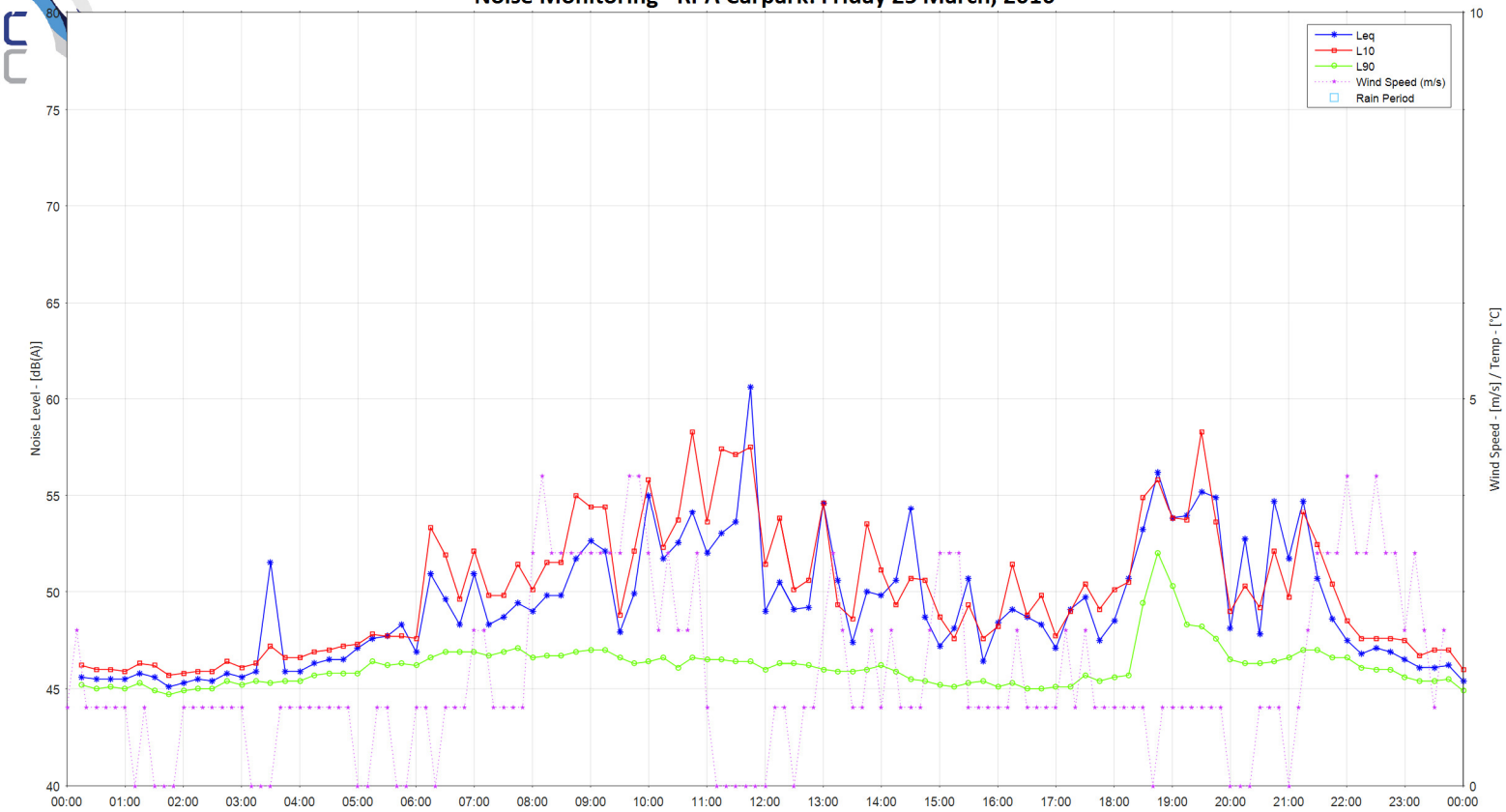
Noise Monitoring - RPA Carpark: Thursday 24 March, 2016



- Rain Period

ACOUSTIC LOGIC

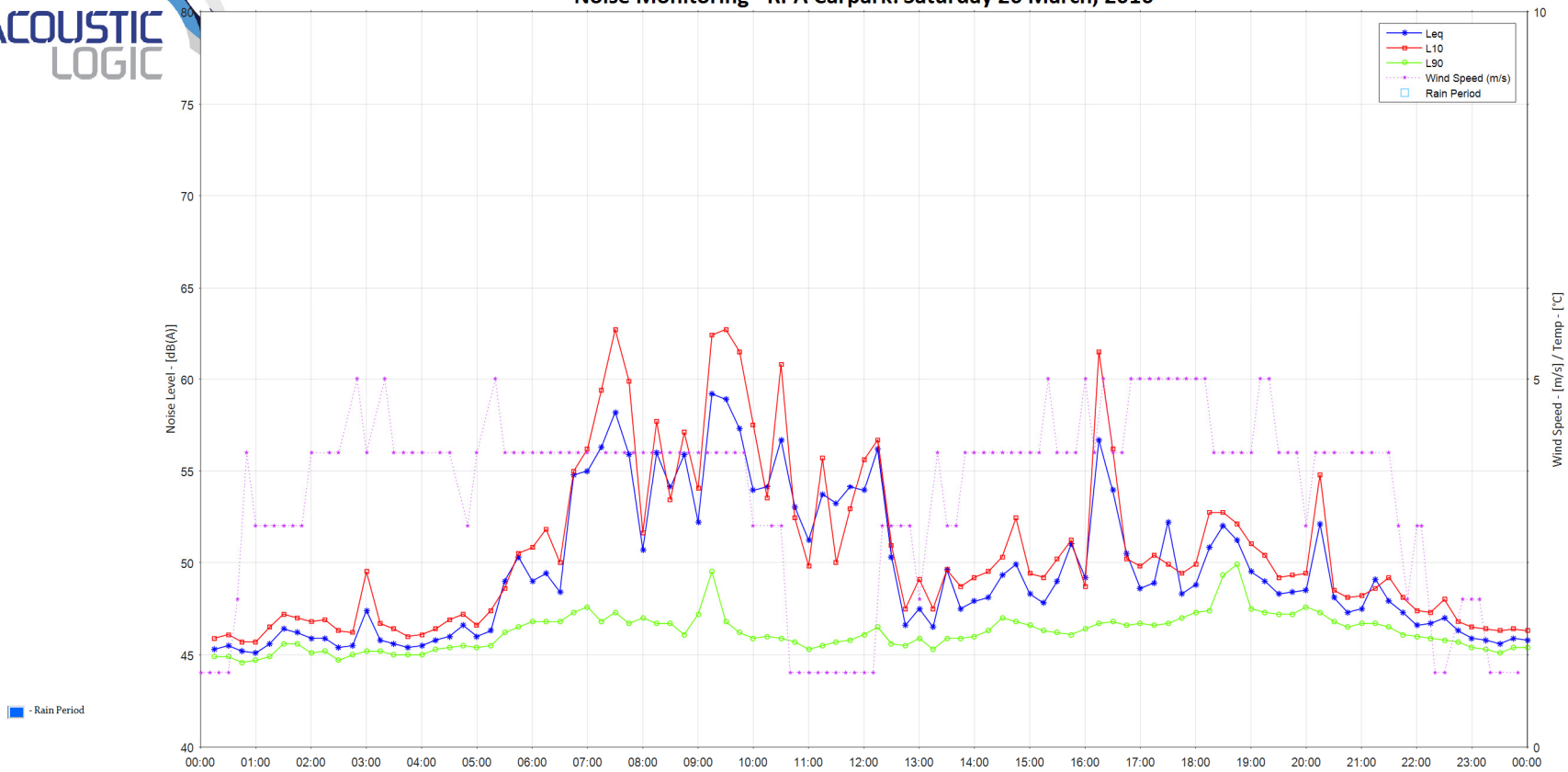
Noise Monitoring - RPA Carpark: Friday 25 March, 2016



- Rain Period

ACOUSTIC LOGIC

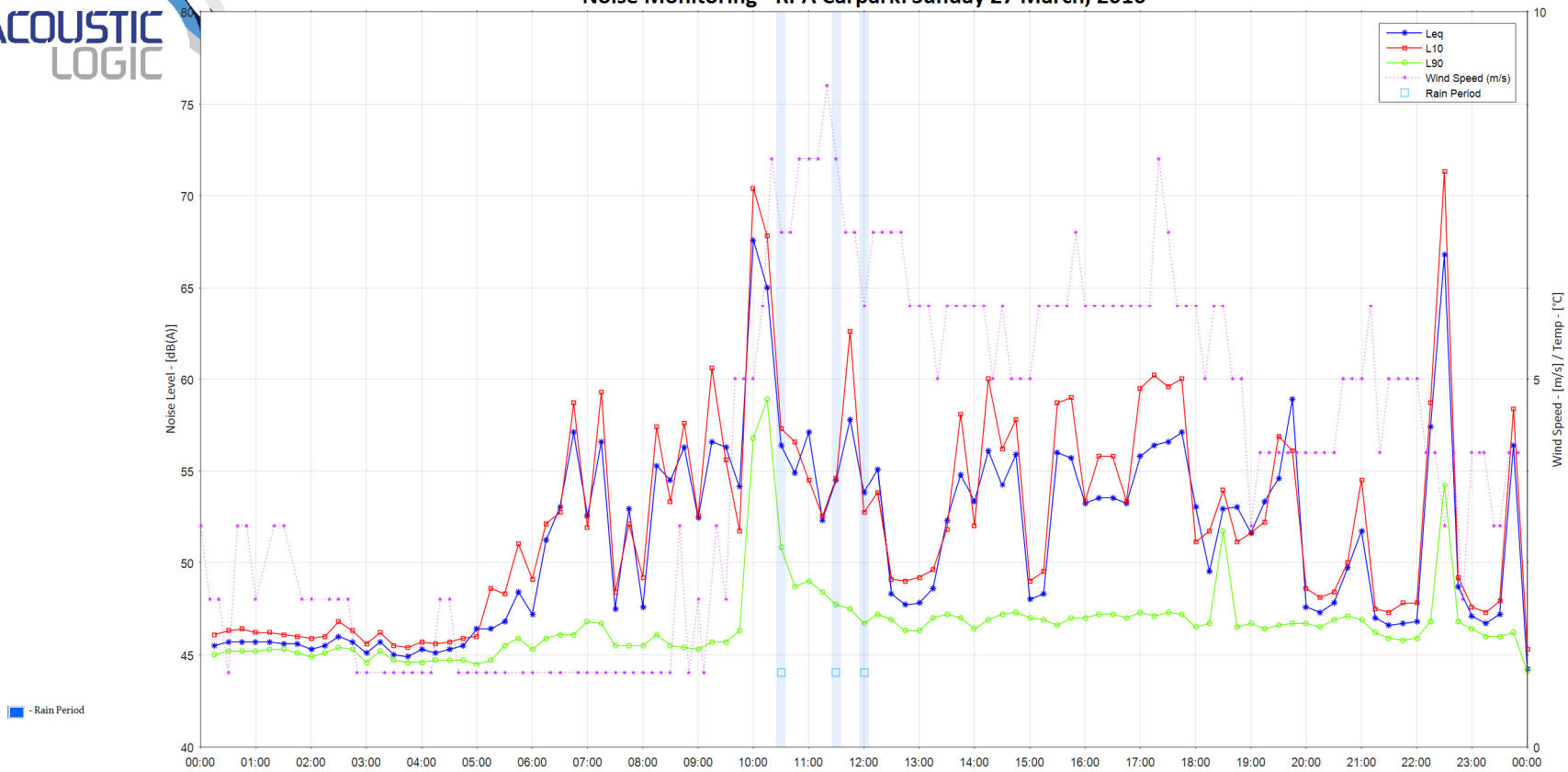
Noise Monitoring - RPA Carpark: Saturday 26 March, 2016



- Rain Period

ACOUSTIC LOGIC

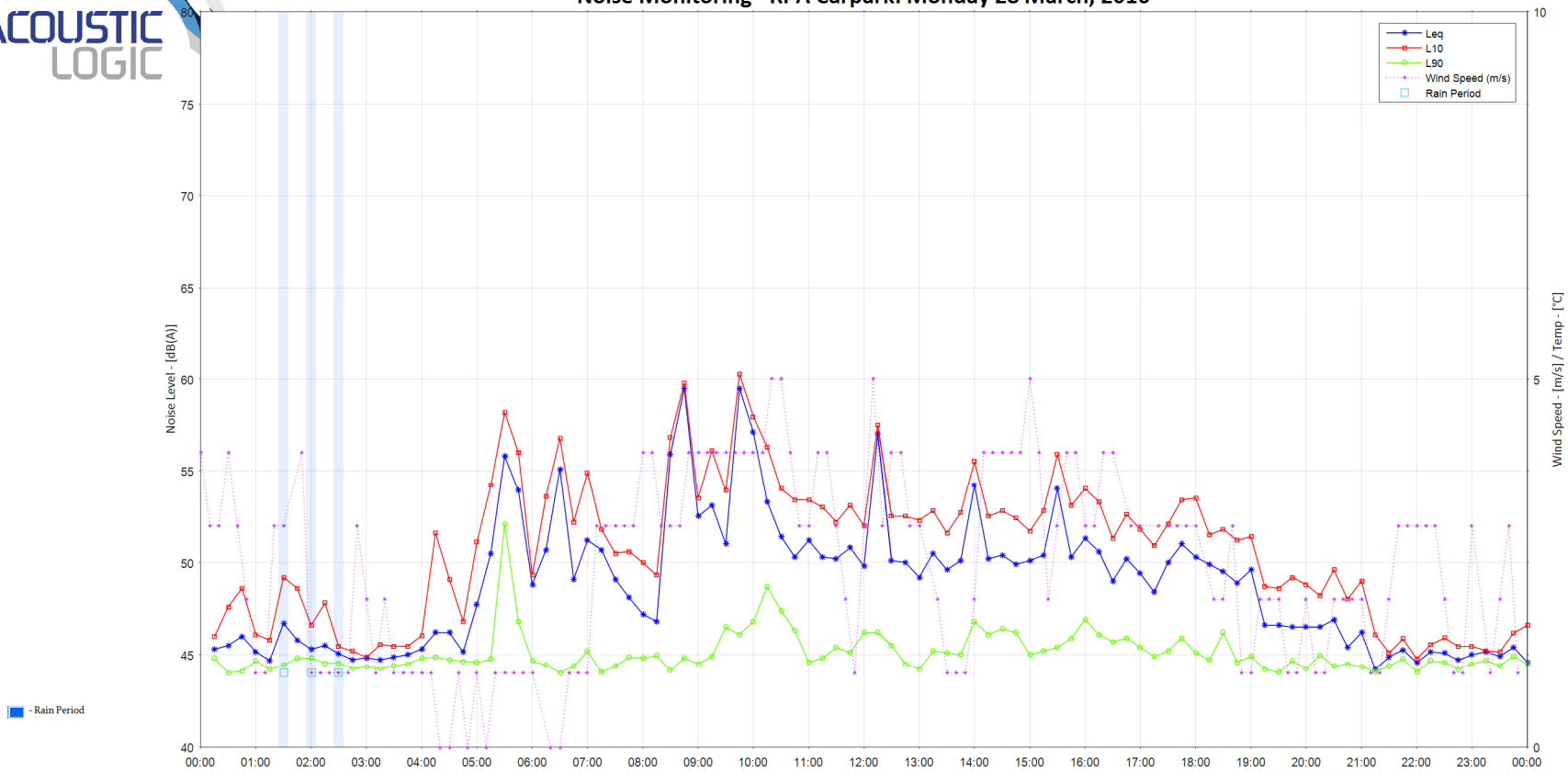
Noise Monitoring - RPA Carpark: Sunday 27 March, 2016



- Rain Period

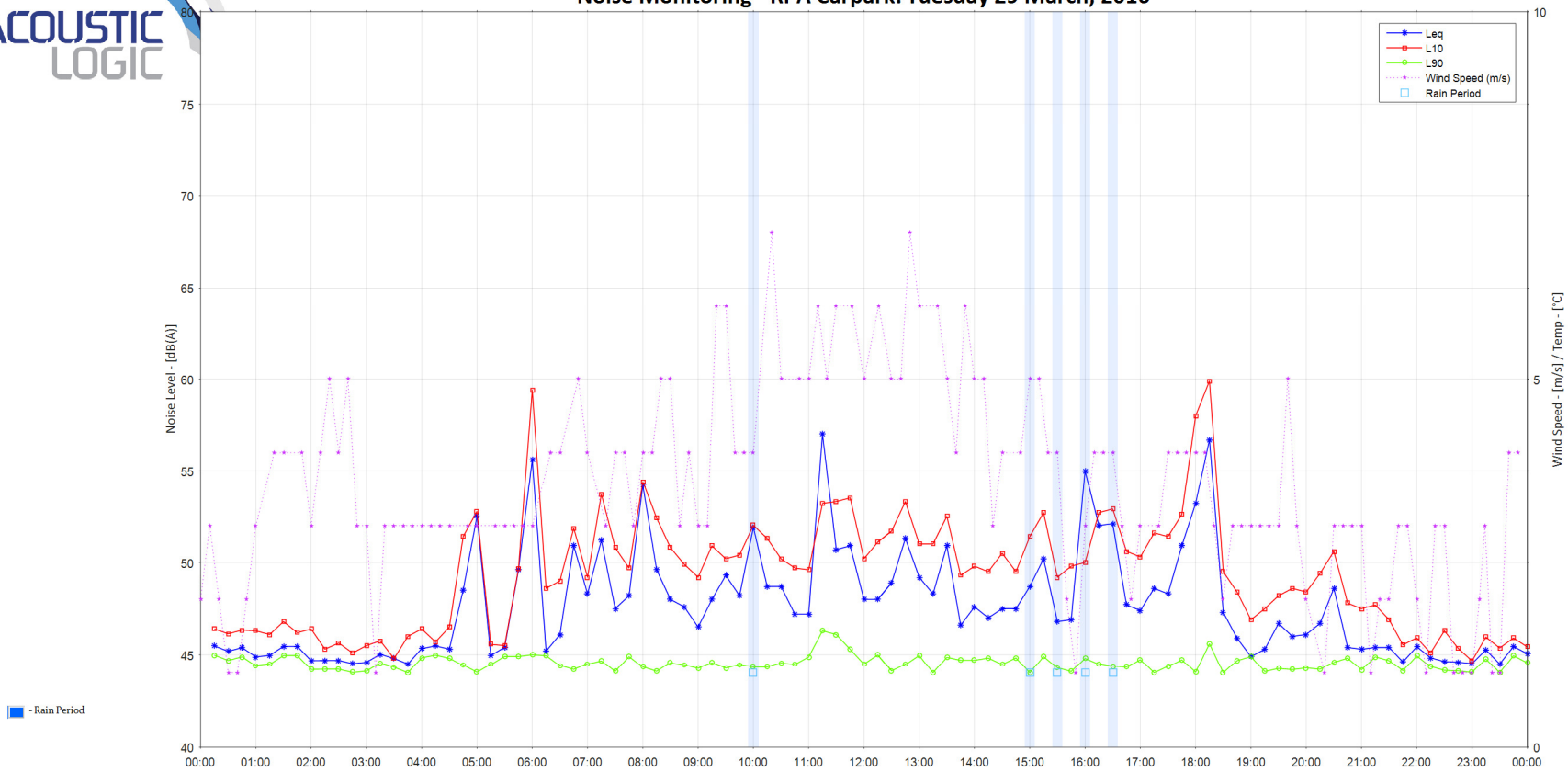
ACOUSTIC LOGIC

Noise Monitoring - RPA Carpark: Monday 28 March, 2016

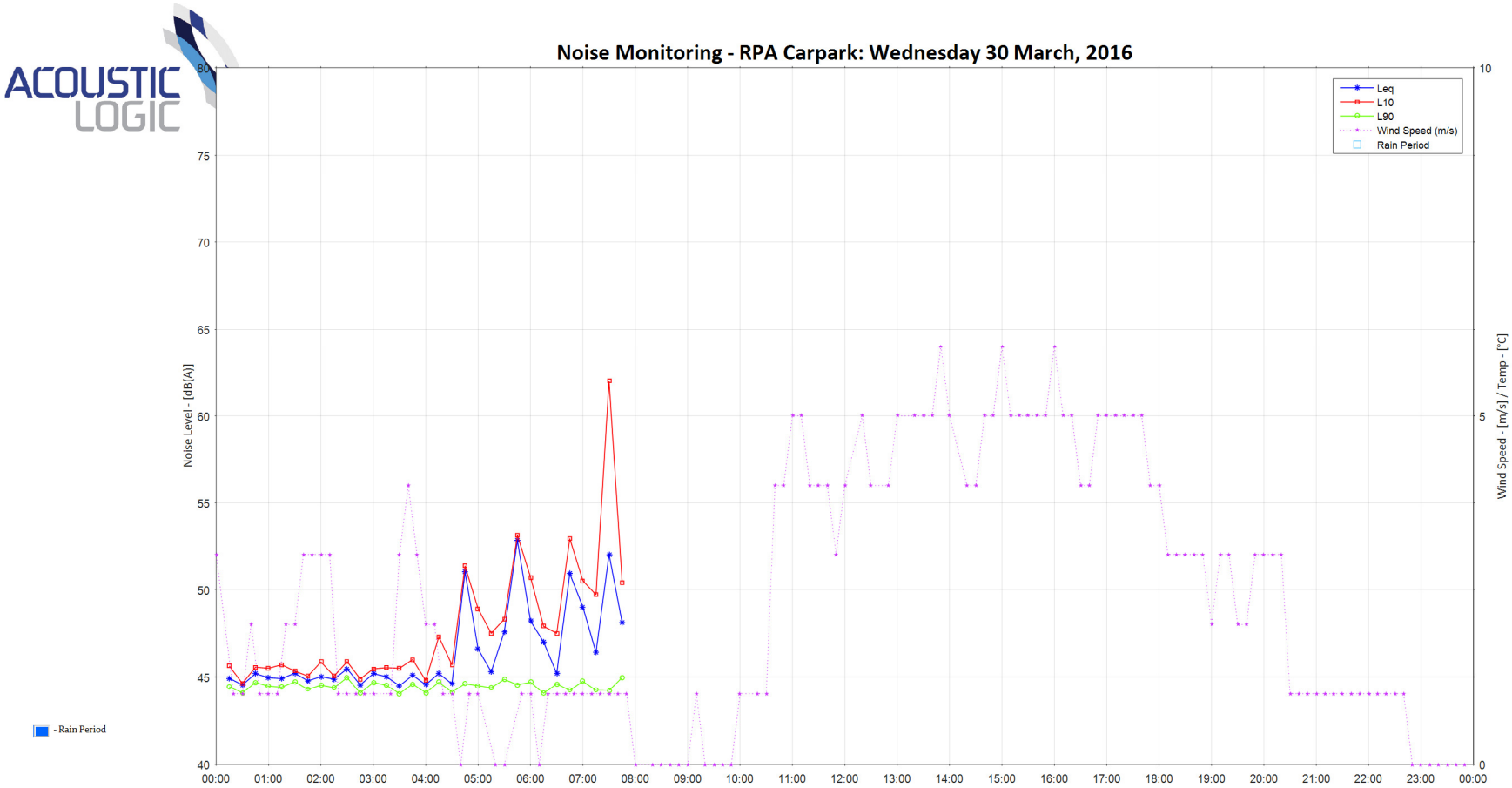


ACOUSTIC LOGIC

Noise Monitoring - RPA Carpark: Tuesday 29 March, 2016



- Rain Period


Noise Monitoring - RPA Carpark: Wednesday 30 March, 2016
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
80
75
70
65
60
55
50
45
40
10
5
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
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13:00
14:00
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17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00
- Rain Period