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Noise Impact Assessment

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1 INTRODUCTION

This report presents an assessment of acoustic impacts associated with the proposed multi-deck car park to be located on the corner of Darcy Road and Institute Road, Westmead within the grounds of the Westmead Hospital.

In this report we will:

- Identify noise sources associated with the proposed development (vehicle noise from the car park building);
- Establish noise emission criteria with reference to the Parramatta City Council DCP and EPA noise emission guidelines;
- Predict operational noise associated with the car park;
- If necessary, determine building/management controls necessary to ensure that compliant noise emissions are achieved.

In addition, the report will include an in-principle review of construction noise. Relevant EPA construction noise will be identified and potential impacts on nearby development examined.

This report will assess construction and operational noise and vibration emissions from the proposed car parks as required by point 9 of the SEARS, application number SSD7262 and issued on 1st October 2015, which states:

"9. Noise and Vibration

Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land. Relevant policies and guidelines:

- *NSW Industrial Noise Policy (EPA)*
- *Interim Construction Noise Guideline (DECC)*
- *Assessing Vibration: A Technical Guideline 2006."*

This report is based on the architectural drawings provided by HDR RD + MSJ, project number 232186, issue 7 and dated 29/10/2015.

2 SITE DESCRIPTION / PROPOSED DEVELOPMENT

The proposed car park will be located on the corner of Darcy Road and Institute Road, Westmead with the grounds of the Westmead Hospital. The car park will be eight storeys high, with a proposed capacity of 1,254 cars, and will operate 24 hours a day, 7 days a week. There will be an overhead walkway which will connect the proposed multi-storey car park to the Dental School Building to the immediate south-east.

Cars will be able to access the multi-storey car park via Institute Road and Darcy Road.

The majority of the car park will be naturally ventilated. Sections of the lower ground floor of the car park may be mechanically ventilated.

Additional works to be carried out will include:

- Demolition of on-grade car park number 7, the trees within car park 7, existing column lighting, fire services building, former Coroner's Court building slab and the eastern section of Institute Road;
- New at-grade car parking area (47 car spaces) to the east of the proposed multi-storey car park;
- Extension of Institute Road to the east to connect to the new road approved under part 5;
- Widening of Institute Road on approach to Darcy Road to provide two traffic lanes (55m long second lane) for intersection improvements
- Landscaping works including creation of park land and new pathway connections.

The nearest receivers to be potentially affected by the operation of the car park are detailed below:

- Receiver 1: Dental school building located approximately 17m south-east of the proposed car park. This building is a part of Westmead Hospital. This office has been advised that the windows on the north-western façade of this receiver (facing the proposed car park) remain closed except for maintenance. There are no sleeping areas in this building.
- Receiver 2: Catherine McAuley High School, located to the south-west of the site across Darcy Road. Classrooms facing the proposed car park have openable windows.
- Receiver 3: Residential development located approximately 150m to the north-west of the proposed car park.
- Receiver 4: Westmead Private Hospital located approximately 180m to the north-west of the proposed car park. The Westmead Private Hospital does have sleeping areas.

Figure 1 shows the site and potentially impacted receivers surrounding the site.

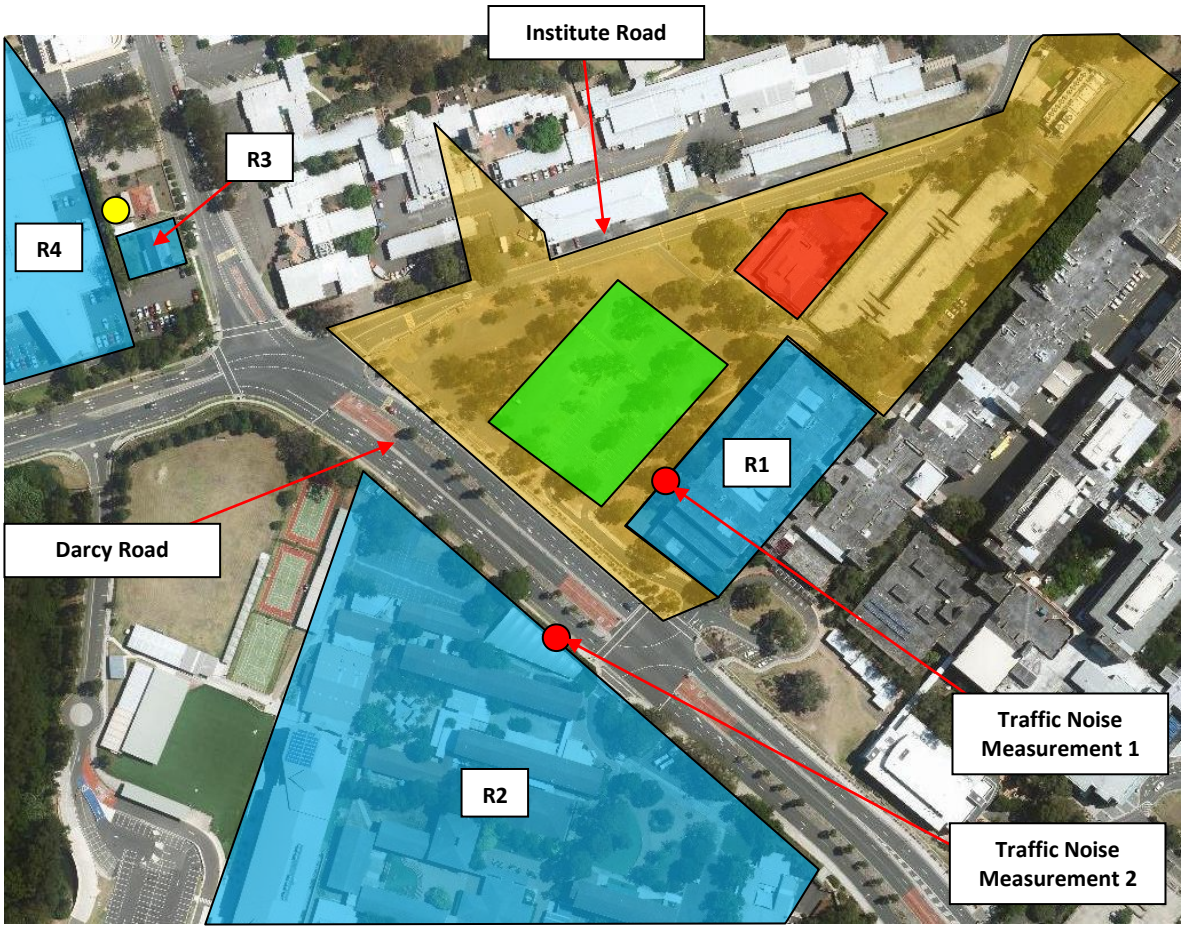


Figure 1 – Site Map

Unattended Noise Monitor Location

Attended Measurement Locations

Site Area

Proposed Multi-Storey Car Park

Proposed At-Grade Car Park

Nearby Noise/Vibration Receivers

3 NOISE DESCRIPTORS

Traffic noise constantly varies in level, due to fluctuations in traffic speed, vehicle types, road conditions and traffic densities. Accordingly, it is not possible to accurately determine prevailing traffic noise conditions by measuring a single, instantaneous noise level. To accurately determine the effects of traffic 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. These parameters are used to measure how much annoyance would be caused by a particular noise source.

In the case of 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 interval.

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 measurement 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 traffic noise.

The L_1 parameter represents the noise level exceeded for 1% of the measurement period.

4 SURVEY OF AMBIENT NOISE

A survey of existing ambient noise at the site was undertaken using a long term noise logger installed at the residents located approximately 150m north-west of the site (refer to figure 1). In addition, attended noise measurements conducted at nearby receivers during peak hour traffic (refer to figure 1 for locations).

Unattended noise monitoring was conducted from the 14th to the 23rd December 2015 using an Acoustic Research Laboratories noise monitor set to A-weighted fast response. The monitor was calibrated at the start and end of the monitoring period using a Rion NC-73 calibrator. No significant drift was noted. Noise logger data is provided in Appendix 1.

The attended traffic noise measurements were conducted on the 15th October 2015 between 5pm and 6pm. Attended measurements were undertaken using a Norsonics Type 140 precision sound level analyser, set to A-weighted fast response. The precision sound level analyser was calibrated before and after the measurements using a Norsonics 1251 sound level calibrator. No significant drift was recorded.

Measured background noise levels obtained from the unattended noise measurements are presented below. Weather affected data has been excluded in determining Rating Background Noise Levels, in addition, the lowest background noise levels during night time period has been adopted to provide conservative noise emission assessment. Rating background noise level Refer to Appendix 1 for the unattended noise monitoring data.

Table 1 – Measured Background Noise Levels

Noise Descriptor	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)	Night (10pm-11pm)	Night (11pm-4am)	Night (4am-6am)	Night (6am-7am)
Background Noise Level (L_{90})	46	46	38	45	38	38	41

The measured traffic noise levels are presented in the table below:

Table 2 – Measured Traffic Noise Levels

Measurement Location	Time Period	Measured Noise Level dB(A)$L_{eq(15min)}$
Dental School Building (Location 1, refer to figure 1)	5:15pm	52dB(A)$L_{eq(15min)}$
Catherine McAuley High School, 3.5m from kerb (Location 2, refer to figure 1)	5:30pm	65dB(A)$L_{eq(15min)}$

5 NOISE EMISSION CRITERIA

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

- Parramatta City Council DCP;
- Australian Standard AS2107:2000;
- EPA Industrial Noise Policy;
- EPA Industrial Noise Policy Application Notes for Sleep Arousal;
- EPA Interim Construction Noise Guidelines;
- Australian Standard AS2436:2000.

5.1 CAR PARK OPERATION NOISE

Noise from the cars manoeuvring within the car parks will be assessed against the requirements of the Parramatta City Council DCP, the NSW EPA Industrial Noise Policy and Australian Standard AS2107:2000.

5.1.1 Parramatta City Council DCP

The Parramatta City Council DCP does not have any specific noise emission criteria for commercial development. In the absence of this, noise emissions from cars manoeuvring within the car park will be assessed based on the requirements of the NSW EPA Industrial Noise Policy and Australian Standard AS2107:2000.

5.1.2 NSW EPA Industrial Noise Policy Intrusiveness Criterion (To Residential Receivers)

Noise impacts at residential receivers from cars manoeuvring in the proposed car park will be assessed against the requirements of the Intrusiveness Criterion of the Industrial Noise Policy.

The Intrusiveness Criterion requires that noise from the site not exceed background noise levels by more than 5dB(A)$L_{eq(15min)}$ when measured at the boundary of nearby residential receivers. This criteria is summarised in the table below

Table 3 – EPA Industrial Noise Policy Intrusiveness Criterion

Receiver Type	Time of Day	Measured Background Noise Level $L_{90(period)}$	Intrusiveness Noise Emission Objective $L_{eq(15min)}$ (Background+5dB(A))
Nearest Residential Receiver (2 Mons Road, receiver 3)	Day (7am-6pm)	46	51
	Evening (6pm-10pm)	46	51
	Night (10pm-11pm)	45	50
	Night (11pm-4am)	38	43
	Night (4am-6am)	38	43
	Night (6am-7am)	41	46

5.1.3 NSW EPA Industrial Noise Policy Amenity Criterion (To School Receiver and Private Hospital Wards)

The noise criteria in the Amenity criteria section of the EPA Industrial Noise Policy applicable to the nearest receivers of the proposed car park are presented in the table below:

Table 4 – EPA Industrial Noise Policy Amenity Criteria Noise Criteria

Existing Sensitive Land Use	Time of Day	Recommended Maximum Noise Level
School Classrooms (receiver 2)	Noisiest 1-hour period when in use	40dB(A)$L_{eq(worst\ 1hr,\ when\ in\ use)}$ (internal)
Hospital Wards (receiver 4)	Noisiest 1-hour period	40dB(A)$L_{eq(worst\ 1hr,\ when\ in\ use)}$ (internal)

The EPA Industrial Noise Policy only specifies internal noise criteria for hospital wards. Given that the dental school building (receiver 1) does not have any sleeping areas, internal noise level criteria for other spaces in hospitals will be based on the 'maximum' levels outlined in Australian Standard AS2107:2000.

5.1.4 Australian Standard AS2107:2000 (To Dental School Building)

The internal noise criteria of Australian Standard AS2107:2000 relevant to this site are outlined in the table below:

Table 5 – AS2107:2000 Internal Noise Criteria

Type of Occupancy/Activity	Time Period	Recommended Maximum Design Sound Level, LA_{eq} dB(A)
Health Buildings – Dental Clinics, Office Areas, Consulting Rooms, Surgeries (Receiver 1)	When in Use	45dB(A)$L_{eq(worst\ 1hr)}$

5.1.5 Sleep Arousal Assessment (Peak Noise Events – Car Start and Door Close)

Given that the car park if proposed to be used during the night time period (10pm to 7am), the site will be assessed for sleep arousal impacts.

Short duration, intermittent noise events (such as car engine starts and car doors closing) are typically assessed with reference to additional acoustic criteria specifically to assess potential sleep disturbance.

Potential impacts have been 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. That is, the L_1 noise level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) outside the window of a sleeping area (residential of hospital sleeping ward) between the hours of 10pm and 7am. If the noise events are within this, then sleep arousal impacts are unlikely and no further analysis is needed. This is consistent with the Noise Guide for Local Government. The guideline level is set out below.

Table 6 – Sleep Arousal Criteria ("Emergence"/Background+15dB(A) Test)

Location	Background Noise Level (10pm-7am) dB(A)$_{L90}$	Emergence Level dB(A) $L_{1(1min)}$
Outside Windows of Residential Receiver 3 and Sleeping Wards of Westmead Private Hospital (Receiver 4)	38	53

- 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, existing noise sources, etc. This test takes into account the noise level and number of occurrences of each event with the potential to create a noise disturbance. As is recommended in the explanatory 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.*

5.2 MECHANICAL SERVICES NOISE

5.2.1 Parramatta City Council DCP

In the absence of any specific criteria relating to noise emissions from commercial development in the Parramatta City Council DCP, mechanical noise emissions from the car park have been assessed in accordance with the requirements of the NSW Environmental Protection Authority (EPA) Industrial Noise Policy. Although the proposed development is not strictly an industrial development, the provisions of the Industrial Noise Policy can be applied to a wide range of land uses in order to develop noise emission goals. Noise generated from the car park should comply with the EPA Industrial Noise Policy's Intrusiveness and Amenity Criteria.

5.2.2 NSW EPA Industrial Noise Policy

5.2.2.1 INP - Intrusiveness Assessment

The Industrial Noise Policy Intrusiveness Criteria Intrusiveness criteria requires that noise from the site not exceed the background noise level by more than 5dB(A)$L_{eq(15min)}$ when measured at the nearest residential receivers.

Table 7 – EPA INP Intrusiveness Criteria

Location	Time of Day	Background noise Level - dB(A)$_{L90}$	Intrusiveness Noise Objective dB(A)$L_{eq(15min)}$ (Background + 5dB)
All Potentially Affected Residential Properties	Day Time (7am – 6pm)	46	51
	Evening (6pm – 10pm)	46	51
	Night (10pm-7am)	38	43

5.2.2.2 INP - Amenity Assessment

The INP amenity criteria provide noise emission goals at nearby receivers depending on the type of receiver. The relevant criteria are presented below.

Table 8 - EPA Amenity Criteria

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A)$L_{eq(Period)}$
All Potentially Affected Residential Properties	Suburban	Day Time (7am – 6pm)	55
		Evening (6pm – 10pm)	45
		Night (10pm-7am)	40
Hospital Ward - external	All	Noisiest 1-hour period	55
School classroom - internal	All	Noisiest 1-hour period when in use	40

5.3 CONSTRUCTION NOISE IMPACTS

5.3.1 EPA Interim Construction Noise Guidelines (ICNG)

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 affected 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.

For hospital wards, operating theatres and classrooms at schools, the ICNG recommends that construction noise should not exceed 45dB(A)$L_{eq(15min)}$ within the internal areas of these receiver types.

5.3.2 Australian Standard AS2436:2010 "Guide to noise control on construction, maintenance and demolition sites

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites AS2436:2010 *"Guide to noise control on construction, maintenance and demolition sites"* nominates the following:

a. That reasonable suitable noise criterion is established,

b. That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and

c. The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the demolition, excavation and construction site.

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic comprises between construction sites and potential noise affected receivers.

5.3.3 Construction Noise Objectives

A summary of the applicable construction noise objectives at the nearest affected receivers

Table 9 – Construction Noise Emission Criteria (Hospital and School Receivers)

Location	Noise Emission Criteria - dB(A)$L_{eq(15min)}$
Receiver 1: Dental School Building to the South-East	45dB(A)$L_{eq(15min)}$ internally
Receiver 2: Catherine McAuley High School to the south-west	45dB(A)$L_{eq(15min)}$ internally
Receiver 4: Westmead Private Hospital	45dB(A)$L_{eq(15min)}$ internally

Table 10 – Construction Noise Emission Criteria (Residential Receivers, during Standard Construction Hours)

Location	"Noise Affected" Management Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$
Receiver 3: Residential at 2 Mons Road	57	75

6 NOISE EMISSION ASSESSMENT

Noise associated with the development will consist of:

- Noise emissions from the operation of the car park, which is assessed with reference to the NSW EPA Industrial Noise Policy and Australian Standard AS2107:2000. Noise sources will consist of:
    - Noise from cars manoeuvring within the car parks.

In addition, a discussion of construction noise will be presented.

The nearest potentially affected receivers are:

- Receiver 1: Dental school building located approximately 17m south-east of the proposed car park. This building is a part of Westmead Hospital.
- Receiver 2: Catherine McAuley High School, located to the south-west of the site across Darcy Road.
- Receiver 3: Residential development located approximately 150m to the north-west of the proposed car park.
- Receiver 4: Westmead Private Hospital located approximately 180m to the north-west of the proposed car park. The Westmead Private Hospital does have sleeping areas.

6.1 CAR PARK NOISE ASSESSMENT

6.1.1 General Cars Manoeuvring within Car Park

The following AM and PM peak car movements for the proposed car park have been predicted and are based on the Transport Impact Assessment prepared by GTA Consultants, re: 15S1337400, dated 11/11/2015:

- AM peak hour of 752 car movements within the multi-storey car park (652 cars entering and 100 cars exiting);
- PM peak hour of 464 car movements within the multi-storey car park (88 cars entering and 376 cars exiting);

Predictions will be made based on the following data/assumptions:

- Sound power level of a car travelling at 10km/hr being 84dB(A)L_{eq}, based on measurements conducted by this office;
- For the day time and evening periods (7am-10pm):
    - AM peak hour of 752 car movements within the multi-storey car park (652 cars entering and 100 cars exiting) and 47 cars entering into the at-grade car parking area to the east of the proposed multi-storey car park.
- For the night time period of 10pm-11pm:
    - 50% of the car movements predicted for the PM peak (i.e. 232 car movements, with 44 cars entering and 188 cars exiting) as instructed by GTA Consultants.
- For the night time period of 11pm-4am:
    - 20% of the car movements predicted for the PM peak (i.e. 93 car movements, with 18 cars entering and 75 cars exiting) as instructed by GTA Consultants.
- For the night time period of 4am-6am:
    - 50% of the car movements predicted for the AM peak (i.e. 376 car movements, with 326 cars entering and 50 cars exiting) as instructed by GTA Consultants.
- For the night time period of 6am-7am:
    - 70% of the car movements predicted for the AM peak (i.e. 526 car movements, with 456 cars entering and 70 cars exiting) as instructed by GTA Consultants.
- Windows of the dental school building (receiver 1). Based on information provided to this office.
- Classrooms of Catherine McAuley High School (receiver 2) and Westmead Private Hospital wards (receiver 4) facing proposed carpark are open. It is assumed that a 10dB(A) noise reduction occurs when an external noise source travels into an internal area through an open window/door.

6.1.1.1 Predicted Noise Levels

Noise emissions from cars manoeuvring within the car park at the nearest receivers will be assessed against the criteria outlined in section 5.1.

The predicted noise levels at the receivers 1, 2 and 4 from the worst case AM peak period (see section 6.1.1) are presented in the table below.

Table 11 – Predicted Noise Levels from Car Park Noise at Receivers 1, 2 and 4

Receiver Location	Predicted Noise Level – dB(A)$L_{eq(15min)}$	Noise Emission Criteria	Complies
Receiver 1: Dental School Building	38dB(A)$L_{eq(15min)}$ internal (windows closed)	45dB(A)$L_{eq(worst\ 1hr)}$	Yes
Receiver 2: Catherine McAuley High School	43dB(A)$L_{eq(15min)}$ internal (windows open)	40dB(A)$L_{eq(worst\ 1hr)}$	See discussion in section 6.1.3.
Receiver 4: Westmead Private Hospital Sleeping Wards	35dB(A)$L_{eq(15min)}$ internal (windows open)	40dB(A)$L_{eq(worst\ 1hr)}$	Yes

The predicted noise levels at the residential receivers along Mons Road to the north are presented in the table below. Noise impacts during the day and evening period are based on the assumption of peak AM traffic flow (see section 6.1.1).

Noise impacts during the night time period are based on the predicted traffic flow numbers provided to this office by GTA Consultants (summarised in section 6.1.1).

Table 12 – Predicted Noise Levels from Car Park Noise at Residential Receiver 3

Receiver Location	Time Period	Predicted Noise Level – dB(A)$L_{eq(15min)}$	Noise Emission Criteria	Complies
Receiver 3: Residential at 2 Mons Road	Day and Evening (7am-10pm)	47dB(A)$L_{eq(15min)}$ external	51dB(A)$L_{eq(15\ min)}$	Yes
	Night (10pm-11pm)	39dB(A)$L_{eq(15min)}$ external	50dB(A)$L_{eq(15\ min)}$	Yes
	Night (11pm-4am)	35dB(A)$L_{eq(15min)}$ external	43dB(A)$L_{eq(15\ min)}$	Yes
	Night (4am-6am)	44dB(A)$L_{eq(15min)}$ external	43dB(A)$L_{eq(15\ min)}$	Marginal*
	Night (6am-7am)	46dB(A)$L_{eq(15min)}$ external	46dB(A)$L_{eq(15\ min)}$	Yes

***Note: the assessment is based on traffic volume of 50% of AM peak. The Rating Background Noise Level adopted for this time period is the lowest noise level during the noise monitoring period. Therefore this prediction shall be regarded as conservative and 1 dB(A) is a minor impact that is considered barely perceptible to the average person based on NSW EPA Road Noise Policy.**

6.1.2 Car Park Noise After 10pm (Sleep Disturbance)

As vehicles may (in exceptional circumstances) potentially leave the site after 10pm, an assessment of potential sleep disturbance has been undertaken. Primary noise sources which have been considered are:

- Noise created by a car starting or door closing. Noise emissions have been predicted on the basis that the sound power level of a door close/car start is 90dB(A)L_{Max}.

Predictions are made at the nearest sleeping area windows to the noise source.

Analysis will be conducted as follows:

- Firstly, the noise event will be assessed with reference to the "background+15dB(A)" criteria (this is the first step of the sleep arousal test outlined in section 5.1.5).

- Secondly, in the event that compliance with the "background+15" test is not satisfied, a more detailed assessment will be undertaken, in which the noise level is predicted inside the bedroom itself.

6.1.2.1 Predicted Noise Levels

Step 1 – Predicted noise levels and assessment against "background+15dB(A)" criteria are as follows.

Table 7 – Sleep Arousal Assessment ("Emergence"/Background+15dB(A) Test)

Noise Source	Receiver Location	Predicted Noise Level	Acoustic Criteria	Complies?
Car Engine Start/Door Close	Outside Window of Residential Receiver 3	39dB(A)$L_{1(1min)}$	53dB(A)$L_{1(1min)}$	Yes
	Outside Window of Westmead Private Hospital Sleeping Wards	37dB(A)$L_{1(1min)}$	53dB(A)$L_{1(1min)}$	Yes

Given that noise emissions comply with the sleep arousal assessment criteria, sleep disturbance impacts on the nearest sleeping areas are unlikely and no further investigation is required.

6.1.3 Discussion

In light of the predicted noise levels presented in section 6.1.1 above, we note the following:

- Noise emissions from cars manoeuvring in the proposed car parks will be compliant with noise emission goals at receivers 1, 3 and 4.

- Noise emissions from cars manoeuvring in the proposed car parks within the internal areas of the nearest classrooms of the Catherine McAuley High School (receiver 2) will exceed the noise emission goals by 3dB(A)L_{eq}. However, we note the following with respect to this exceedance:

    - This exceedance is only predicted during a worst case scenario of use of the proposed car park (that is, 752 car movements within the multi-storey car park and 47 cars entering the at grade car park to the east during a peak hour period).

    - The predicted noise levels assume that the windows/doors of the classrooms are open. With windows/doors closed, noise emissions from the car park to the internal areas of the classrooms would be reduced by a further 10-20dB(A) of the predicted noise levels presented in the table above.

    - Based on the attended traffic noise measurements conducted along Darcy Road in front of the school (see figure 1 and table 2), noise levels within the nearest classrooms with windows open from existing traffic noise alone is predicted to be approximately 54dB(A)L_{eq}. Given this, noise impacts on the internal areas of classrooms with windows open during a period of peak use of the proposed car park (43dB(A)L_{eq}) will be negligible.

    - Based on the above, it can be reasonably stated that any additional noise generated by the operation of the proposed car park will not be perceivable over and above the existing traffic noise already impacting the Catherine McAuley High School.

6.1.4 Recommendations

The following development controls should be incorporated to ensure that noise impacts on the nearest receivers are minimised:

- The car park pavement shall be smooth to ensure minimal vertical displacement and potential for noise generated by wheel to concrete impacts. The surface finish shall be of broom finish or similar to minimise squealing of car tyres.

- Grates and any cover plates are to be fixed flush and tight.

- Install signs at the entrance of the car park reminding people to minimise noise in the car park, especially during the night time period (10pm-7am).

- Detailed review of any mechanical plant (such as car park supply and exhaust fans) should be undertaken at CC stage, once plant selections and locations are finalised. Compliance with EPA Industrial Noise Policy requirements will be achievable using standard acoustic treatments (in duct lining/attenuators, equipment enclosures etc.).

6.1.4.1 Noise Emission Compliance Testing Upon Completion

Upon completion of the car park, it is recommended that certification testing be conducted of operational noise from the multi storey car park at all nearby receivers to ensure compliance with noise emission goals outlined in 5.1 and 5.2.

The certification testing would be undertaken by means of attended noise measurements during a period of peak use of the car park.

6.2 CONSTRUCTION IMPACTS

6.2.1 Construction Noise Emission Assessment

6.2.1.1 Source Noise Data

The A-weighted sound power levels for typical equipment/processes anticipated to be used during the construction of the project site are outlined in Table below.

Table 13 – Sound Power Levels

STAGE	EQUIPMENT /PROCESS	SOUND POWER LEVEL dB(A)$Leq_{(15min)}$
Demolition	Angle Grinder	105
	Hammering	110
	12 tonne Truck	105
Piling	CFA Piling	103
Excavation	Excavator with Pneumatic Hammer	118
Construction	Angle grinders	105
	Electric Saw	102
	Drill	95
	Hammering	110
	Air compressor	86
	Concrete Pump	105
	Concrete Vibrator	100
	Cement Mixing Truck	105
	Crane	96

The noise levels presented in the above table are derived from the following sources, namely:

- On-site measurements
- Table D2 of Australian Standard 2436-1981
- Data held by this office from other similar studies.

6.2.1.2 Construction Noise Emission Predictions

Indicative maximum noise emissions from construction activities above have been predicted to the nearest noise receivers and are presented below.

Table 14 – Predicted Construction Noise Levels

Receiver Location	Noise Emission Criteria	Predicted noise Level dB(A)$L_{eq,\ 15min}$			
		Demolition	Piling	Excavation	Construction
Receiver 1: Dental School Building (internal, windows closed)	45dB(A)$L_{eq(15min)}$ internally	48	41	56	48
Receiver 2: Catherine McAuley High (internal, windows closed)	45dB(A)$L_{eq(15min)}$ internally	42	35	50	42
Receiver 3: Residential at 2 Mons Road (external)	57dB(A)$L_{eq(15min)}$ externally	62*	55	70*	62*
Receiver 4: Westmead Private Hospital (internal, windows closed)	45dB(A)$L_{eq(15min)}$ internally	31	24	39	31

*Note: noise management is required to mitigate the impact onto the nearest residential receivers, details refer to Section 6.2.1.3.

6.2.1.3 Recommended Construction Noise Emission Controls

Given that specific excavation/construction methodologies have not been established at this stage, the predicted noise level presented above are approximate. Based on the predictions above, we make the following recommendations with respect to controlling construction noise impacts on nearby receivers:

- It is recommended that the standard construction hours outlined in the Interim Construction Noise Guideline be adopted for this site. That is:
    - 7am to 6pm Mondays to Fridays;
    - 8am to 1pm Saturdays; and
    - No construction work on Sundays or public holidays.
- This office has been advised that the client is in regular communication with the Dental School (receiver 1), Catherine McAuley High School (receiver 2) and Westmead Private Hospital. Given this, it is recommended that intra-day respite periods for high noise generating construction activities (hydraulic hammering, grinding etc.) are determined in consultation with these nearby receivers.
- Equipment shall be well maintained.
- Stationed equipment shall be located as far as possible towards the northern boundary of the site and screened by enclosure.
- Trucks and concrete trucks must turn off their engines during idling to reduce impacts on adjacent receivers (unless truck ignition needs to remain on during concrete pumping).
- It is recommended that a safety risk assessment of construction activities be conducted to determine whether it will be feasible to use less annoying and noise intrusive movement/reversing alarms for vehicles in order to reduce noise impacts on nearby receivers.

6.2.2 Vibration Impact Assessment

The following guidelines will be adopted to address construction vibration impacts:

- German Standard DIN 4150-3 (1999-02): *"Structural Vibration – Effects of Vibration on Structures"* – which will be used to assess and limit building damage risk.

- EPA Assessing Vibration a technical guideline – which contains guidelines to assess and limit impacts on building occupant's amenity.

Site investigation indicated that the nearest vibration sensitive receiver is:

- Receiver 1: Dental School Building located approximately 17m to the south-east of the site.

The criteria and the application of this standard are discussed in separate sections below.

6.2.2.1 Building Damage Limit

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in Table 5.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 15 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			Plane of Floor of Uppermost Storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

6.2.2.2 Amenity Criteria

Table 2.2 of EPA "Assessing Vibration: A technical guideline" specified the following vibration goal for human comfort:

Table 16 –Preferred and Maximum Weighted RMS values Vibration Acceleration (m/s2) 1-80 Hz

Location	Assessment Period	Preferred Values Z-axis	Preferred Values X & Y-axis	Maximum Values Z-axis	Maximum Values X & Y-axis
Continuous Vibration					
Office	Day time	0.020	0.014	0.040	0.028
Impulsive Vibration					
Office	Day time	0.64	0.46	1.28	0.92

Acceptable values for intermittent vibration shall comply with the requirements in Table 2.4 of EPA "Assessing Vibration: A technical guideline" detailed as below.

Table 17 - Acceptable Vibration Dose Values for Intermittent Vibration (m/s1.75)

Location	Day time preferred value	Day time maximum value
Office	0.40	0.80

6.2.2.3 Vibration Safety Guard System

Proposed activities that have the potential to produce significant ground vibration include:

- Demolition
- Excavation and anchoring.
- Hydraulic hammering.

6.2.2.4 Safeguards to Protect Sensitive Structures

It is impossible to predict the vibrations induced by the demolition/excavation/construction operations on site at potentially affected receivers. This is because vibration level is principally proportional to the energy impact which is unknown nature of terrain in the area (type if soil), drop weight, height etc.

Acoustic Consult should undertake monitoring of initial demolition/excavation /construction process when conducted near potentially affected receivers to ensure that vibration criteria set out in section 8.1 are not exceeded.

6.2.2.5 Vibration Monitoring (if required)

In the event that complaints are made from the nearest receivers regarding vibration impacts from the subject site, vibration monitors will be installed at the property boundary of the neighbouring site nearest to the subject site to monitor vibration levels.

6.2.2.5.1 Downloading of Vibration Monitoring Data

Downloading of the vibration monitor data will be conducted on a regular basis. In the event of exceedance of the vibration criteria, downloading of the vibration monitor data will be conducted more frequently. Results obtained from the vibration monitor will be presented in a graph format and will be forwarded to the client for review. It is proposed that reports are provided fortnightly with any exceedances in the vibration criteria reported as detailed in this report.

6.2.2.5.2 Presentation of Vibration Logger Results

A fortnightly report will be submitted to project manager via email summarising the vibration events. The vibration exceedance of limit is recorded the report shall be submitted within 24 hours. Complete results of the continuous vibration logging will be presented in fortnight reports including graphs of collected data.

7 CONCLUSION

This report presents an acoustic assessment of potential noise impacts from the proposed multi-deck car park to be located on the corner of Darcy Road and Institute Road, Westmead at Westmead Hospital.

An assessment of noise impacts from the operation of the proposed car park have has been presented 6.1 of the report. Recommendations have been presented in section 6.1.3.

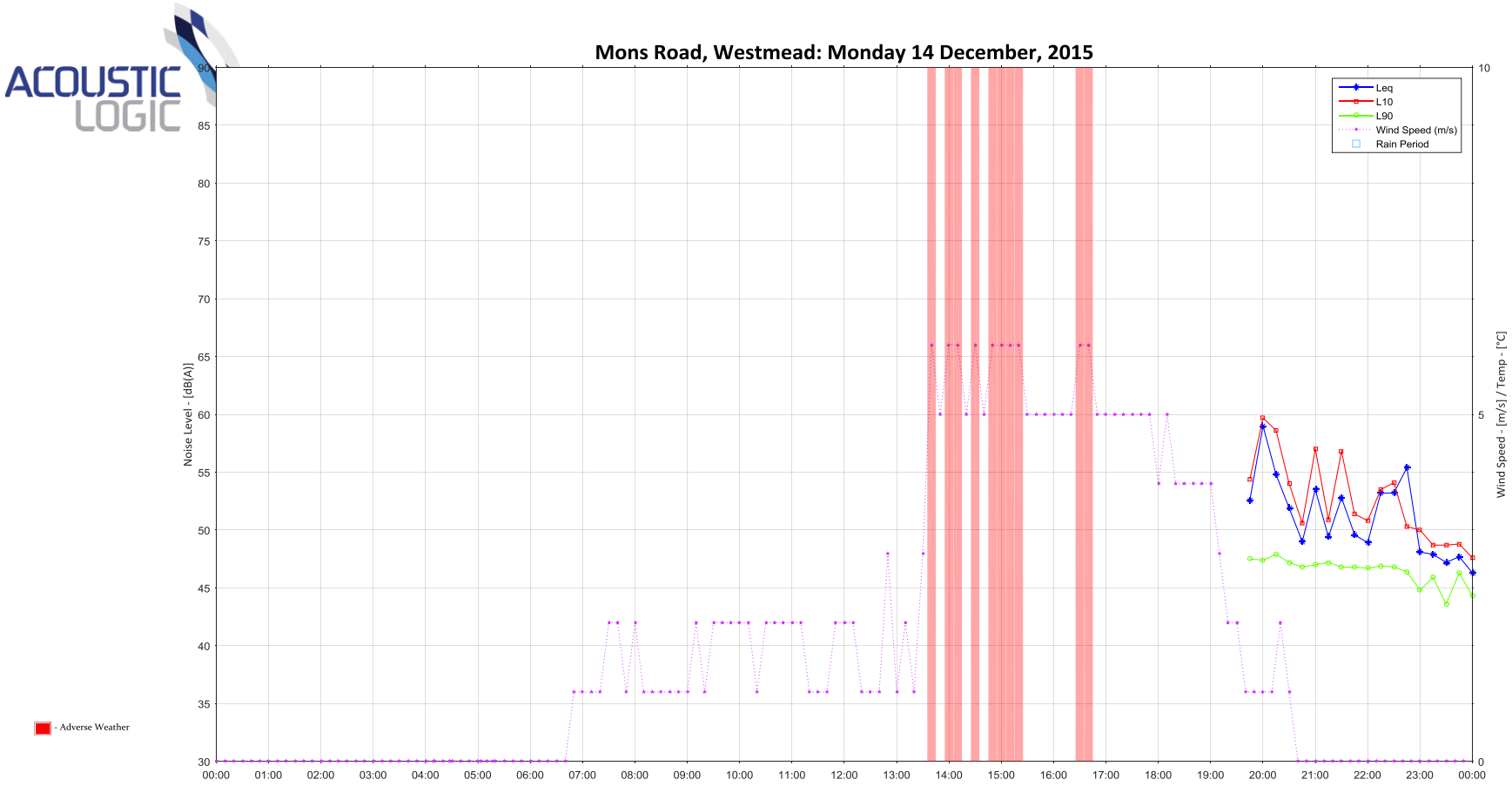
An indicative assessment of construction noise and vibration impacts has been presented in section 6.2 of this report.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Justin Leong

APPENDIX 1 – UNATTENDED NOISE MONITORING DATA


Mons Road, Westmead: Monday 14 December, 2015
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
90
85
80
75
70
65
60
55
50
45
40
35
30
10
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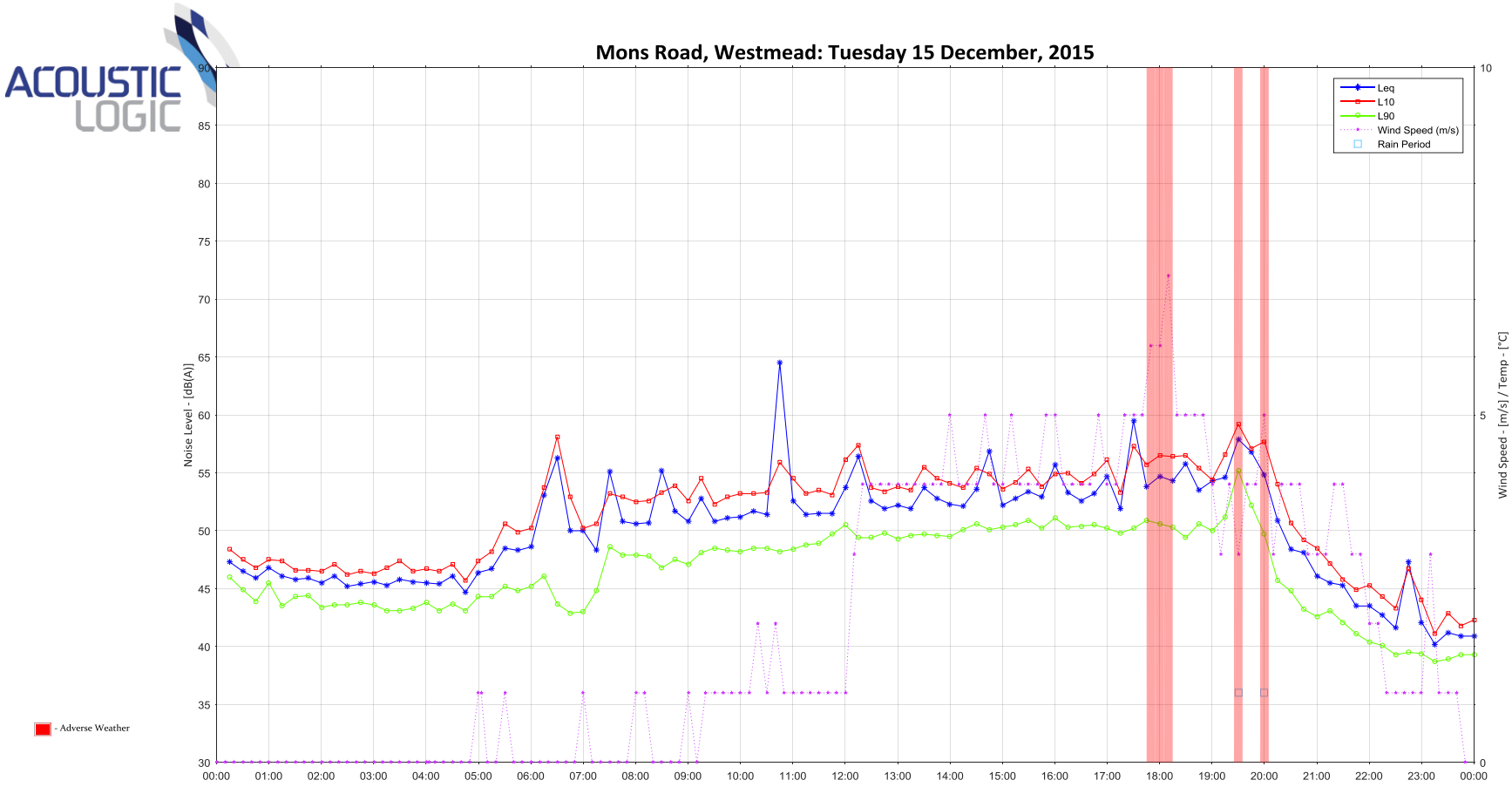
Mons Road, Westmead: Tuesday 15 December, 2015
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
90
85
80
75
70
65
60
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45
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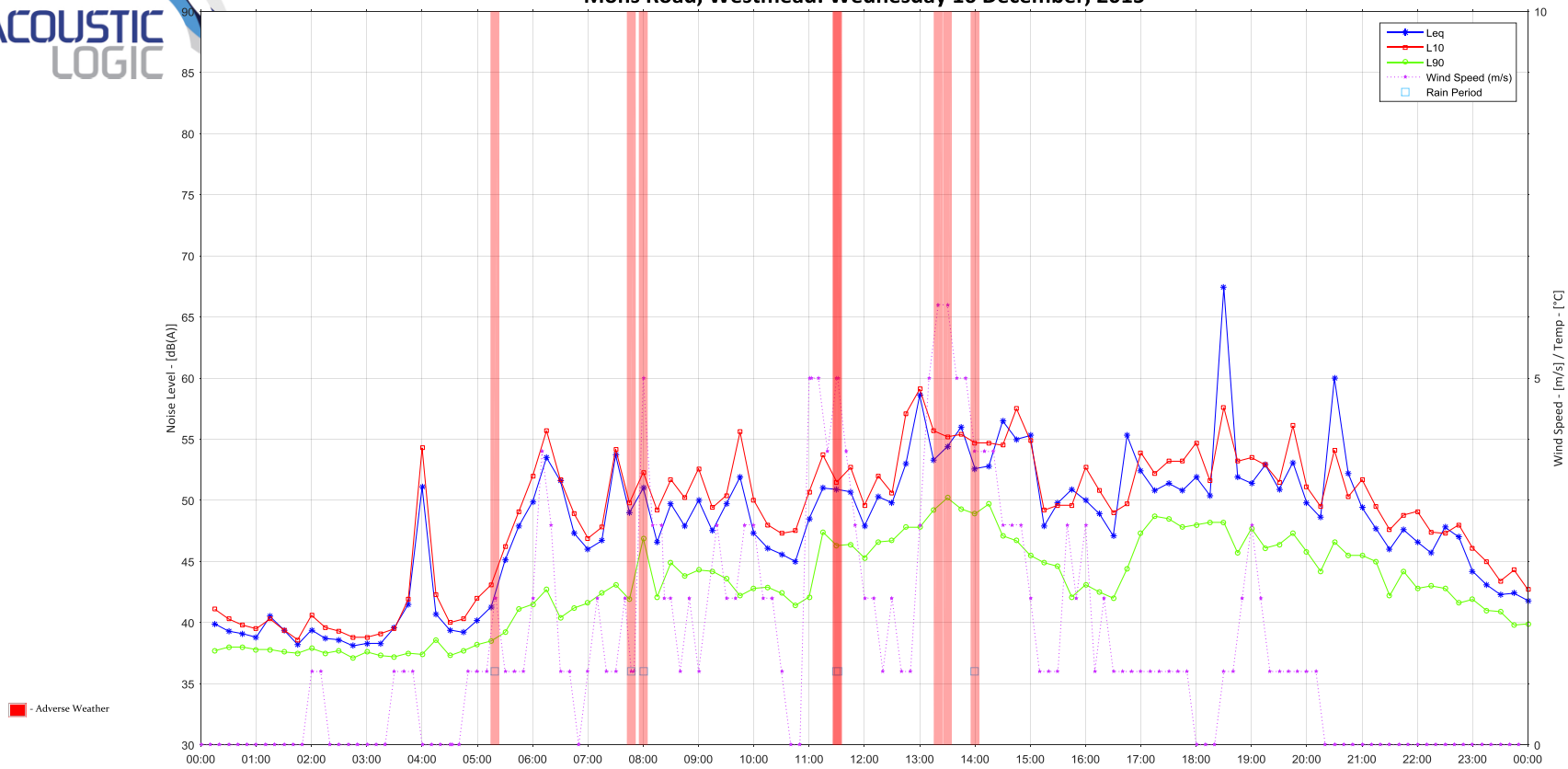
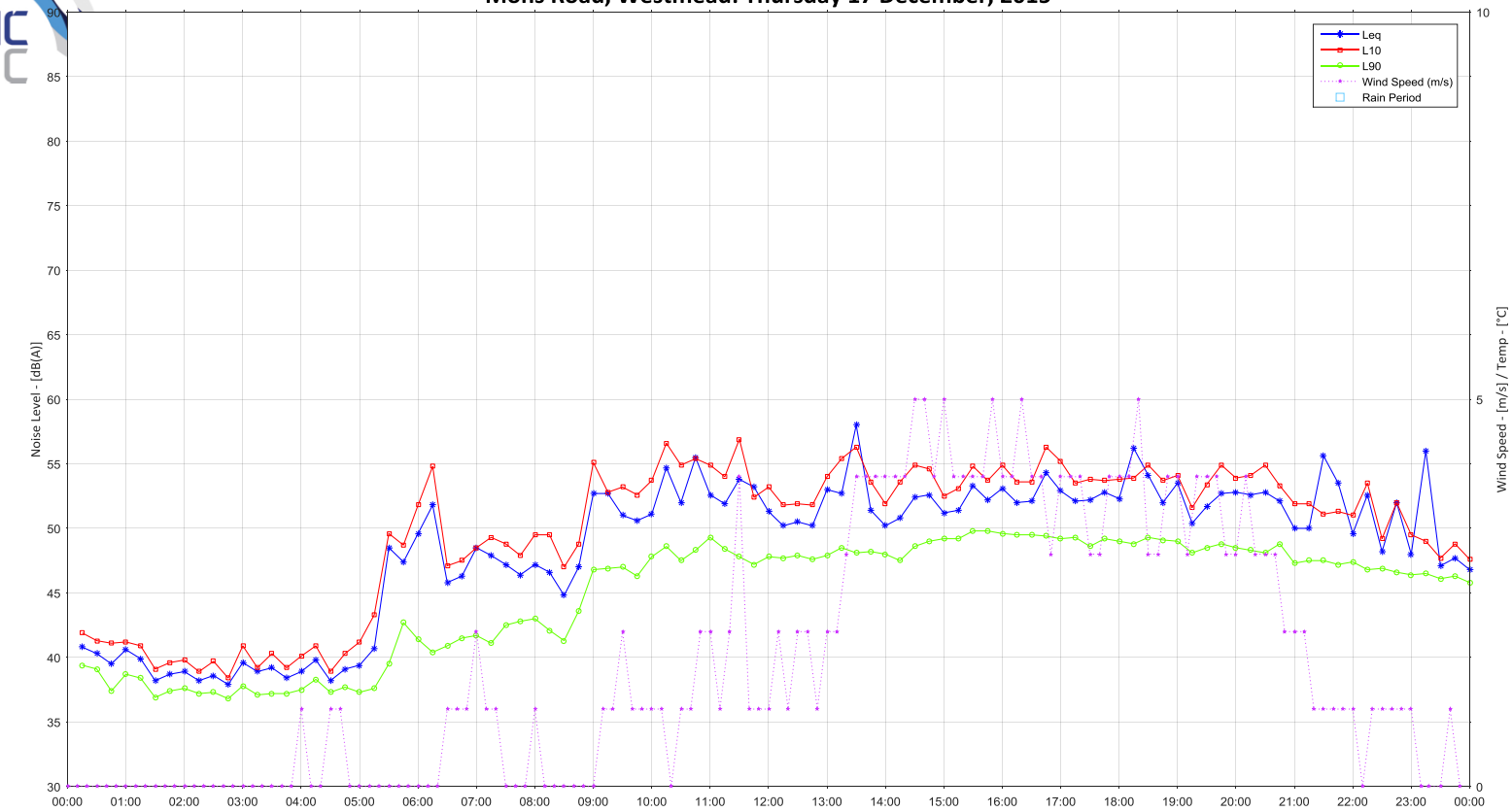
ACOUSTIC LOGIC

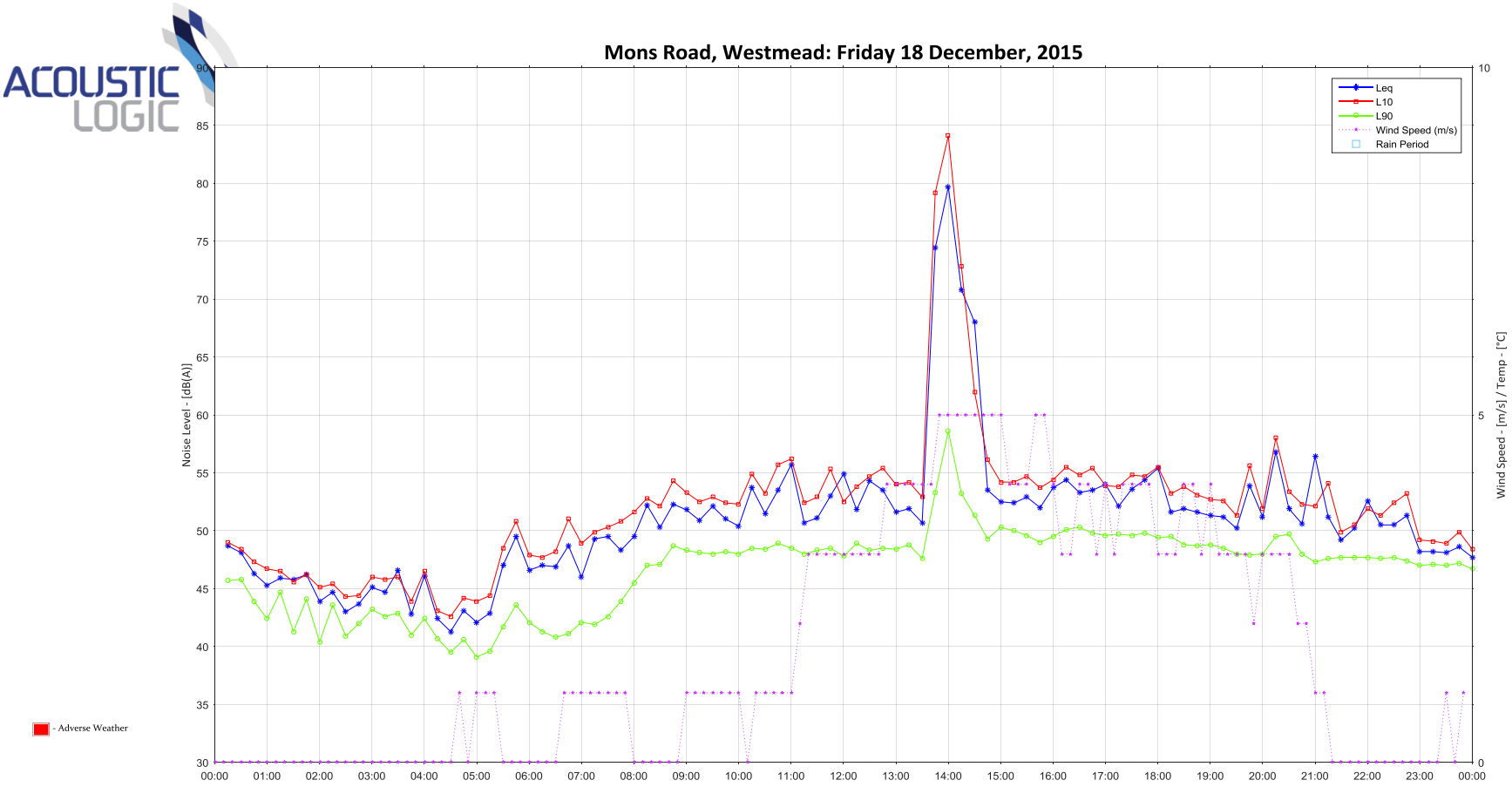
Mons Road, Westmead: Wednesday 16 December, 2015



Mons Road, Westmead: Thursday 17 December, 2015



- Adverse Weather


Mons Road, Westmead: Friday 18 December, 2015
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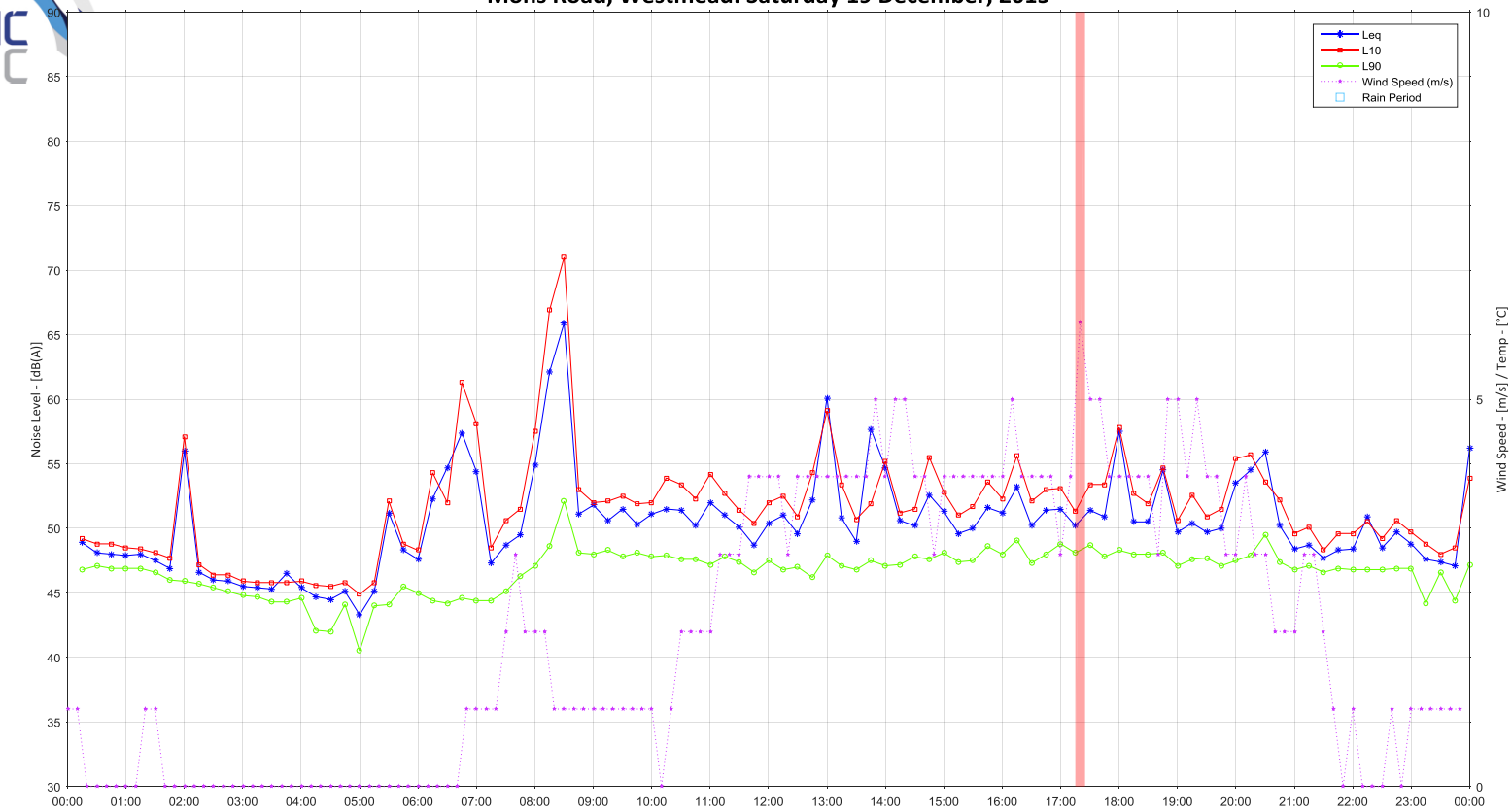
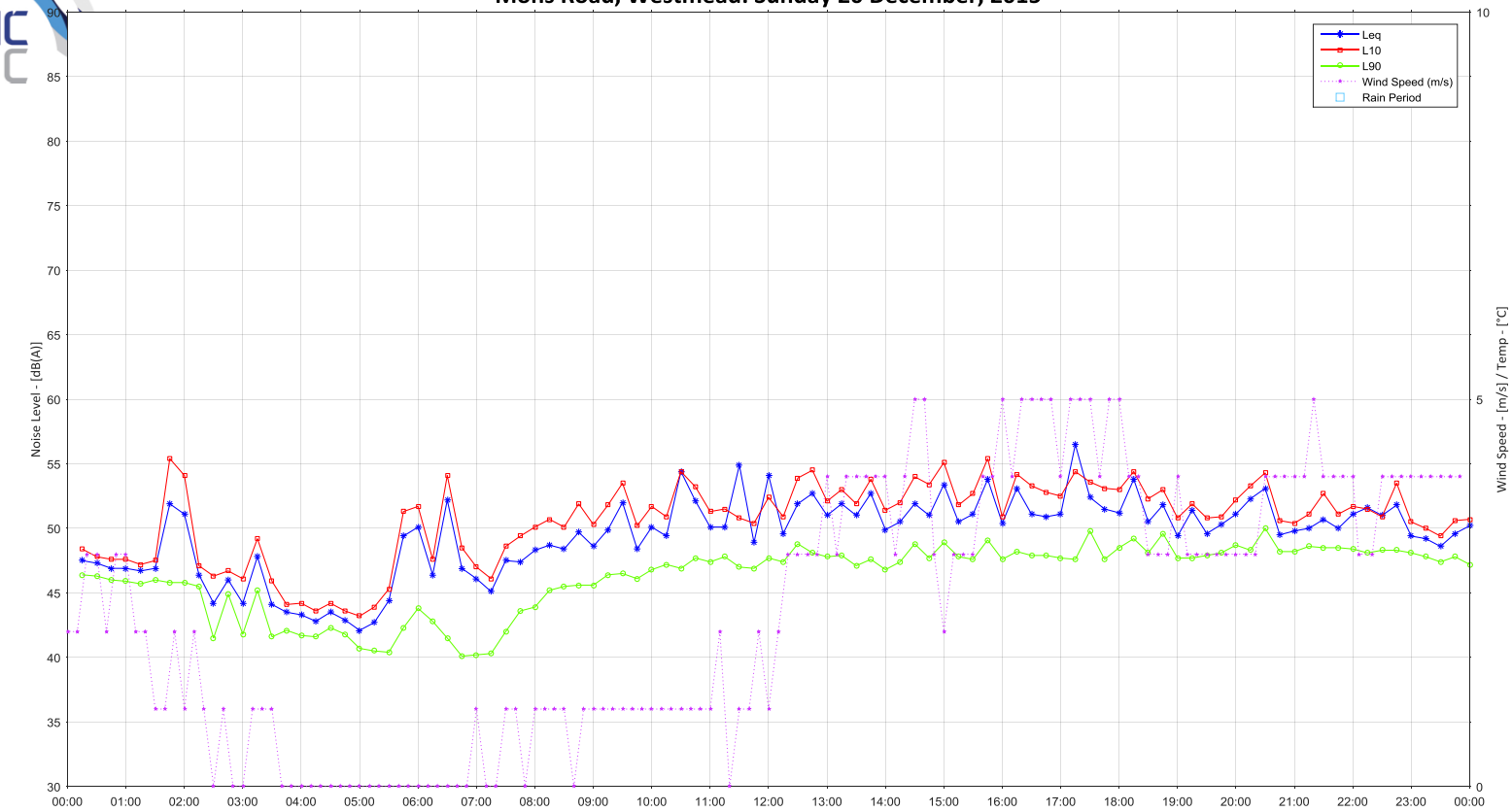
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather

Mons Road, Westmead: Saturday 19 December, 2015

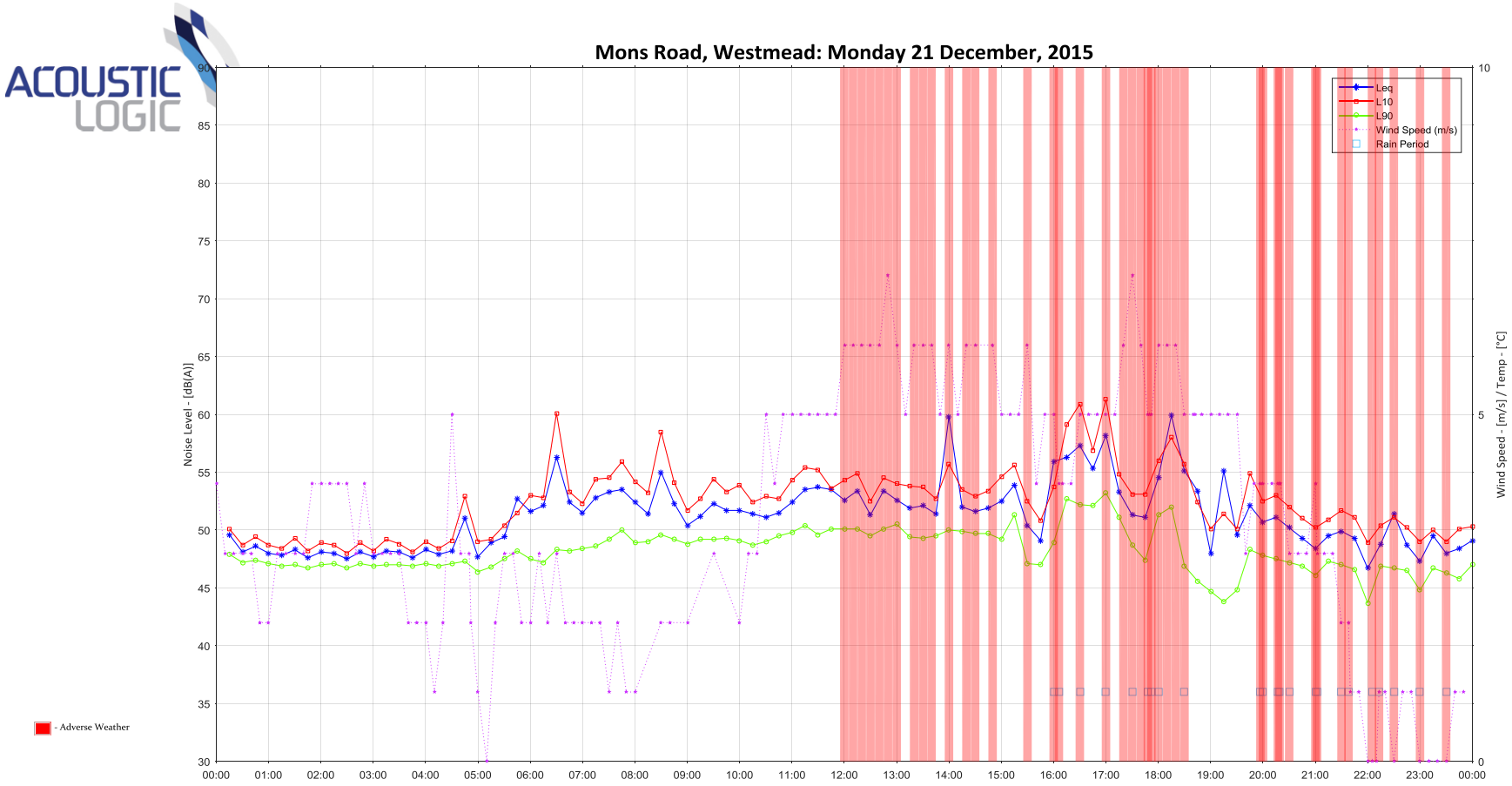


- Adverse Weather

Mons Road, Westmead: Sunday 20 December, 2015



- Adverse Weather


Mons Road, Westmead: Monday 21 December, 2015
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
90
85
80
75
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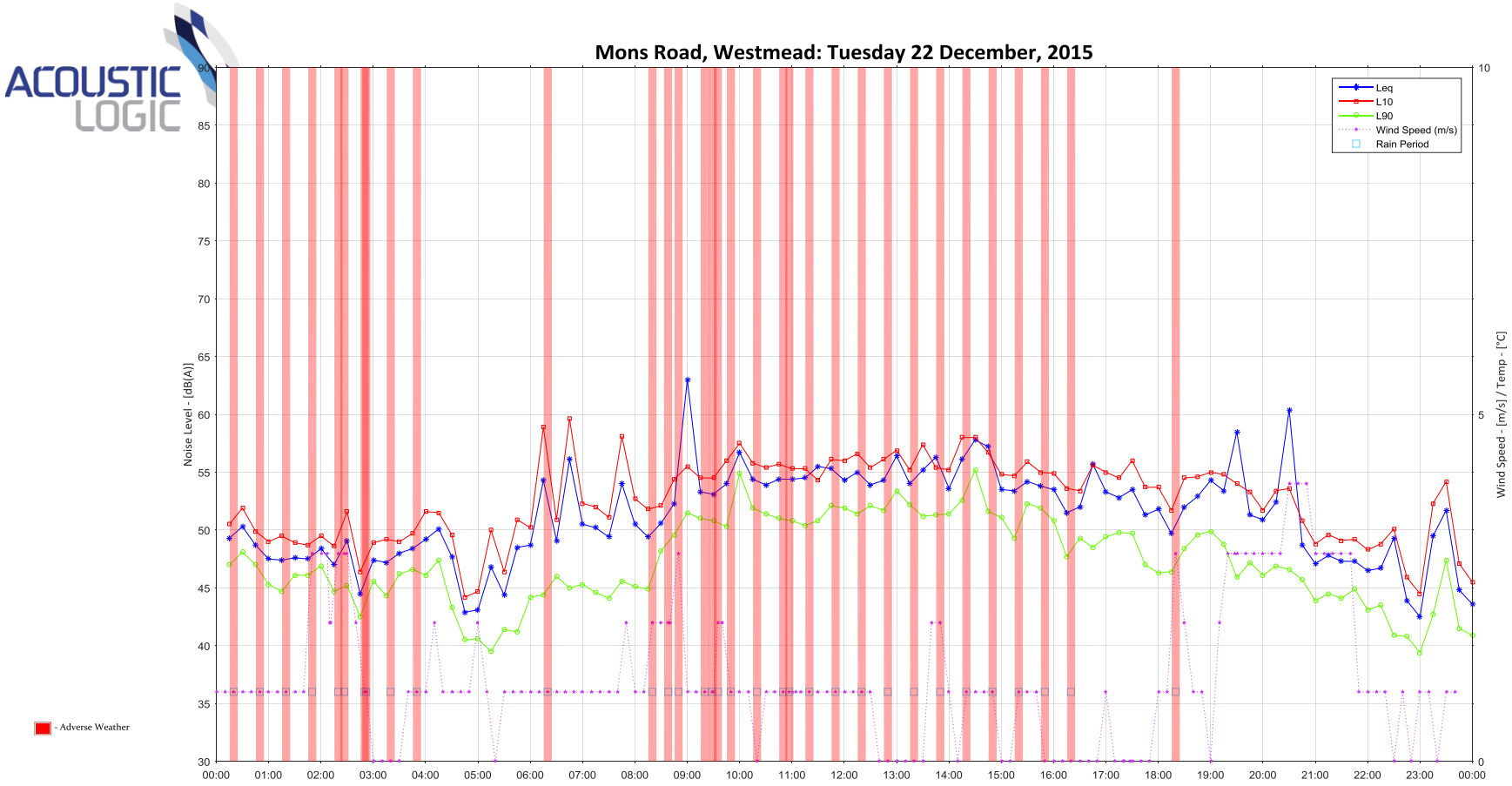
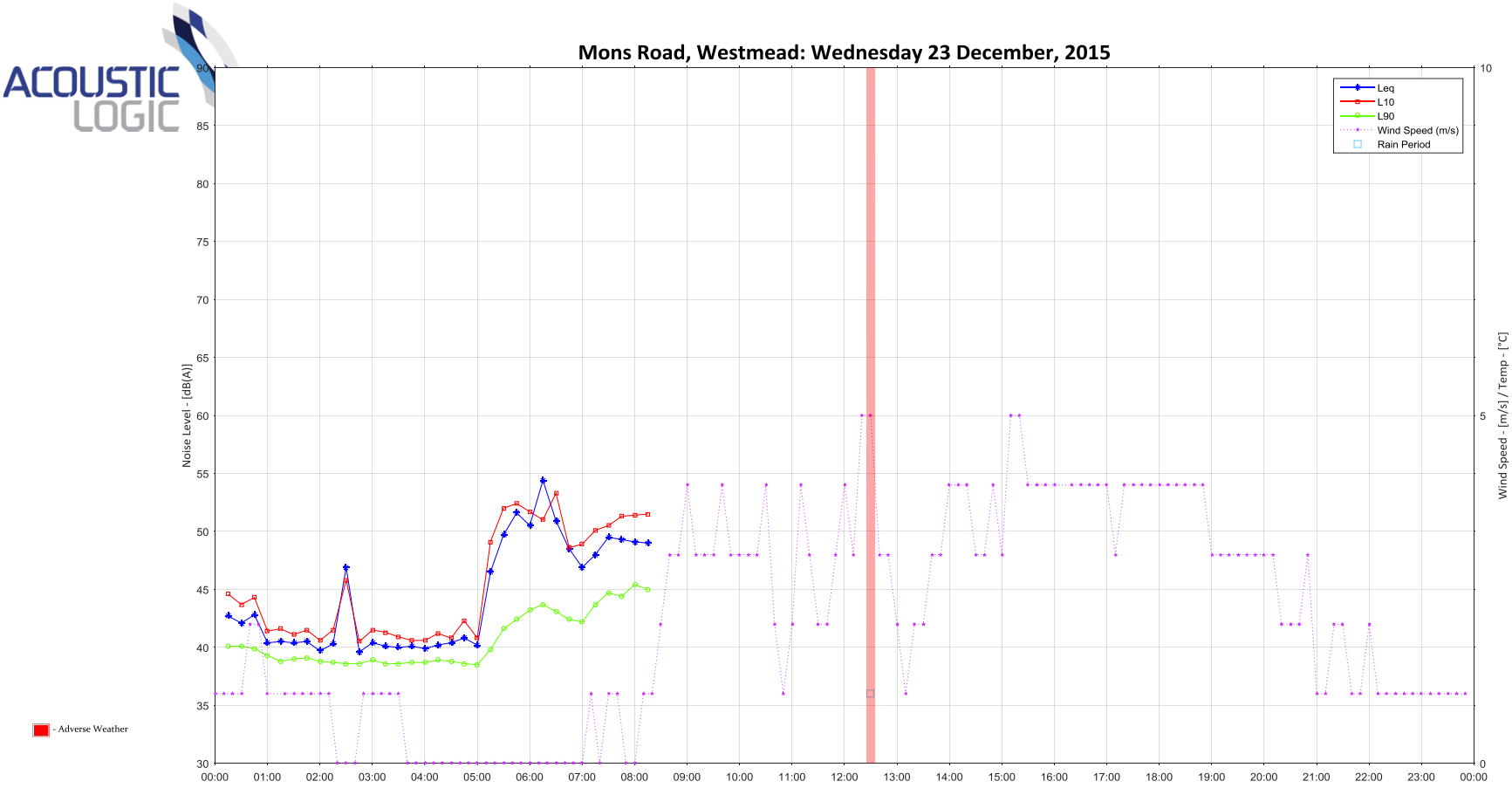

Mons Road, Westmead: Tuesday 22 December, 2015
Leq
L10
L90
Wind Speed (m/s)
Rain Period
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
- Adverse Weather


Mons Road, Westmead: Wednesday 23 December, 2015
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather