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Main Works (SSD: 10389)

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1 EXECUTIVE SUMMARY

Acoustic Logic Consultancy (ALC) has been engaged to prepare an acoustic assessment report to support the Main Works SSD Application for the Health and Academic Precinct located at Liverpool Hospital, Liverpool.

Liverpool Hospital is located within the Liverpool Central Business District (CBD), on the corner of Elizabeth Street and Goulburn Streets, Liverpool. The hospital campus includes land east and west of the Main Southern Railway, which forms an eastern and western campus. The proposed works are located in the western portion of the western hospital campus. The site is legally described as Lot 501 in DP1165217.

The application seeks consent for the construction and operation of a new multi-storey Integrated Services Building providing new treatment and support services that will integrate with the existing hospital. The works also include the refurbishment of certain existing hospital facilities. For a detailed project description refer to the EIS prepared by Ethos Urban.

The proposed redevelopment will be assessed based on the requirements below:

- Requirements of *SEARs document,* 'SSD: 10389';
- Liverpool Development Control Plan 2008;
- Australian and New Zealand AS/NZS 2107:2016 'Recommended design sound levels and reverberation times for building interiors';
- NSW Government, Health Infrastructure 'Engineering Services Guidelines' 2017;
- NSW Environmental Protection Authority 'Noise Policy for Industry' 2017;
- NSW Environmental Protection Authority, *'Interim Construction Noise Guideline'*;
- Australian Standards AS2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites;
- NSW Environmental Protection Authority, *'Assessing Vibration: A technical Guideline';*
- DIN 4150, *'Vibration in Buildings (1999-02)';* and
- ASHRAE Handbook 2007.

Table 1 – Secretary's Environmental Assessment Requirements

Key Issue	Requirement	Relevant Report Section
Noise and Vibration	Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.	Section 9
	Identify and provide a quantitative assessment of the potential noise and vibration impacts on the identified sensitive receivers due to the operations of the hospital, including any proposed helicopter landing site (HLS) within the development.	Section 5.3 – 7
	Justify any work hours outside of the standard Interim Construction Noise Policy guidelines.	Section 13.1 & 15.1

2 INTRODUCTION

This report presents our assessment for the SSD Application of the redevelopment of the Health and Academic Precinct located at Liverpool Hospital, Liverpool. The assessment is based on the Main Works SSDA plans provided to this office from Fitzpatrick & partners project No. 21807, dated 24th January 2020, Revision 05.

3 SITE DESCRIPTION

The redevelopment of the Liverpool Health and Academic Precinct includes the demolition of existing buildings along Goulburn Street and the construction of a new 7-storey Integrated Services Building (ISB) along with building refurbishment and associated site works.

The land uses surrounding the hospital are the existing hospital, residential and educational receivers. Site investigation has been carried out and the nearest potentially most affected receivers are:

- **Receiver 1:** Remaining Liverpool Hospital Development.
- **Receiver 2:** Residential receivers located at 49, 53, 55-59, 61, 63, 67, 71, 73-75 Goulburn Street to the West. Residential receivers are multi-storey.
- **Receiver 3:** South West Radiation located at 51 Goulburn Street to the West. Receiver is single storey.
- **Receiver 4:** Health Services Building and Ingham Institute located at 1 Campbell Street to the North. Receivers are multi-storey.
- **Receiver 5:** Liverpool Girls High School located at 96 Forbes Street to the North-East. Educational receiver is double storey.
- **Receiver 6:** Tafe NSW Liverpool located at 14 College Street to the South. Educational receiver is double storey.

See Figure 1 below for a site survey and noise monitoring and measurement locations and Figure 2 for a site plan overview of the proposed redevelopment site.

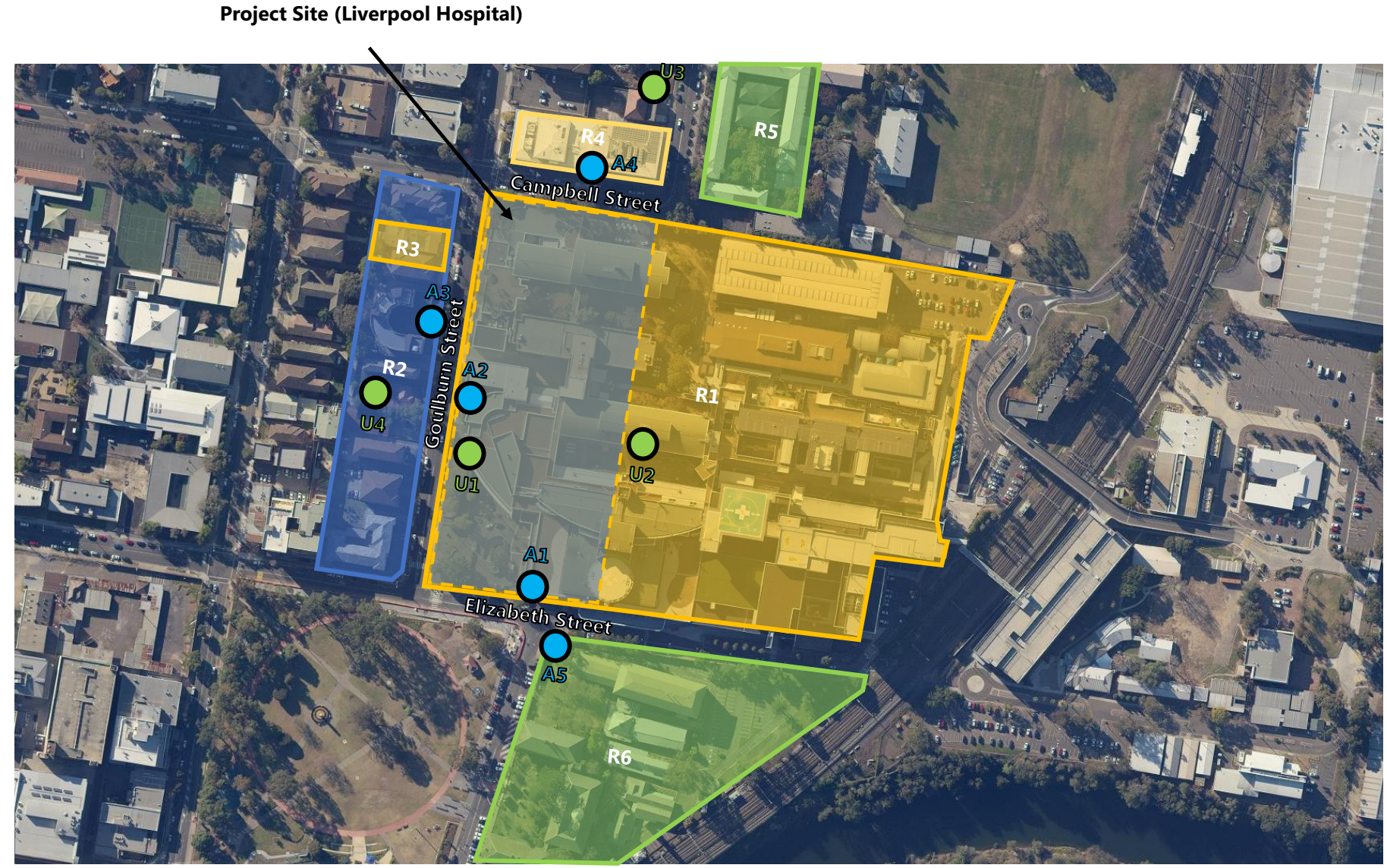


Figure 1: Site Map and Noise Monitor Locations

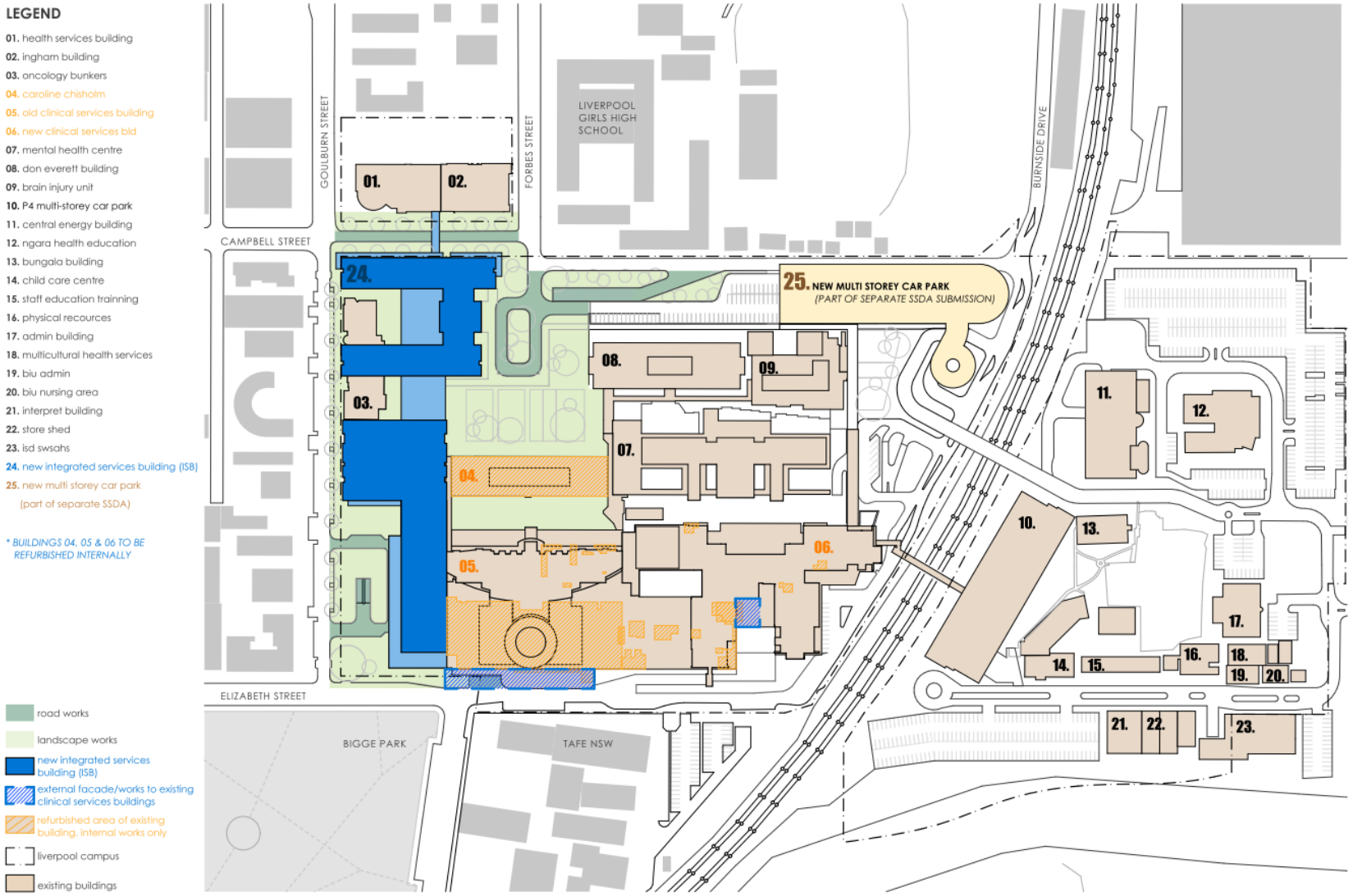


Figure 2: Site Plan Overview

4 MAJOR ACOUSTIC ISSUES RELATED TO THE PROPOSED REDEVELOPMENT

Acoustic investigation has been carried out and the following acoustic issues are related to the proposed redevelopment and will be addressed in this report:

- Traffic noise intrusion into the project site from Elizabeth Street and Goulburn Street;
- Emergency helicopter noise intrusion into the proposed new buildings;
- External noise emissions from the plant servicing the Liverpool Hospital; and
- Noise and vibration impact from the construction of the project site.

5 TRAFFIC NOISE INTRUSION INTO THE PROPOSED DEVELOPMENT

5.1 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-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 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 at the source.

Conversely, the L_{10} 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.

5.2 INTERNAL NOISE CRITERIA

The traffic noise intrusion into the project site shall satisfy the requirements detailed below:

- Liverpool Development Control Plan 2008;
- Australian and New Zealand AS/NZS 2107:2016 'Recommended design sound levels and reverberation times for building interiors'; and
- NSW Government, Health Infrastructure 'Engineering Services Guidelines' 2017.

5.2.1 Liverpool Development Control Plan 2008

The Liverpool Development Control Plan 2008 document does not contain any explicit internal noise level criteria from external noise impacts. Therefore; the following criteria below will be adopted.

5.2.2 Australian and New Zealand AS/NZS 2107:2016 'Recommended design sound levels and reverberation times for building interiors'

Australian Standard AS 2107-2016: Recommended design sound levels and reverberation times for building interiors specifies allowable internal noise levels for internal spaces within residential and commercial buildings. Table 1, in Section 5 of AS 2107-2016, gives the following maximum internal noise levels for commercial buildings and residential buildings near major roads.

Table 2 - Recommended Design Sound Level

Space /Activity Type	Recommended Maximum Design Sound Level dB(A) L_{eq}
Emergency Areas	40-45dB(A)L_{eq}
Corridors/Lobbies	50dB(A)L_{eq}
Delivery Suites	45-50dB(A)L_{eq}
Intensive Care Wards	40-45dB(A)L_{eq}
Kitchens, sterilizing and service areas	55dB(A)L_{eq}
MRI/CT Scan/X-Ray areas/Ultra Sound	45-50dB(A)L_{eq}
Nurseries	35-45dB(A)L_{eq}
Office Areas	35-45dB(A)L_{eq}
Operating Theatres	40-50dB(A)L_{eq}
Post-Op, Pre-Op, Recovery rooms	40-45dB(A)L_{eq}
Surgeries/treatment/procedure rooms	40-45dB(A)L_{eq}
Waiting rooms, Reception areas	40-50dB(A)L_{eq}

5.2.3 Requirements by NSW Health – Engineering Services Guidelines 2017

Building shell is to be acoustically designed such that internal noise levels of Column A, *Table 12 of the NSW Health Infrastructure Engineering Services Guidelines* for continuous noise sources are achieved, as detailed below.

Table 3 - Health Infrastructure Engineering Services Guidelines Continuous Internal Noise Criteria (to be Adopted for Continuous Noise Impacts)

Area Designation	Continuous Internal Noise Levels dB(A)L_{eq}	
	Satisfactory	Maximum
Corridors and Lobby Spaces	40	50
Operating Theatre	40	45
Birthing Room/Delivery Suite	45	50
Intensive Care	40	45
Patient Wards	35	40
Consultation/Interview Rooms	40	45
Treatment/Medication/Examination Room	40	45
Waiting Rooms, Reception Areas	40	50
Cafeterias/Dining	45	50
Meeting Room	35	40
Board/Conference Room	30	35
Open Plan Offices	40	45
Private Offices	35	40
Laboratories	45	50
Classrooms, Training Rooms	35	40
Toilet	50	55

5.3 EXTERNAL NOISE MEASUREMENTS

This section of the report details the noise measurements conducted at the site to establish traffic and the surrounding environmental noise levels impacting the development.

Unattended and attended traffic noise measurements have been carried out around project site.

5.3.1.1 Measurement Equipment

- Unattended noise monitoring was conducting using one Acoustic Research Laboratories Pty Ltd noise logger. The logger was programmed to store 15-minute statistical noise levels throughout the monitoring period. The equipment was calibrated at the beginning and the end of each measurement using a Rion NC-73 calibrator; no significant drift was detected. All measurements were taken on A-weighted fast response mode.

- Attended short term measurements of traffic noise were undertaken by this office. Measurements were conducted using a Norsonic 140 Sound Analyser. The analyser was set to fast response and calibrated before and after the measurements using a Norsonic Sound Calibrator type 1251. No significant drift was noted.

5.3.1.2 Measurement Period

- Unattended noise monitoring was conducted within the following time period:

  U1: Wednesday, 28th November 2018 to Tuesday, 11th December 2018.

- Attended noise measurements were undertaken within the following time periods:

  A1 & A2: Tuesday, 11th December 2018 between 9:00am and 10:00am.

5.3.1.3 Measurement Location

U1: The unattended noise monitor was installed on the Library Balcony along the western façade. The noise monitor had a 180° view of Goulburn street and was approximately 15m from the kerb. See Figure 1 for a detailed location and Figure 2 below for a photo of the noise monitor installed on site.

A1 & A2: Attended noise measurements were conducted 5m from the kerb with a 180° view of the road. See Figure 1 for a detailed location.

5.3.1.4 Measured Traffic Noise Levels

Attended and Unattended noise measurements have been summarised below for each location.

5.3.1.5 Unattended Traffic Noise Monitoring

The following table presents the results of the unattended traffic noise monitoring.

Table 4 – Unattended Noise Monitor - Traffic Noise Measurements

Date	Measured Traffic Noise Level dB(A)L_{eq}	
	Day (7am-10pm)	**Night (10pm-7am)**
Wednesday, 28th November 2018	-	55
Thursday, 29th November 2018	59	56
Friday, 30th November 2018	62	54
Saturday, 1st December 2018	59	52
Sunday, 2nd December 2018	59	54
Monday, 3rd December 2018	60	60
Tuesday, 4th December 2018	60	63
Wednesday, 5th December 2018	71	62
Thursday, 6th December 2018	60	60
Friday, 7th December 2018	59	60
Saturday, 8th December 2018	61	52
Sunday, 9th December 2018	56	53
Monday, 10th December 2018	59	53
Tuesday, 11th December 2018	-	-
Logarithmic Average	**60**	**57**

5.3.1.6 Attended Traffic Noise Measurements

Attended traffic noise measurement locations and the measured noise levels are below:

Table 5 – Attended Traffic Noise Measurement Results

Location	Measured Noise Level dB(A)L_{eq}
Elizabeth Street 5m distance from the Kerb 180° view of road	62 dB(A)L_{eq}
Goulburn Street 5m distance from the Kerb 180° view of road	61 dB(A)L_{eq}

5.3.1.7 Summarised External Noise Levels

The existing traffic noise levels listed in the table below were determined based on the unattended noise monitoring and attended noise measurement data.

Table 6 – Measured Existing Traffic Noise Levels

Location	Summary of Measured Existing Traffic Noise Levels	
	Daytime (7am-10pm) dB(A)$L_{eq(15hour)}$	**Night time (10pm-7am) dB(A)$L_{eq(9hour)}$**
Elizabeth Street (See Figure 1) 5m from kerb 180° view of the road	62dB(A)$L_{eq(15hour)}$	59dB(A)$L_{eq(9hour)}$*
Goulburn Street (See Figure 1) 5m from kerb 180° view of the road	61dB(A)$L_{eq(15hour)}$	58dB(A)$L_{eq(9hour)}$*

*Adjusted based off unattended noise monitoring

6 EMERGENCY HELICOPTER NOISE INTRUSION

6.1 INTERNAL NOISE CRITERIA

Emergency helicopter noise intrusion into the project site shall satisfy the requirements detailed below:

- NSW Government, Health Infrastructure 'Engineering Services Guidelines' 2017.

6.1.1 Requirements by NSW Health – Engineering Services Guidelines 2017

Building shell is to be acoustically designed such that internal noise levels of column C, *Table 12 of the NSW Health Infrastructure Engineering Services Guidelines* for Internal Noise Levels from Helicopters are achieved, as detailed below.

Table 7 - Health Infrastructure Engineering Services Guidelines Internal Noise Levels Helicopter

Area Designation	Internal Noise Levels Helicopter dB(A)$L_{Max, slow}$
Corridors and Lobby Spaces	80
Operating Theatre	65
Birthing Room/Delivery Suite	75
Intensive Care	65
Patient Wards	68
Consultation/Interview Rooms	65
Treatment/Medication/Examination Room	65
Waiting Rooms, Reception Areas	80
Cafeterias/Dining	80
Meeting Room	70
Board/Conference Room	70
Open Plan Offices	75
Private Offices	70
Laboratories	75
Classrooms, Training Rooms	75
Toilet	70

6.2 HELICOPTER HELI PAD LOCATIONS

Detailed Helipad locations and their fly path above the project site as presented in the *'Liverpool Health and Academic Precinct, Main Works Submission Aviation Flight Path Report'* dated 18 Jan 20 prepared by AviPro is shown in Figure 3 below.

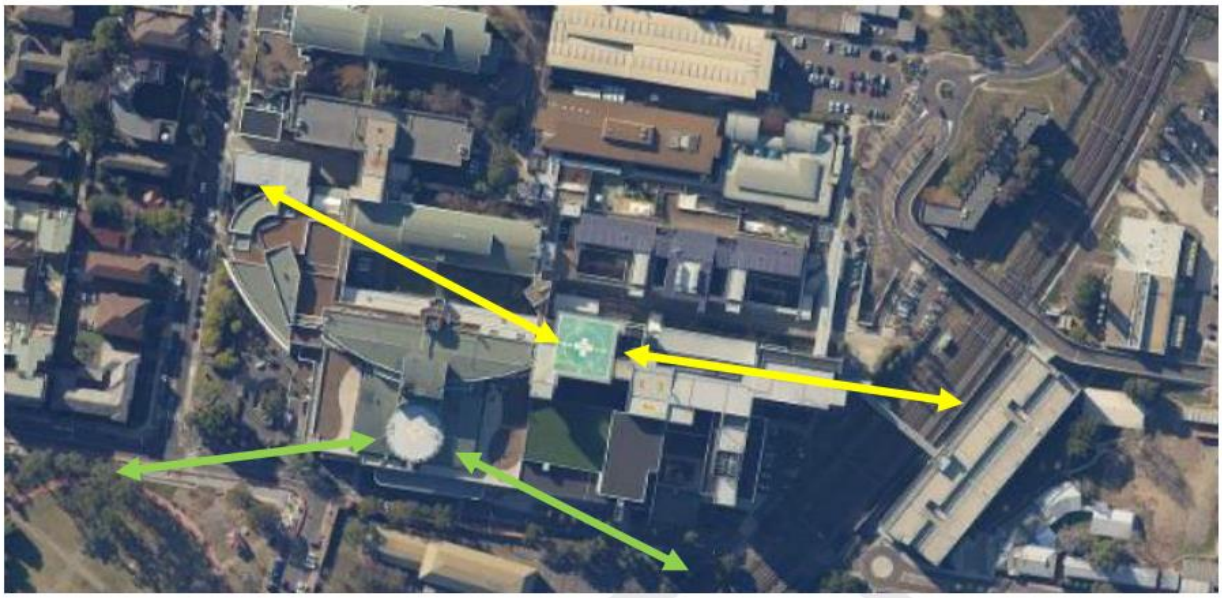


Figure 3: Helicopter Flying Path Details

The typical helicopter noise has been measured by this office during the acoustic service of previous stages/development within Liverpool Hospital. The helicopter servicing the project site has a sound power level of approximately 135dB(A)L_{Max}. The sound power level of 135dB(A)L_{Max} will be used in assessing helicopter movements from the Helipads located on the rooftop of the Liverpool Hospital.

The helicopter predicted noise levels have been modelled in SoundPLAN and are presented in Appendix 4 of this report.

7 EXTERNAL NOISE INTRUSION ANALYSIS AND RECOMMENDATIONS

External noise intrusion into the proposed new areas of the Liverpool Hospital was assessed using the measured and predicted noise levels above.

Calculations were undertaken taking into account the orientation of windows, barrier effects *(where applicable)*, the total area of glazing, facade transmission loss and room sound absorption characteristics. In this way, the likely interior noise levels can be predicted.

Note: As floor plates and layouts have not been finalised, indicative room dimensions of 6(m) x 6(m) x 2.7(m) have been used with full height and full width glazing. Detailed acoustic analysis is recommended once floor plates and elevations have been finalised.

7.1 RECOMMENDED CONSTRUCTIONS

7.1.1 Glazed Windows and Doors

The following constructions are recommended to comply with the project noise objectives. Aluminium framed/sliding glass doors and windows will be satisfactory provided they meet the following criteria. All external windows and doors listed are required to be fitted with Q-lon type acoustic seals. (**Mohair Seals are unacceptable**).

Thicker glazing may be required for structural, safety or other purposes. Where it is required to use thicker glazing than scheduled, this will also be acoustically acceptable.

The recommended indicative glazing constructions are presented in Appendix 5 *'Indicative Glazing Mark-Up'* of this report. Detailed glazing structure shall be confirmed at CC stage when floor plans and elevations are finalised.

It is recommended that only window systems having test results indicating compliance with the required ratings obtained in a certified laboratory be used where windows with acoustic seals have been recommended.

In addition to complying with the minimum scheduled glazing thickness, the R_w rating of the glazing fitted into open-able frames and fixed into the building opening will require the use of acoustic seals around the full perimeter of open-able frames and the frame will need to be sealed into the building opening using a flexible sealant.

Table 8- Minimum R_w of Glazing (with Acoustic Seals)

Glazing Assembly	Minimum R_w of Installed Window
6.38mm Laminated	31
10.38mm Laminated	35
10.38mm Laminated/100mm Air Gap/10mm Float	45

7.1.2 External Roof/Ceiling

External roof construction will be constructed from concrete or masonry elements, this proposed structure will not require any further acoustic upgrading. In the event that any penetrations are required through the external skin, an acoustic grade sealant should be used to minimise all gaps.

7.1.3 External Walls

External wall construction will be constructed from concrete and masonry elements, this proposed structure will not require any further acoustic upgrading. In the event that any penetrations are required through the external skin, an acoustic grade sealant should be used to minimise all gaps.

7.1.4 Entry Doors

External opening entry doors shall have glazing thicknesses equal to those recommended in section 7.1.1 Recommended Glazing Construction and are to have Raven RP10 to the top and sides, and Raven RP38 to the underside of the door.

8 NOISE EMISSIONS FROM THE PROJECT SITE

The major noise sources generated by operation of project site are below:

- Operation of mechanical plant servicing the project building.

8.1 BACKGROUND NOISE LEVELS

Background noise measurements around the project site have been ascertained through the means of attended noise measurements and unattended noise monitoring.

Unattended background noise monitoring was carried out at the following 3 locations:

U2: Liverpool Hospital Ground floor internal courtyard;

U3: Northern boundary of 43 Forbes Street, Liverpool; and

U4: Backyard of the residential dwelling located at 63 Goulburn Street in the North-West boundary of the property.

8.1.1 Equipment Used

Attended Noise Measurements: Attended background noise measurements were conducted using a Norsonic 140 Sound Analyser. The analyser was set to fast response and calibrated before and after the measurements using a Norsonic Sound Calibrator type 1251. No significant drift was noted.

Unattended Noise Monitoring: Background noise was recorded using three Acoustic Research Laboratories Pty Ltd noise loggers. The loggers were programmed to store 15-minute statistical noise levels throughout the unattended monitoring period. The equipment was calibrated at the beginning and the end of the measurement using a Rion NC-73 calibrator; no significant drift was detected. All measurements were taken on A-weighted fast response mode.

8.1.2 Measurement Period/Locations

Attended Noise Measurements: Attended background noise measurements were conducted at all sensitive receiving locations around the project site as follows below (See Figure 1 for a detailed noise measurement location):

A1 & A2: Tuesday, 11th December 2018 between 9:00am and 10:00am.

A3, A4 & A5: Friday, 14th June 2019 between 8:30am and 11:00am.

Unattended Noise Monitoring:

Except of Fact Sheet A of the NSW Noise Policy for Industry states:

Monitoring location	Reasonably most- or potentially most-affected residence(s).[3]	Reasonably most- or potentially most-affected residence(s)[3] and/or location of complaint.[3]

Site investigation indicates that the most-potentially affected noise receivers are the residential receivers located at 49, 53, 55-59, 61, 63, 67, 71, 73-75 Goulburn Street given the proximity of these residential receivers to the Liverpool Hospital project site. Details refer to Figure 6 below.

U2: Noise monitoring was conducted between Wednesday, 28th November 2018 to Tuesday, 11th December 2018. The noise monitor was setup in the Liverpool Hospital Ground floor internal courtyard. See Figure 1 for a detailed noise monitoring location and Figure 4 below for a photo of the installed noise monitor.

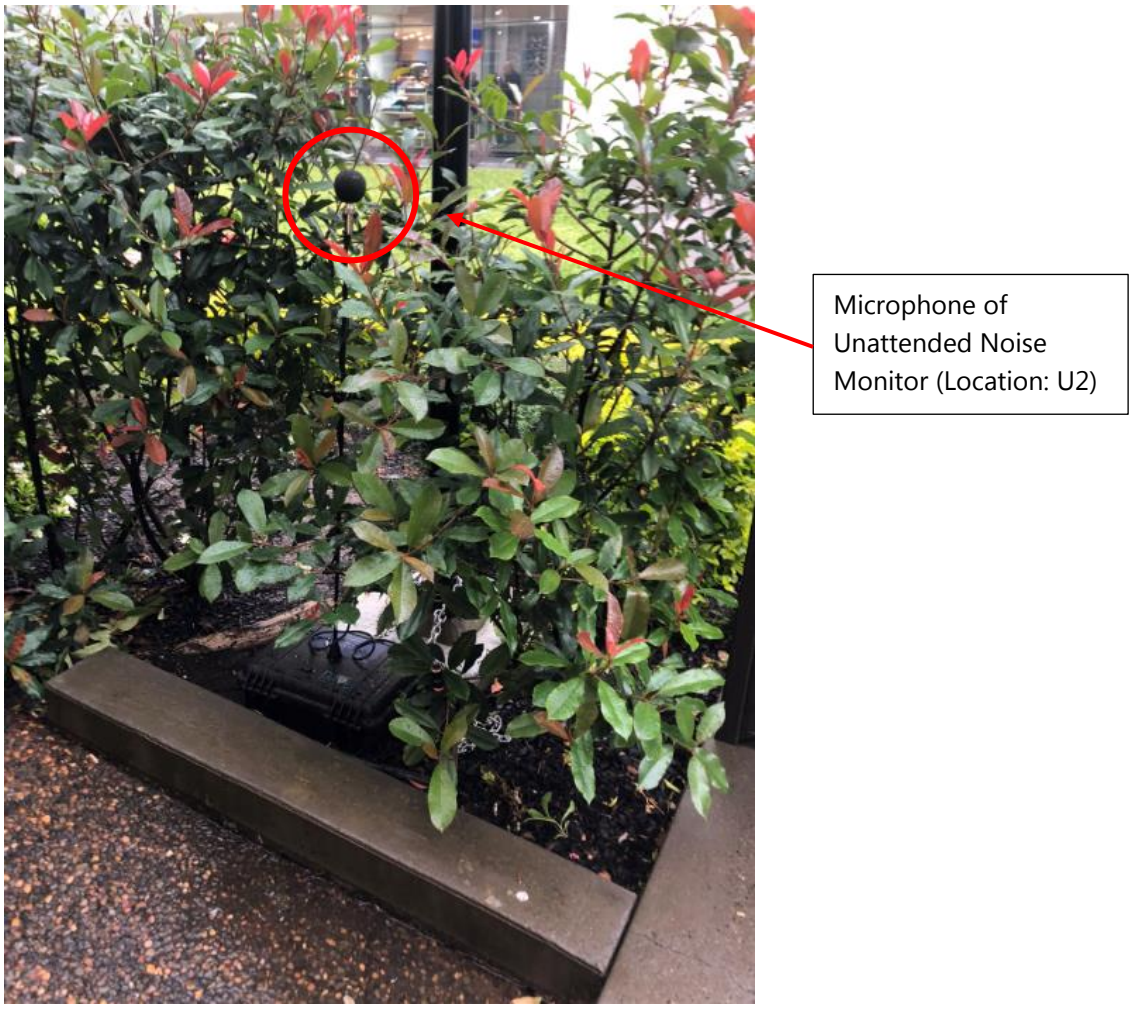


Figure 4 – Photo of Unattended Noise Monitoring Location U2 (Within Liverpool Hospital Internal Courtyard)

U3: Noise monitoring was conducted between Tuesday, 9th July 2019 and Tuesday, 16th July 2019. The noise monitor was setup along the northern boundary of 43 Forbes Street, Liverpool. See Figure 1 for a detailed noise monitoring location and Figure 4 below for a photo of the installed noise monitor.

Figure 5 – Photo of Unattended Noise Monitoring Location U3 (On northern boundary of 43 Forbes Street)

U4: Noise monitoring was conducted between Wednesday, 15th April 2020 to Tuesday, 28th April 2020. The noise monitor was setup in the backyard of the residential dwelling located at 63 Goulburn Street in the North-West boundary of the property. See Figure 1 for a detailed noise monitoring location and Figure 6 below for a photo of the installed noise monitor.

Figure 6 – Photo of Unattended Noise Monitoring Location U4 (63 Goulburn Street, Liverpool)

8.1.3 Measured Rating Background Noise Levels

The NPfI states:

Monitoring should not be conducted (or monitoring data are to be excluded) when average wind speeds are greater than 5 metres per second at microphone height, or during rain. Exceptions to this rule are allowed, provided the proponent is able to show that the wind induced noise on the microphone and sound levels due to rain are at least 10 dB(A) below the background noise levels under investigation.

And;

Re-monitoring may not be required, where monitoring contains weather affected data, if it can be ascertained that the affected samples are not within the expected 'quieter' times of an assessment period (day/evening/night); that is, those time periods where the lowest 10th percentile background noise level might occur. In this case it should be fully justified in the noise-assessment report that the weather-affected data would not affect the lowest 10th percentile background noise level. This could be done through the clear identification of set daily noise patterns of 'quiet' periods exhibited by the measured data from the non-affected days. There should be enough non-affected data available for the assessor to be confident that any pattern identified is valid. For these cases the affected samples need **not** be removed from the data set before the 10th percentile is determined in Step 2.

In respect of the above it is noted that:

- The weather data used was obtained from the Bankstown Airport Weather Station. While the weather station data provides the most accurate indicator of likely wind effects, it cannot predict the actual wind speed at the noise measurement site. Given that the logging locations are likely to be more screened from wind, the wind speed at the noise measurement site is likely to be less than at the weather station used.
- However, the noise data of dB(A)L_{min} has been adopted for periods affected by adverse weather conditions to provide a conservative acoustic assessment.

The results of the attended and unattended background noise measurements are presented in the tables below.

The measured background noise levels dB(A)L_{90} for day, evening and night-time periods are shown in the table below.

- Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
- Evening is defined as the period from 6pm to 10pm; and
- Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

The results of the attended and unattended background noise measurements are presented in the tables below:

Attended Noise Measurement Results

Table 9 – Attended Noise Measurements

Location	Time	Measured Background Noise Level dB(A)L_{90}
A1 – Southern Boundary, Liverpool Hospital	Tuesday, 11th December 2018 9:00am – 10:00am	51
A2 – Western Boundary, Liverpool Hospital		53
A3 – Goulburn Street Receivers	Friday, 14th June 2019 8:30am – 11:00am	56
A4 – Campbell Street Receivers		55
A5 – Corner of Elizabeth Street and College Street Receivers		56

Unattended Noise Monitoring Results

Table 10 – Rating Background Noise Levels – Unattended Noise Monitoring Location #2

Noise Monitoring Location	Date	Day ABL* (7am-6pm)	Evening ABL* (6pm-10pm)	Night ABL* (10pm-7am)
U2: Unattended Noise Monitoring (See Figure 1)	Wednesday, 28th November 2018	-	51*	51*
	Thursday, 29th November 2018	52*	51*	52
	Friday, 30th November 2018	51*	52	52
	Saturday, 1st December 2018	52	53	52
	Sunday, 2nd December 2018	50*	50*	52
	Monday, 3rd December 2018	50*	50*	52
	Tuesday, 4th December 2018	51*	51*	51*
	Wednesday, 5th December 2018	53	52	52
	Thursday, 6th December 2018	51*	51*	52
	Friday, 7th December 2018	51*	51*	52
	Saturday, 8th December 2018	50*	52	52
	Sunday, 9th December 2018	50*	52	52
	Monday, 10th December 2018	52	51*	52
	Tuesday, 11th December 2018	-	-	-
	RBL	**51**	**51**	**52**

*Note: dB(A)L_{min} has been adopted to exclude weather affected data during monitoring periods.

Items marked "-" above did not record data through the entire period due to the monitor being installed prior during or after the period and therefore have been excluded.

Table 11 – Rating Background Noise Levels – Unattended Noise Monitoring Location #3

Noise Monitoring Location	Date	Day ABL* (7am-6pm)	Evening ABL (6pm-10pm)	Night ABL* (10pm-7am)
U3: Unattended Noise Monitoring (See Figure 1)	Tuesday, 9th July 2019	-	43	41
	Wednesday, 10th July 2019	45	44	38*
	Thursday, 11th July 2019	41*	44	40
	Friday, 12th July 2019	43*	40*	38*
	Saturday, 13th July 2019	40*	42	39*
	Sunday, 14th July 2019	40*	42	39*
	Monday, 15th July 2019	42*	42	41
	Tuesday, 16th July 2019	-	-	-
	RBL	**42**	**42**	**39**

*Note: dB(A)L_{min} has been adopted to exclude weather affected data during monitoring periods.

Items marked "-" above did not record data through the entire period due to the monitor being installed prior during or after the period and therefore have been excluded.

Table 12 – Rating Background Noise Levels – Unattended Noise Monitoring Location #4

Noise Monitoring Location	Date	Day ABL (7am-6pm)	Evening ABL (6pm-10pm)	Night ABL (10pm-7am)
U4: Unattended Noise Monitoring (See Figure 1)	Wednesday, 15th April 2020	-	42	38
	Thursday, 16th April 2020	44	42	40
	Friday, 17th April 2020	41	42	38
	Saturday, 18th April 2020	39	39	35
	Sunday, 19th April 2020	39	40	38
	Monday, 20th April 2020	42	40	38
	Tuesday, 21st April 2020	42	42	38
	Wednesday, 22nd April 2020	42	41	39
	Thursday, 23rd April 2020	42	40	39
	Friday, 24th April 2020	43	41	38
	Saturday, 25th April 2020	39	42	37
	Sunday, 26th April 2020	39	40	39
	Monday, 27th April 2020	40	39	37
	Tuesday, 28th April 2020	-	-	-
	RBL	**42**	**41**	**38**

Items marked "-" above did not record data through the entire period due to the monitor being installed prior during or after the period and therefore have been excluded.

Table 13 – Summarised Rating Background Noise Levels

Location	Time	Measured Background Noise Level dB(A)L_{90}
U2: Unattended Noise Monitoring (See Figure 1)	Day (7am-6pm)	51
	Evening (6pm-10pm)	51
	Night (10pm-7am)	52
U3: Unattended Noise Monitoring (See Figure 1)	Day (7am-6pm)	42
	Evening (6pm-10pm)	42
	Night (10pm-7am)	39
U4: Unattended Noise Monitoring (See Figure 1)	Day (7am-6pm)	**42**
	Evening (6pm-10pm)	**41**
	Night (10pm-7am)	**38**

Note: The lowest RBL of each time period will be adopted to setup noise emission criteria to provide conservative noise emission assessment.

8.2 MECHANICAL PLANT SERVICING THE PROJECT SITE

The noise emissions from plant servicing the project building shall satisfy the requirements below:

- Liverpool Development Control Plan 2008; and
- NSW Environmental Protection Authority 'Noise Policy for Industry' 2017.

8.2.1 Liverpool Development Control Plan 2008

The Liverpool Development Control Plan 2008 document does not contain any explicit noise criteria for noise emissions. Therefore; the NSW EPA Noise Policy for Industry criteria will be adopted.

8.3 NSW ENVIRONMENTAL PROTECTION AUTHORITY 'NOISE POLICY FOR INDUSTRY" 2017

The NPfI 2017 provides guidelines for assessing noise impacts from industrial developments. The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The NPfI has two requirements which both have to be complied with, namely project amenity criterion and an intrusiveness criterion.

8.3.1 Intrusiveness Criterion

The guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A).

Intrusive criteria based on the minimum RBL recommended by EPA for project site are detailed in table below.

Table 14 – NPfI Intrusiveness Criteria

Time of day	Background Noise Level dB(A)L_{90}	Intrusiveness Criteria (Background+5dB(A)) dB(A)L_{eq}
Day (7am-6pm)	42	47
Evening (6pm-10pm)	41	46
Night (10pm-7am)	38	43

8.3.2 Project Amenity Criterion

The guideline is intended to limit the absolute noise level from all noise sources to a level that is consistent with the general environment.

The NPfI requires Project Amenity Noise Levels to be calculated below:

$$L_{Aeq,\ 15\ min} = \textit{Recommended Amenity Noise Level} - 5\ dB(A) + 3\ dB(A)$$

Pursuant to the NPfI, the residential receivers in the vicinity would be considered suburban. Corresponding Project Amenity Criteria noise emission goals are presented below.

Table 15 –NPfI Project Amenity Criteria

Type of Receiver	Time of day	Recommended Amenity Noise Level dB(A)L_{eq}	Project Amenity Noise Level dB(A)$L_{eq,\ 15min}$
Residential (Suburban)	Day (7am-6pm)	55	53
	Evening (6pm-10pm)	45	43
	Night (10pm-7am)	40	38
Commercial	When in use	63	
School Classroom (Internal)	Noisiest 1-hour period When in use	35	
Hospital Ward	Noisiest 1-hour (Internal)	35	
	Noisiest 1-hour (External)	50	

8.3.3 Sleep Arousal Criteria

Section 2.5 of NPfI 2017 recommended the following noise limit to mitigate sleeping disturbance:

Where the subject development/ premises night -time noise levels at a residential location exceed:

- *$L_{Aeq,\ 15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*

A detailed maximum noise level even assessment should be undertaken.

Table 16 - Sleep Arousal Emergence Criteria (Night)

Location	Rating Background Noise Level (Night) - dB(A)L_{90}	Emergence Level
All Potentially Affected Residential Properties	38	43 dB(A)$L_{eq,\ 15min}$; 53 dB(A)$L_{max,\ F}$

8.3.4 Summary of Noise Emission Criteria

The noise emission criteria from plant servicing the project building have been summarised below.

Table 17 - Summarised Noise Emission Criteria

Location	Time	Noise Objectives
Residential Boundaries around Project site	Day (7am-6pm)	47 dB(A)$L_{eq,\ 15min}$`
	Evening (6pm-10pm)	43 dB(A)$L_{eq,\ 15min}$
	Night (10pm-7am)	38 dB(A)$L_{eq,\ 15min}$ 53 dB(A)$L_{max,\ F}$
Commercial Boundaries	When in use	63 dB(A)L_{eq}
School Classroom (Internal)	Noisiest 1-hour period When in use	35
Hospital Ward	Noisiest 1-hour (Internal)	35
	Noisiest 1-hour (External)	50

8.3.5 Mechanical Plant Servicing the Project Site

Mechanical plant to service the project site including air conditioning, ventilation fans, etc. Detailed mechanical design and equipment selections are not available at this stage, detailed acoustic controls can be worked out at CC stage to ensure that the overall plant noise emissions satisfy the requirements above.

Plant shall be acoustically treated to prevent noise emissions from adversely impacting the surrounding properties in conjunction with the criteria detailed in this report. This may include selecting the quietest plant practicable, or treating the plant with enclosures, barriers, duct lining and silencers, etc as required to comply with the sound level recommendations.

Experience with similar projects indicates that it would be possible to achieve the requirement with appropriate treatment of the plant. General requirements for a number of potential plant items on the site are expanded on below. A preliminary review of the major plant items and general fans has been provided below.

8.3.5.1 Air Handling Units

Air Handing Units are typically located inside dedicated plant rooms, which provide good acoustic shielding. In regard to air flow; outside air to and exhaust from the AHU's is recommended to be ducted via rigid ducts which have the potential to be treated using lining, bends and silencers/attenuators. Thus, all AHUs are capable of meeting the noise emission criteria, set out in section 8.3 of this report

8.3.5.2 Cooling Tower

Typically, all cooling towers are to have variable speed drives, to allow for reduced fan speed during periods of low load. Typically, a fan speed of no more than 50% would be expected at night-time, which, based on the noise emission criteria presented in section 8.3 of this report, is the most-stringent time period.

8.3.5.3 Emergency Generators

Generators are proposed to be used only in emergency situations.

Generators are to be installed on a concrete plinth. Plinth is to be isolated from the structural slab by two layers of 10mm thick Vibramat (from Acoustic Supplies) or equal. There should be no rigid connection between plinth and structural slab.

Generator should be isolated from the plinth using 50mm static deflection spring vibration isolators.

8.3.5.4 Fans and Other General Plant Items

All fans are capable of meeting the noise emission criteria, set out in section 8.3 of this report, with the implementation of lined duct work and bends.

8.3.5.5 Supply / Exhaust Fans

Supply and exhaust fans may be located within the underground plant rooms or in rooftop plant areas. These units typically emit high noise levels and require acoustic treatment such as silencers and internal lined ductwork. Silencer requirements would be determined once fan selections have been completed.

8.3.5.6 Minor Plant

Other minor plant items, such as bathroom or kitchen exhaust fans, may also be required. These items typically emit relatively low noise levels and may require minimal acoustic treatment of a standard nature, such as internally lining of ductwork.

8.3.5.7 Major Plant

It is at the construction design stage that consideration should be given to the placement of equipment including intake and discharge air locations. In addition to the location of the equipment acoustic treatments to the major plant items may include silencers, treatment to ducting, time control, operational limitations, vibration isolation and the like.

9 CONSTRUCTION NOISE AND VIBRATION IMPACTS

9.1 SENSITIVE RECEIVERS

The nearest sensitive receivers in the vicinity of the project site are as follows below:

- **Receiver 1:** Remaining Liverpool Hospital Development.
- **Receiver 2:** Residential receivers located at 49, 53, 55-59, 61, 63, 67, 71, 73-75 Goulburn Street to the West. Residential receivers are multi-storey.
- **Receiver 3:** South West Radiation located at 51 Goulburn Street to the West. Receiver is single storey.
- **Receiver 4:** Health Services Building and Ingham Institute located at 1 Campbell Street to the North. Receivers are multi-storey.
- **Receiver 5:** Liverpool Girls High School located at 96 Forbes Street to the North-East. Educational receiver is double storey.
- **Receiver 6:** Tafe NSW Liverpool located at 14 College Street to the South. Educational receiver is double storey.

9.2 NOISE MANAGEMENT LEVEL

Establishment of criteria for construction noise requirements will be in accordance with the following documents.

- Liverpool Development Control Plan 2008;
- NSW Environmental Protection Authority 'Interim Construction Noise Guideline';
- Australian Standard AS2107:2016; and
- Australian Standards AS2436:2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites.

9.2.1 Liverpool Development Control Plan 2008

Part 1 – General Controls for all development

14. Demolition of Existing Developments

Controls

Demolition

1. All demolition work must comply with the *Australian Standard AS2601 - 1991, The Demolition of Structures*.
2. Security fencing such as hoardings must be provided around the perimeter of the demolition site prior to work commencing to prevent access by unauthorised persons at all times during the demolition period. Approval of the fencing by Council must be received prior to erection.
3. Demolition must not be conducted in high winds to ensure dust does not spread beyond the site boundaries.
4. All lead contaminated materials identified in the building must be handled and disposed of in accordance with the *NSW Environment Protection Authority's* requirements.
5. Dust Controls must be implemented on site prior to and during demolition.

6. Asbestos, if identified in the building, must be removed and disposed of in accordance with the requirements of Work Cover.
7. All trucks/trailers entering or leaving the site must have their loads adequately covered. A sign indicating this should be placed at the entry to and exit from the site.
8. Temporary toilet facilities must be provided on the site until all demolition work is completed.
9. Demolition activities on site must be limited to the following hours:
   - Monday to Friday 7:00am to 6:00pm
   - Saturday 8:00am to 1:00pm
   - No work on Sunday and Public Holidays
10. Sound pressure levels emanating from the site must not exceed levels established by the *NSW Environment Protection Authority*.
11. A Waste Management Plan (WMP) is to be submitted with the Development Application. The WMP must include volume or area estimates and information about reuse, recycling and disposal options for all types of waste produced on-site, including excavation materials.
12. The waste management plan together with proof of lawful disposal for all waste that is disposed of, or otherwise recycled from the site must be retained on site. Proof is to include a log book with associated receipt/invoices, waste classification, and site validation certificate. All entries must include:
    - Time and Date
    - Description and size of waste
    - Waste facility used
    - Vehicle registration and company name

    Both the log book and the associated recepts must be made available for inspection by authorised Council Officer at any time during site works.
13. Where subdivision works are proposed, relevant sections of the WMP must be completed. If the destination for excavation material is not a licensed waste facility, it must have development consent to receive such material.
14. Where subdivision works are proposed, relevant sections of the WMP must be completed. If the destination for excavation material is not a licensed waste facility, it must have development consent to receive such material.
15. A Dilapidation Report for any demolition within the zone of influence of any other building.

9.2.2 NSW EPA Interim Construction Noise Guideline

Given the scale of the proposed works, the "quantitative" assessment procedure, as outlined in the Interim Construction Noise Guideline (ICNG) will be used (as opposed to the simpler "qualitative" assessment method outlined in the guidelines). The quantitative assessment method requires:

- Determination of noise generation management levels (based on background noise levels on site).
- Prediction of operational noise levels at nearby development.
- If necessary, recommendation of noise controls strategies in the event that compliance with noise emission management levels is not possible.

9.2.2.1 At Residential Receivers

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

Recommended Standard Hours
Monday to Friday (7am – 6pm) & Saturday (8am – 1pm)

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise affected" 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 affected" level occurs when construction noise exceeds ambient levels by more than 10dB(A)$L_{eq(15min)}$.
- "*Highly noise affected level"*. Where noise emissions are such that nearby properties are "highly noise affected", noise controls such as respite periods should be considered. For residential properties, the "highly noise affected" level occurs when construction noise exceeds 75dB(A)$L_{eq(15min)}$ at nearby residences.

Outside Recommended Standard Hours
Saturday (1pm-3pm)

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise affected" level at a nearby residence, and all feasible and reasonable practices have been applied and the proponent should negotiate with the community. The noise affected level for works being undertaken outside of the *"Recommended Standard Hours"* period is more stringent where the "noise affected" level occurs when construction noise exceeds ambient levels by more than 5dB(A)$L_{eq(15min)}$.

Outside Recommended Standard Hours (Special Construction Hours)
Friday (6pm-10pm), Saturday (5pm-10pm), Sunday (8am-10pm)

- *"Noise affected" level*. Where construction noise is predicted to exceed the "noise affected" level at a nearby residence, and all feasible and reasonable practices have been applied and the proponent should negotiate with the community. The noise affected level for works being undertaken outside of the *"Recommended Standard Hours"* period is more stringent where the "noise affected" level occurs when construction noise exceeds ambient levels by more than 5dB(A)$L_{eq(15min)}$.

Table 18 – Construction Noise Management Levels to Residential Receivers

Location	Recommended Standard Hours "Noise Affected" Level - dB(A)$L_{eq(15min)}$	"Highly Noise Affected" Level - dB(A)$L_{eq(15min)}$	Saturday: 1pm-3pm Outside Recommended Standard Hours "Noise Affected" Level - dB(A)$L_{eq(15min)}$
R2: Goulburn Street Residential Receivers	BG 42+10 = 52	75	BG 42+5 = 47

In addition, the following special construction hours have been recommended for the construction of the Main Works on selected evenings and weekends so as to maintain operation of the existing hospital and in consideration of Council restricted hours of operation on Campbell street during weekdays.

Table 19 – Construction Noise Management Levels to Residential Receivers (Special Construction Hours)

Location	Friday: 6pm-10pm Outside Recommended Standard Hours "Noise Affected" Level - dB(A)$L_{eq(15min)}$	Saturday: 5pm-10pm Outside Recommended Standard Hours "Noise Affected" Level - dB(A)$L_{eq(15min)}$	Sunday: 8am-5pm Outside Recommended Standard Hours "Noise Affected" Level - dB(A)$L_{eq(15min)}$	Sunday: 5pm-10pm Outside Recommended Standard Hours "Noise Affected" Level - dB(A)$L_{eq(15min)}$
R2: Goulburn Street Residential Receivers	BG 42 + 5 = 47	BG 42 + 5 = 47	BG 42 + 5 = 47	BG 42 + 5 = 47

9.2.2.2 To Educational Receivers

Table 3 of the ICGN outlines the following management noise levels to internal areas of classrooms at schools and other educational institutions:

Table 20 – Noise Management Level for Educational Buildings (ICGN)

Space	Management Level dB(A)$L_{eq\ (15\ min)}$
Classrooms at schools and other educational institutions	45

9.2.2.3 To Hospital Noise Receivers

Table 3 of the ICGN outlines the following management noise levels to internal areas of hospital buildings:

Table 21 – Noise Management Level for Hospital Buildings (ICGN)

Space	Management Level dB(A)$L_{eq\ (15\ min)}$
Hospital Wards and operating theatres	45

The ICGN does not have management noise levels for other areas of the nearby hospital receivers (offices, consulting rooms etc. as discussed in Section 2). Section 4.1.3 of the ICGN states:

*"**4.1.3 Commercial and industrial premises***

… The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors may assist in determining relevant noise levels (Standards Australia 2000)."

9.2.3 Australian Standard AS2107:2016

Demolition/Excavation/Construction noise management levels for noise sensitive spaces in the nearby hospital buildings not covered in the ICGN will be based on the maximum recommended noise levels presented in section AS2107:2016. These are presented in the table below:

Table 22 – Noise Management Level for Hospital Buildings (Internal - AS2107:2016)

Space	Management Level dB(A)$L_{eq\ (15\ min)}$
Consulting Rooms	45
Treatment Rooms	45
Office Areas	45
Operating Theatres	50
X-Ray Areas	50

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

Australian Standard AS2436 provides guidance on noise and vibration control in respect to construction and demolition sites, and the preparation of noise and vibration management plans, work method statements and impact studies. The Standard states that:

- *"Some construction and demolition activities are by their very nature noisy. The authorities responsible for setting noise level criteria for essential works will take note of the constraints imposed by such activities, especially when they are of short duration."*
- Construction, demolition and maintenance works pose different problems of noise and vibration control when compared with most other types of industrial activity, since

  (a) they are mainly carried on in the open;

  (b) they are often temporary in nature although they may cause considerable disturbance whilst they last;

  (c) the noise and vibration arise from many different activities and kinds of plant, and their intensity and character may vary greatly during different phases of the work; and

  (d) the sites cannot be separated by planning control, from areas that are sensitive to noise and vibration.

The Standard provides advice and guidelines for the prediction of impacts and the methods available to manage impacts. It guideline promulgates feasible and reasonable mitigation strategies and controls, and stakeholder liaison, in the effort to reach a realistic compromise between site activities and impacts on neighbouring properties.

Based on the above, the following procedure will be used to assess noise emissions:

- Predict noise levels produced by typical construction activities at the sensitive receivers.
- Develop a suitable noise criterion based on the NSW Environmental Protection Authority Interim Construction Noise Guideline.
- Adopt management conditions as per AS 2436 in the event of a non-compliance.

9.2.5 Summarised Noise Management Levels

The summarised noise management levels for the proposed demolition/excavation/construction activities are presented in the table below.

Table 23 – Summarised Noise Management Levels

Location	Management Level dB(A)$L_{eq\ (15\ min)}$
Goulburn Street Residential Receivers	**Recommended Standard Hours** "Noise Affected" Level - 52 "Highly Noise Affected" Level – 75 **Outside Recommended Standard Hours** "Noise Affected" Level – 47 **Outside Recommended Standard Hours (Special Construction Hours)** Friday: 6pm-10pm "Noise Affected" Level – 47 Saturday: 5pm-10pm "Noise Affected" Level – 47 Sunday: 8am-5pm "Noise Affected" Level – 47 Sunday: 5pm-10pm "Noise Affected" Level - 47
Educational Receivers	45 (Internal)
Bedroom Wards	
Consulting Rooms	
Treatment Rooms	
Office Areas	
Operating Theatres	
X-Ray Areas	50 (Internal)

10 CONSTRUCTION VIBRATION CRITERIA

Vibration criteria for the nearest receivers will be based on the following documents:

- DIN 4150-3 (1999-02);
- EPA "Assessing Vibration: A technical guideline"; and
- ASHRAE Handbook 2007.

10.1.1 DIN 4150

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 the table below.

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 24 – 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

10.1.2 Assessing Amenity

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

Table 25 – Preferred and Maximum Weighted RMS Values for Vibration Acceleration (m/s^2) 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					
Critical Areas	Day time	0.005	0.0036	0.010	0.0072
Residences	Day time	0.010	0.0071	0.020	0.014
Office	Day time	0.020	0.014	0.040	0.028
Impulsive Vibration					
Critical Areas	Day time	0.005	0.0036	0.010	0.0072
Residence	Day time	0.3	0.21	0.6	0.42
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 26 - Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Day time preferred value	Day time maximum value
Critical Areas	0.10	0.20
Residences	0.20	0.40
Office	0.40	0.80

10.1.3 Hospital Specific Vibration Limits

This office has been advised that vibration sensitive equipment is located within the existing hospital.

No specific allowable vibration levels have been provided to this office. Given this, the appropriate vibration curve from the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Handbook based on the equipment type will be used.

The ASHRAE Handbook specifies vibration levels associated with potential disruption to the use of sensitive equipment within a building. The maximum vibration velocities [$mm.s^{-1}$] recommended from 1-100Hz is given in Figure 37 of the ASHRAE used in conjunction with recommended equipment requirements curves given in table 46. Figure 37 and table 46 from the 2007 ASHRAE document is presented below in Figure and Table 27 respectively.

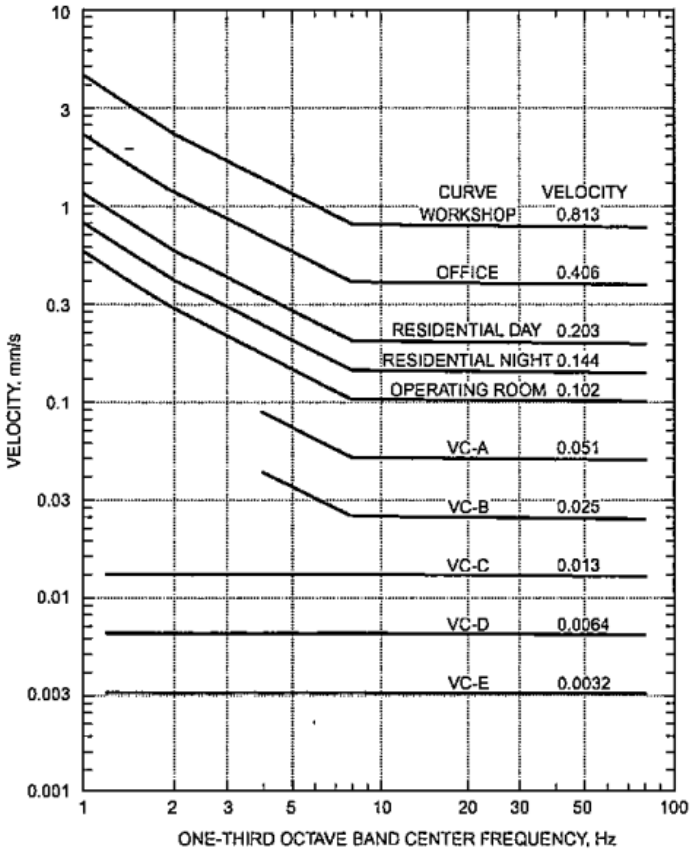


Fig. 37 Building Vibration Criteria for Vibration Measured on Building Structure

Figure 4 – Fig. 37 from 2007 ASHRAE Handbook: Vibration Criteria Curves

Table 27 – Tab. 46 from 2007 ASHRAE Handbook: Equipment Vibration Criteria

Equipment Requirements	Curve
Adequate for computer equipment, probe test equipment, and microscopes less than 40x magnification	0.203 (Residential – day)
Bench Microscopes up to 100x magnification; laboratory robots	0.102 (Operating Room)
Bench microscopes up to 400x magnification; optical and other precision balances; coordinate measuring machines; metrology laboratories; optical comparators; microelectronics manufacturing equipment; proximity and projection aligners, etc.	0.051 (VC – A)
Microsurgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400x magnification; optical equipment on isolation tables; microelectronic manufacturing equipment, such as inspection and lithography equipment (including steppers) to 3mm line widths	0.025 (VC – B)
Electron microscopes up to 30,000x magnification; microtomes; magnetic resonance imagers; microelectronics manufacturing equipment, such as lithography and inspection equipment to 1mm detail size	0.013 (VC – C)
Electron microscopes at magnification greater than 30,000x magnification; mass spectrometers; cell implant equipment; microelectronic manufacturing equipment such as, aligners, steppers and other critical equipment for photolithography with line widths of 1/2μm; includes electron beam systems	0.0064 (VC – D)
Un-isolated laser and optical research systems; microelectronics manufacturing equipment, such as aligners, steppers and other critical equipment for photolithography with line widths of 1/4μm; includes electron beam systems	0.0032 (VC – E)

a. See Figure for corresponding vibration curve.

We note that that Table 46 of ASHRAE does not have any vibration criteria for X-Ray imaging machines. **Given this, vibration criteria for the X-ray imaging will be based on the "Operating Room" Curve of Figure 37 of the ASHRAE vibration criteria**.

All vibration monitoring results recorded on site are presented against the vibration curves listed above. The appropriate level of vibration will ultimately be determined by the staff operating the equipment and whether or not the level of distortion created by the excavation works is acceptable. We note that the VC curves are a representation of the level of disruption to the activities and/or operations undertaken by the machine and not the limit where damage would be expected to occur to the unit.

10.1.4 Summarised Recommended Vibration Limits

The summarised vibration criteria are presented in the table below.

Table 28 – Recommended Vibration Limit

Vibration Receiver	Recommended Vibration Limits PPV (mm/s)
Operating Theatres	VC – B Curve of Figure 37 of the ASHRAE vibration criteria
X-Ray Imaging Room	"Operating Theatre" Curve of Figure 37 of the ASHRAE vibration criteria
Residential Buildings	5
Other Hospital Buildings	20

11 PRELIMINARY CONSTRUCTION NOISE EMISSION ASSESSMENT (STANDARD CONSTRUCTION HOURS)

11.1 PROPOSED SCOPE OF WORK DURING STANDARD CONSTRUCTION HOURS

The proposed scope of work to be undertaken during this stage is detailed as follows:

- Demolition of the existing hospital building structure along Goulburn Street;
- Excavation of the foundation;
- Piling; and
- Construction of a new 7 storey Integrated Services Building.

11.2 PROPOSED STANDARD CONSTRUCTION HOURS OF WORK

The above scope of work is proposed to be undertaken during the following standard construction hour periods:

Monday to Friday: 7:00am to 6:00pm;

Saturday: 8:00am to 1:00pm; and

Sunday/Public Holidays: No Works.

See Figure 1 for a detailed location where the construction works are to be undertaken and the nearest surrounding receivers to the project site.

11.3 ACTIVITIES TO BE CONDUCTED AND THE ASSOCIATED NOISE SOURCES

Preliminary noise impacts will be determined from primary processes and equipment. The sound power levels of these activities/equipment are presented in the table below.

Table 29 – Sound Power Levels of the Proposed Equipment

EQUIPMENT / PROCESS	SOUND POWER LEVEL dB(A)
Handheld Jackhammer	120*
Excavator with Bucket	105
Excavator with Hydraulic Hammer	118
Semi-Trailer	105
Demolition Saw	113
Bobcat	105
Concrete Pump	105
Cement Mixing Truck	105
Powered Hand Tools	95*
Electric Tower Crane	96
Mobile Crane	105
CFA Piling	103

*** Includes 5dB(A) addition for characteristics of noise source.**

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

- On site measurements;
- Table A1 of Australian Standard 2436-2010 & Table A1 of Australian Standard 2436-2010; and
- Data held by this office from other similar studies.

11.4 PRELIMINARY NOISE ASSESSMENT DURING STANDARD CONSTRUCTION HOURS

11.4.1 Methodology

Noise from the loudest typical construction activities have been predicted to the nearest most affected sensitive receivers. The predicted noise levels are presented in this section and are based on the areas on site in which the plant is likely to be used.

Where the position of the construction activity is variable, a range of predicted noise levels is presented to take into account the change in noise impact depending on where on the site the work is conducted.

Predictions take into account:

- The distance between the noise source and the receiver; and
- The screening effect provided by barriers or building structures (where relevant).

Note: As detailed demolition, excavation and construction methodology is not available at this stage, the following assumptions have been made:

- The electric tower crane is setup along the western façade of the construction site (nearest to Goulburn Street residential receivers); and
- Concrete trucks, concrete pumps and a mobile crane are located along the western façade of the construction site (nearest to Goulburn Street residential receivers).

11.4.2 Predicted Noise Levels

Please see the tables below for predicted noise levels for each receiver.

Table 30 – Predicted Noise Generation to Receiver 1 – Remaining Liverpool Hospital Development

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Bedroom Wards/ Consulting Rooms/Treatment Rooms/Office Areas/Operating Theatres</u> 45dB(A) <u>X-Ray Areas</u> 50dB(A)	35-56
Excavator with Bucket		20-41
Excavator with Hydraulic Hammer		33-54
Semi-Trailer		20-41
Demolition Saw		28-49
Bobcat		20-41
Concrete Pump		20-41
Cement Mixing Truck		20-41
Powered Hand Tools		10-31
Electric Tower Crane		11-32
Mobile Crane		20-41
CFA Piling		18-39

Table 31 – Predicted Noise Generation to Receiver 2 – Goulburn Street Residences

Activity	**External Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)***
Handheld Jackhammer	**Standard Construction Hours** **(Monday – Friday)** 7:00am – 6:00pm 52dB(A) **(Saturday)** 8:00am – 1:00pm 52dB(A)	65-85
Excavator with Bucket		50-70
Excavator with Hydraulic Hammer		63-83
Semi-Trailer		50-70
Demolition Saw		58-78
Bobcat		50-70
Concrete Pump		50-70
Cement Mixing Truck		50-70
Powered Hand Tools		40-60
Electric Tower Crane		41-61
Mobile Crane		50-70
CFA Piling		48-68

Table 32 – Predicted Noise Generation to Receiver 3 – South West Radiation

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	36-53
Excavator with Bucket		21-38
Excavator with Hydraulic Hammer		34-51
Semi-Trailer		21-38
Demolition Saw		29-46
Bobcat		21-38
Concrete Pump		21-38
Cement Mixing Truck		21-38
Powered Hand Tools		11-28
Electric Tower Crane		12-29
Mobile Crane		21-38
CFA Piling		19-36

Table 33 – Predicted Noise Generation to Receiver 4 – Health Services Building/Ingham Institute

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	33-57
Excavator with Bucket		18-42
Excavator with Hydraulic Hammer		31-55
Semi-Trailer		18-42
Demolition Saw		26-50
Bobcat		18-42
Concrete Pump		18-42
Cement Mixing Truck		18-42
Powered Hand Tools		8-32
Electric Tower Crane		9-33
Mobile Crane		18-42
CFA Piling		16-40

Table 34 – Predicted Noise Generation to Receiver 5 – Liverpool Girls High School

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Classrooms/Teaching Spaces 45dB(A)	23-43
Excavator with Bucket		8-28
Excavator with Hydraulic Hammer		21-41
Semi-Trailer		8-28
Demolition Saw		16-36
Bobcat		8-28
Concrete Pump		8-28
Cement Mixing Truck		8-28
Powered Hand Tools		0-18
Electric Tower Crane		0-19
Mobile Crane		8-28
CFA Piling		6-26

Table 35 – Predicted Noise Generation to Receiver 6 – Tafe NSW Liverpool

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Classrooms/Teaching Spaces 45dB(A)	23-47
Excavator with Bucket		8-32
Excavator with Hydraulic Hammer		21-45
Semi-Trailer		8-32
Demolition Saw		16-40
Bobcat		8-32
Concrete Pump		8-32
Cement Mixing Truck		8-32
Powered Hand Tools		0-22
Electric Tower Crane		0-23
Mobile Crane		8-32
CFA Piling		6-30

11.5 AMELIORATIVE MEASURES

11.5.1 Site Specific Recommendations

Detailed site-specific recommendations to mitigate noise and vibration impacts on surrounding receivers are to be determined once construction methodology is finalised.

11.6 GENERAL RECOMMENDATIONS

General noise management practices which may be adopted are discussed below. In addition, notification, reporting and complaints handling procedures should be adopted as recommended in section in this report.

11.6.1 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant. Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be affected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance which is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10 or 15mm plywood would be acceptable for the barriers.

11.6.2 Silencing Devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

11.6.3 Material Handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

11.6.4 Treatment of Specific Equipment

In certain cases, it may be possible to specially treat a piece of equipment to reduce the sound levels emitted. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

11.6.5 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. This includes locating fixed plant items as far as possible from residents as well as rotating plant and equipment to provide respite to receivers.

Construction vehicles accessing the site should not queue in residential streets and should only use the designated construction vehicle routes. Loading of these vehicles should occur as far as possible from any sensitive receiver.

12 PRELIMINARY CONSTRUCTION VIBRATION ASSESSMENT (STANDARD CONSTRUCTION HOURS)

12.1 VIBRATION PRODUCING ACTIVITIES

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

- Demolition Work; and
- Excavation Work.

12.2 SAFEGUARDS TO PROTECT SENSITIVE STRUCTURES

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

Note: Sample testing of vibration impacts from the demolition and excavation works to the sensitive receiving spaces of the Liverpool Hospital is recommended prior to commencement of the Main Works.

12.3 VIBRATION MONITORING (IF REQUIRED)

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

12.3.1 Downloading of Vibration Monitor 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.

12.3.2 Presentation of Vibration Monitor Results

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

13 PRELIMINARY CONSTRUCTION NOISE EMISSION ASSESSMENT (OUTSIDE STANDARD CONSTRUCTION HOURS)

13.1 OUTSIDE STANDARD CONSTRUCTION HOURS CONSTRUCTION WORK JUSTIFICATION

The following commentary has been provided to this office from Johnstaff in regard to justification for construction works to be undertaken outside of the *"Recommended Standard Construction Hours"* detailed in the Interim Construction Noise Guideline (ICNG) document.

"The "recommended standard hours" for "normal construction", as proposed in the Interim Construction Noise Guideline (ICNG), are:

- *Monday to Friday 7:00am to 6:00pm;*
- *Saturday 8:00am to 1:00pm; and*
- *No work on Sundays and Public Holidays.*

Section 4.12 outlines the proposed general hours of work for construction and the special construction hours required on selected weekends. The reasons for the extended general construction hours on Saturday afternoons, plus the additional selected "weekend work" outside of the "recommended standard hours", are to ensure continuity of excellence in the provision of health services and patient care in accordance with the requirements of Liverpool Hospital. Currently Liverpool City Council impose restricted hours of operation on Campbell Street during weekdays to reduce impacts to the adjacent high schools and therefore the additional hours allow for health services and patient care to continue during weekday periods.

Having regard to the above, it is considered that the proposed hours of work are a "reasonable" variation or departure from the "recommended standard hours". The basis for this conclusion is to be found in:

- *the definition of "reasonable" in the ICNG having regard to the nature and purpose of the proposed development.*
- *the analysis of the source/type of construction work noise likely to be generated by the ISB.*
- *the proposed construction management and recommended mitigation measures."*

Given the above justification for construction works to be undertaken outside of the "*Recommended Standard Hours"* we note the following:

The *'Outside Standard Construction Hours"* period proposed for construction works to be undertaken is from 1:00pm to 3:00pm on Saturday. The Preliminary Construction Noise Assessment presented in Section 13.5 of this report, predicted construction noise levels to the nearest sensitive receivers (residential receivers located along Goulburn Street) exceed the Noise Management Trigger Level of 47dB(A)$L_{eq,\ 15min}$. Noise controls such as respite hours for noisy work (hydraulic hammering, piling) and consultation to the nearest receivers are recommended.

13.2 PROPOSED SCOPE OF WORK OUTSIDE STANDARD CONSTRUCTION HOURS

The proposed scope of work to be undertaken during this stage is detailed as follows:

- Demolition of the existing hospital building structure along Goulburn Street;
- Excavation of the foundation;
- Piling; and
- Construction of a new 7 storey Integrated Services Building.

13.3 PROPOSED OUTSIDE STANDARD CONSTRUCTION HOURS OF WORK

The above scope of work is proposed to be undertaken during the following periods:

Saturday: 1:00pm to 3:00pm.

See Figure 1 for a detailed location where the construction works are to be undertaken and the nearest surrounding receivers to the project site.

13.4 ACTIVITIES TO BE CONDUCTED AND THE ASSOCIATED NOISE SOURCES

Preliminary noise impacts will be determined from primary processes and equipment. The sound power levels of these activities/equipment are presented in the table below.

Table 36 – Sound Power Levels of the Proposed Equipment

EQUIPMENT / PROCESS	SOUND POWER LEVEL dB(A)
Handheld Jackhammer	120*
Excavator with Bucket	105
Excavator with Hydraulic Hammer	118
Semi-Trailer	105
Demolition Saw	113
Bobcat	105
Concrete Pump	105
Cement Mixing Truck	105
Powered Hand Tools	95*
Electric Tower Crane	96
Mobile Crane	105
CFA Piling	103

*** Includes 5dB(A) addition for characteristics of noise source.**

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

- On site measurements;
- Table A1 of Australian Standard 2436-2010 & Table A1 of Australian Standard 2436-2010; and
- Data held by this office from other similar studies.

13.5 PRELIMINARY NOISE ASSESSMENT (OUTSIDE STANDARD CONSTRUCTION HOURS)

13.5.1 Methodology

Noise from the loudest typical construction activities have been predicted to the nearest most affected sensitive receivers. The predicted noise levels are presented in this section and are based on the areas on site in which the plant is likely to be used.

Where the position of the construction activity is variable, a range of predicted noise levels is presented to take into account the change in noise impact depending on where on the site the work is conducted.

Predictions take into account:

- The distance between the noise source and the receiver; and
- The screening effect provided by barriers or building structures (where relevant).

Note: As detailed demolition, excavation and construction methodology is not available at this stage, the following assumptions have been made:

- The electric tower crane is setup along the western façade of the construction site (nearest to Goulburn Street residential receivers); and
- Concrete trucks, concrete pumps and a mobile crane are located along the western façade of the construction site (nearest to Goulburn Street residential receivers).

13.5.2 Predicted Noise Levels

Please see the tables below for predicted noise levels for each receiver.

Table 37 – Predicted Noise Generation to Receiver 1 – Remaining Liverpool Hospital Development

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Bedroom Wards/ Consulting Rooms/Treatment Rooms/Office Areas/Operating Theatres</u> 45dB(A) <u>X-Ray Areas</u> 50dB(A)	35-56
Excavator with Bucket		20-41
Excavator with Hydraulic Hammer		33-54
Semi-Trailer		20-41
Demolition Saw		28-49
Bobcat		20-41
Concrete Pump		20-41
Cement Mixing Truck		20-41
Powered Hand Tools		10-31
Electric Tower Crane		11-32
Mobile Crane		20-41
CFA Piling		18-39

Table 38 – Predicted Noise Generation to Receiver 2 – Goulburn Street Residences

Activity	**External Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)***
Handheld Jackhammer	**Outside Standard Construction Hours** **(Saturday)** 1:00pm – 3:00pm 47dB(A)	65-85
Excavator with Bucket		50-70
Excavator with Hydraulic Hammer		63-83
Semi-Trailer		50-70
Demolition Saw		58-78
Bobcat		50-70
Concrete Pump		50-70
Cement Mixing Truck		50-70
Powered Hand Tools		40-60
Electric Tower Crane		41-61
Mobile Crane		50-70
CFA Piling		48-68

Table 39 – Predicted Noise Generation to Receiver 3 – South West Radiation

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	36-53
Excavator with Bucket		21-38
Excavator with Hydraulic Hammer		34-51
Semi-Trailer		21-38
Demolition Saw		29-46
Bobcat		21-38
Concrete Pump		21-38
Cement Mixing Truck		21-38
Powered Hand Tools		11-28
Electric Tower Crane		12-29
Mobile Crane		21-38
CFA Piling		19-36

Table 40 – Predicted Noise Generation to Receiver 4 – Health Services Building/Ingham Institute

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	33-57
Excavator with Bucket		18-42
Excavator with Hydraulic Hammer		31-55
Semi-Trailer		18-42
Demolition Saw		26-50
Bobcat		18-42
Concrete Pump		18-42
Cement Mixing Truck		18-42
Powered Hand Tools		8-32
Electric Tower Crane		9-33
Mobile Crane		18-42
CFA Piling		16-40

Table 41 – Predicted Noise Generation to Receiver 5 – Liverpool Girls High School

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Classrooms/Teaching Spaces</u> 45dB(A)	It is assumed that the receiver is not operational during the proposed extended construction hours
Excavator with Bucket		
Excavator with Hydraulic Hammer		
Semi-Trailer		
Demolition Saw		
Bobcat		
Concrete Pump		
Cement Mixing Truck		
Powered Hand Tools		
Electric Tower Crane		
Mobile Crane		
CFA Piling		

Table 42 – Predicted Noise Generation to Receiver 6 – Tafe NSW Liverpool

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Classrooms/Teaching Spaces</u> 45dB(A)	It is assumed that the receiver is not operational during the proposed extended construction hours
Excavator with Bucket		
Excavator with Hydraulic Hammer		
Semi-Trailer		
Demolition Saw		
Bobcat		
Concrete Pump		
Cement Mixing Truck		
Powered Hand Tools		
Electric Tower Crane		
Mobile Crane		
CFA Piling		

13.6 AMELIORATIVE MEASURES

13.6.1 Site Specific Recommendations

Detailed site-specific recommendations to mitigate noise and vibration impacts on surrounding receivers are to be determined once construction methodology is finalised.

13.7 GENERAL RECOMMENDATIONS

General noise management practices which may be adopted are discussed below. In addition, notification, reporting and complaints handling procedures should be adopted as recommended in section in this report.

13.7.1 Acoustic Barrier

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant. Equipment which is on the move or working in rough or undulating terrain cannot be effectively attenuated by placing barriers at the source.

Barriers can also be placed between the source and the receiver.

The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be affected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where no line of sight is obstructed by the barrier, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance which is approximately 10dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10 or 15mm plywood would be acceptable for the barriers.

13.7.2 Silencing Devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

13.7.3 Material Handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

13.7.4 Treatment of Specific Equipment

In certain cases, it may be possible to specially treat a piece of equipment to reduce the sound levels emitted. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

13.7.5 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. This includes locating fixed plant items as far as possible from residents as well as rotating plant and equipment to provide respite to receivers.

Construction vehicles accessing the site should not queue in residential streets and should only use the designated construction vehicle routes. Loading of these vehicles should occur as far as possible from any sensitive receiver.

14 PRELIMINARY CONSTRUCTION VIBRATION ASSESSMENT (OUTSIDE STANDARD CONSTRUCTION HOURS)

14.1 VIBRATION PRODUCING ACTIVITIES

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

- Demolition Work; and
- Excavation Work.

14.2 SAFEGUARDS TO PROTECT SENSITIVE STRUCTURES

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

Note: Sample testing of vibration impacts from the demolition and excavation works to the sensitive receiving spaces of the Liverpool Hospital is recommended prior to commencement of the Main Works.

14.3 VIBRATION MONITORING (IF REQUIRED)

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

14.3.1 Downloading of Vibration Monitor 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.

14.3.2 Presentation of Vibration Monitor Results

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

15 PRELIMINARY CONSTRUCTION NOISE EMISSION ASSESSMENT (OUTSIDE STANDARD CONSTRUCTION HOURS, SPECIAL CONSTRUCTION HOURS)

15.1 SPECIAL CONSTRUCTION HOURS JUSTIFICATION

The following commentary has been provided to this office from Johnstaff in regard to justification for construction works to be undertaken outside of the *"Recommended Standard Construction Hours"* detailed in the Interim Construction Noise Guideline (ICNG) document.

"Special construction hours will be required to for the construction of the Main Works on selected evenings and weekends so as to maintain operation of the existing hospital and in consideration of Council restricted hours of operation on Campbell street during weekdays."

Given the above justification for construction works to be undertaken outside of the "Recommended Standard Hours" we note the following:

The 'Outside Standard Construction Hours" period proposed for construction works to be undertaken is from Friday: 6:00 pm to 10:00 pm; Saturday: 5:00 pm to 10:00 pm and Sunday: 8:00 am to 10:00 pm. The Preliminary Construction Noise Assessment presented in Section 15.5 of this report, predicted construction noise levels to the nearest sensitive receivers (residential receivers located along Goulburn Street) exceed the Noise Management Trigger Level of 47dB(A)$L_{eq,\ 15min}$. Noise controls such as respite hours for noisy work (hydraulic hammering, piling) and consultation to the nearest receivers are recommended.

15.2 PROPOSED SCOPE OF WORK DURING SPECIAL CONSTRUCTION HOURS

The proposed scope of work to be undertaken during this stage is detailed as follows:

- Friday: Limited to site establishment activities in preparation for weekend works.
- Saturday: General construction activities excluding excavation, sawing of rock, jack hammers, pile drivers, vibratory rollers/compactors of the like.
- Sunday: General construction activities including excavation, sawing of rock, jack hammers, pile drivers, vibratory rollers/compactors of the like.
- Sunday: General construction activities excluding excavation, sawing of rock, jack hammers, pile drivers, vibratory rollers/compactors of the like.

15.3 PROPOSED SPECIAL CONSTRUCTION HOURS OF WORK

The above scope of work is proposed to be undertaken during the following periods:

Friday: 6:00 pm to 10:00 pm;

Saturday: 5:00 pm to 10:00 pm;

Sunday: 8:00 am to 5:00 pm; and

Sunday: 5:00 pm to 10:00 pm.

See Figure 1 for a detailed location where the construction works are to be undertaken and the nearest surrounding receivers to the project site.

15.4 ACTIVITIES TO BE CONDUCTED AND THE ASSOCIATED NOISE SOURCES

Preliminary noise impacts will be determined from primary processes and equipment. The sound power levels of these activities/equipment are presented in the table below.

Table 43 – Sound Power Levels of the Proposed Equipment

EQUIPMENT / PROCESS	SOUND POWER LEVEL dB(A)
Handheld Jackhammer	120*
Excavator with Bucket	105
Excavator with Hydraulic Hammer	118
Semi-Trailer	105
Demolition Saw	113
Bobcat	105
Concrete Pump	105
Cement Mixing Truck	105
Powered Hand Tools	95*
Electric Tower Crane	96
Mobile Crane	105
CFA Piling	103

*** Includes 5dB(A) addition for characteristics of noise source.**

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

- On site measurements;
- Table A1 of Australian Standard 2436-2010 & Table A1 of Australian Standard 2436-2010; and
- Data held by this office from other similar studies.

15.5 PRELIMINARY NOISE ASSESSMENT (OUTSIDE STANDARD CONSTRUCTION HOURS, SPECIAL CONSTRUCTION HOURS)

15.5.1 Methodology

Noise from the loudest typical construction activities have been predicted to the nearest most affected sensitive receivers. The predicted noise levels are presented in this section and are based on the areas on site in which the plant is likely to be used.

Where the position of the construction activity is variable, a range of predicted noise levels is presented to take into account the change in noise impact depending on where on the site the work is conducted.

Predictions take into account:

- The distance between the noise source and the receiver; and
- The screening effect provided by barriers or building structures (where relevant).

Note: As detailed demolition, excavation and construction methodology is not available at this stage, the following assumptions have been made:

- The electric tower crane is setup along the western façade of the construction site (nearest to Goulburn Street residential receivers); and
- Concrete trucks, concrete pumps and a mobile crane are located along the western façade of the construction site (nearest to Goulburn Street residential receivers).

15.5.2 Predicted Noise Levels

Please see the tables below for predicted noise levels for each receiver.

Table 44 – Predicted Noise Generation to Receiver 1 – Remaining Liverpool Hospital Development (Friday 6pm-10pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Semi-Trailer	Bedroom Wards/ Consulting Rooms/Treatment Rooms/Office Areas/Operating Theatres 45dB(A) X-Ray Areas 50dB(A)	20-41
Bobcat		20-41
Powered Hand Tools		10-31
Electric Tower Crane		11-32
Mobile Crane		20-41

Table 45 – Predicted Noise Generation to Receiver 1 – Remaining Liverpool Hospital Development (Saturday 5pm-10pm & Sunday 5pm-10pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Semi-Trailer	Bedroom Wards/ Consulting Rooms/Treatment Rooms/Office Areas/Operating Theatres 45dB(A) X-Ray Areas 50dB(A)	20-41
Bobcat		20-41
Concrete Pump		20-41
Cement Mixing Truck		20-41
Powered Hand Tools		10-31
Electric Tower Crane		11-32
Mobile Crane		20-41

Table 46 – Predicted Noise Generation to Receiver 1 – Remaining Liverpool Hospital Development (Sunday 8am-5pm Only)

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Bedroom Wards/ Consulting Rooms/Treatment Rooms/Office Areas/Operating Theatres</u> 45dB(A) <u>X-Ray Areas</u> 50dB(A)	35-56
Excavator with Bucket		20-41
Excavator with Hydraulic Hammer		33-54
Semi-Trailer		20-41
Demolition Saw		28-49
Bobcat		20-41
Concrete Pump		20-41
Cement Mixing Truck		20-41
Powered Hand Tools		10-31
Electric Tower Crane		11-32
Mobile Crane		20-41
CFA Piling		18-39

Table 47 – Predicted Noise Generation to Receiver 2 – Goulburn Street Residences (Friday 6pm-10pm Only)

Activity	External Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*
Semi-Trailer	**Outside Standard Construction Hours, Special Construction Hours** **(Friday)** 6:00pm – 10:00pm 47dB(A)	50-70
Bobcat		50-70
Concrete Pump		50-70
Cement Mixing Truck		50-70
Powered Hand Tools		40-60
Electric Tower Crane		41-61
Mobile Crane		50-70

Table 48 – Predicted Noise Generation to Receiver 2 – Goulburn Street Residences (Saturday 5pm-10pm & Sunday 5pm-10pm Only)

Activity	External Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*
Semi-Trailer	**Outside Standard Construction Hours, Special Construction Hours** **(Saturday)** 5:00pm – 10:00pm 47dB(A) **(Sunday)** 5:00pm – 10:00pm 47dB(A)	50-70
Bobcat		50-70
Concrete Pump		50-70
Cement Mixing Truck		50-70
Powered Hand Tools		40-60
Electric Tower Crane		41-61
Mobile Crane		50-70

Table 49 – Predicted Noise Generation to Receiver 2 – Goulburn Street Residences (Sunday 8am-5pm Only)

Activity	External Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(External Areas)*
Handheld Jackhammer	**Outside Standard Construction Hours, Special Construction Hours (Sunday)** 8:00am – 5:00pm 47dB(A)	65-85
Excavator with Bucket		50-70
Excavator with Hydraulic Hammer		63-83
Semi-Trailer		50-70
Demolition Saw		58-78
Bobcat		50-70
Concrete Pump		50-70
Cement Mixing Truck		50-70
Powered Hand Tools		40-60
Electric Tower Crane		41-61
Mobile Crane		50-70
CFA Piling		48-68

Table 50 – Predicted Noise Generation to Receiver 3 – South West Radiation (Friday 6pm-10pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Semi-Trailer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	21-38
Bobcat		21-38
Powered Hand Tools		11-28
Electric Tower Crane		12-29
Mobile Crane		21-38

Table 51 – Predicted Noise Generation to Receiver 3 – South West Radiation (Saturday 5pm-10pm & Sunday 5pm-10pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Semi-Trailer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	21-38
Bobcat		21-38
Concrete Pump		21-38
Cement Mixing Truck		21-38
Powered Hand Tools		11-28
Electric Tower Crane		12-29
Mobile Crane		21-38

Table 52 – Predicted Noise Generation to Receiver 3 – South West Radiation

(Sunday 8am-5pm Only)

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	36-53
Excavator with Bucket		21-38
Excavator with Hydraulic Hammer		34-51
Semi-Trailer		21-38
Demolition Saw		29-46
Bobcat		21-38
Concrete Pump		21-38
Cement Mixing Truck		21-38
Powered Hand Tools		11-28
Electric Tower Crane		12-29
Mobile Crane		21-38
CFA Piling		19-36

Table 53 – Predicted Noise Generation to Receiver 4 – Health Services Building/Ingham Institute (Friday 6pm-10pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Semi-Trailer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	18-42
Bobcat		18-42
Powered Hand Tools		8-32
Electric Tower Crane		9-33
Mobile Crane		18-42

Table 54 – Predicted Noise Generation to Receiver 4 – Health Services Building/Ingham Institute (Saturday 5pm-10pm & Sunday 5pm-10pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Semi-Trailer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	18-42
Bobcat		18-42
Concrete Pump		18-42
Cement Mixing Truck		18-42
Powered Hand Tools		8-32
Electric Tower Crane		9-33
Mobile Crane		18-42

Table 55 – Predicted Noise Generation to Receiver 4 – Health Services Building/Ingham Institute (Sunday 8am-5pm Only)

Activity	Internal Noise Management Level dB(A) $L_{eq\ (15min)}$	Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)*
Handheld Jackhammer	Consulting Rooms/Treatment Rooms/Office Areas 45dB(A)	33-57
Excavator with Bucket		18-42
Excavator with Hydraulic Hammer		31-55
Semi-Trailer		18-42
Demolition Saw		26-50
Bobcat		18-42
Concrete Pump		18-42
Cement Mixing Truck		18-42
Powered Hand Tools		8-32
Electric Tower Crane		9-33
Mobile Crane		18-42
CFA Piling		16-40

Table 56 – Predicted Noise Generation to Receiver 5 – Liverpool Girls High School

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Classrooms/Teaching Spaces</u> 45dB(A)	It is assumed that the receiver is not operational during the proposed extended construction hours
Excavator with Bucket		
Excavator with Hydraulic Hammer		
Semi-Trailer		
Demolition Saw		
Bobcat		
Concrete Pump		
Cement Mixing Truck		
Powered Hand Tools		
Electric Tower Crane		
Mobile Crane		
CFA Piling		

Table 57 – Predicted Noise Generation to Receiver 6 – Tafe NSW Liverpool

Activity	**Internal Noise Management Level dB(A) $L_{eq\ (15min)}$**	**Predicted Noise Level dB(A)$L_{eq(15min)}$ *(Internal Areas)***
Handheld Jackhammer	<u>Classrooms/Teaching Spaces</u> 45dB(A)	It is assumed that the receiver is not operational during the proposed extended construction hours
Excavator with Bucket		
Excavator with Hydraulic Hammer		
Semi-Trailer		
Demolition Saw		
Bobcat		
Concrete Pump		
Cement Mixing Truck		
Powered Hand Tools		
Electric Tower Crane		
Mobile Crane		
CFA Piling		

16 PRELIMINARY CONSTRUCTION VIBRATION ASSESSMENT (OUTSIDE STANDARD CONSTRUCTION HOURS, SPECIAL CONSTRUCTION HOURS)

16.1 VIBRATION PRODUCING ACTIVITIES

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

- Demolition Work; and
- Excavation Work.

16.2 SAFEGUARDS TO PROTECT SENSITIVE STRUCTURES

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

Note: Sample testing of vibration impacts from the demolition and excavation works to the sensitive receiving spaces of the Liverpool Hospital is recommended prior to commencement of the Main Works.

16.3 VIBRATION MONITORING (IF REQUIRED)

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

16.3.1 Downloading of Vibration Monitor 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.

16.3.2 Presentation of Vibration Monitor Results

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

17 CONCLUSION

Acoustic assessment for the Main Works SSD Application for the redevelopment of the Liverpool Health and Academic Precinct has been carried out. The findings are summarised below:

Traffic and emergency helicopter noise intrusion into the project site will satisfy the requirements below:

- Liverpool Development Control Plan 2008;
- Australian and New Zealand AS/NZS 2107:2016 'Recommended design sound levels and reverberation times for building interiors'; and
- NSW Government, Health Infrastructure 'Engineering Services Guidelines' 2017.

Noise emissions from the operation of the project site will satisfy the requirements below:

- Liverpool Development Control Plan 2008; and
- NSW Environmental Protection Authority 'Noise Policy for Industry' 2017.

Construction noise emission management levels have been setup based on requirements of the Liverpool Development Control Plan 2008, NSW Interim Construction Noise Guideline, Australian Standard AS2107:2016 and AS2436:2010. A preliminary noise emission assessment during the Standard Construction Hours, Outside Standard Construction Hours and Special Construction Hours has been undertaken, however; detailed noise controls are to be determined once a contractor has been engaged and the demolition/excavation/construction methodology is finalised.

Construction vibration limits has been setup in Section 10 based on requirements of DIN 4150, EPA document Assessing Vibration: A technical guideline and the 2007 ASHRAE Handbook. Detailed vibration safeguard system will be determined at CC stage.

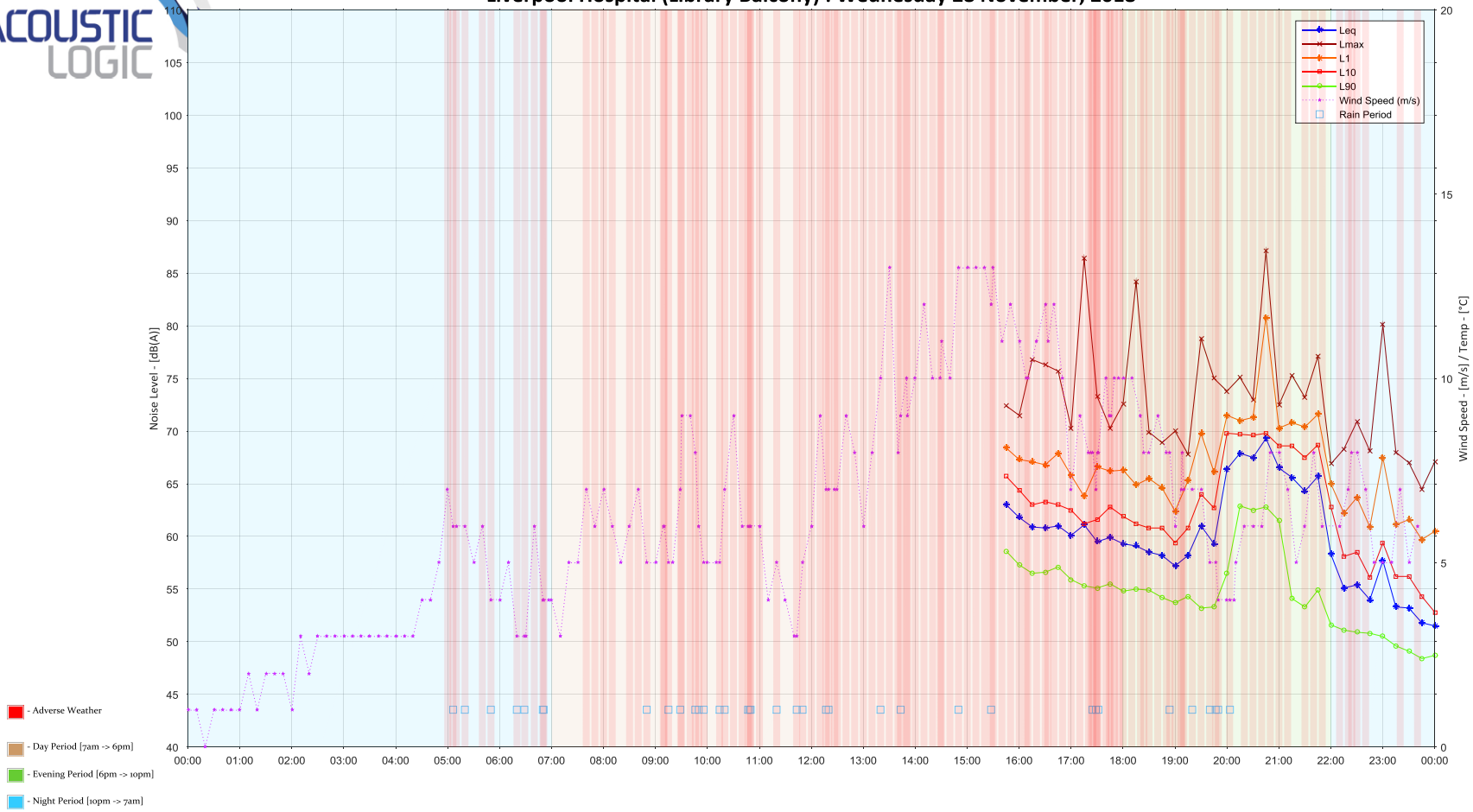
We trust this information is satisfactory. Please contact us should you have any further queries.

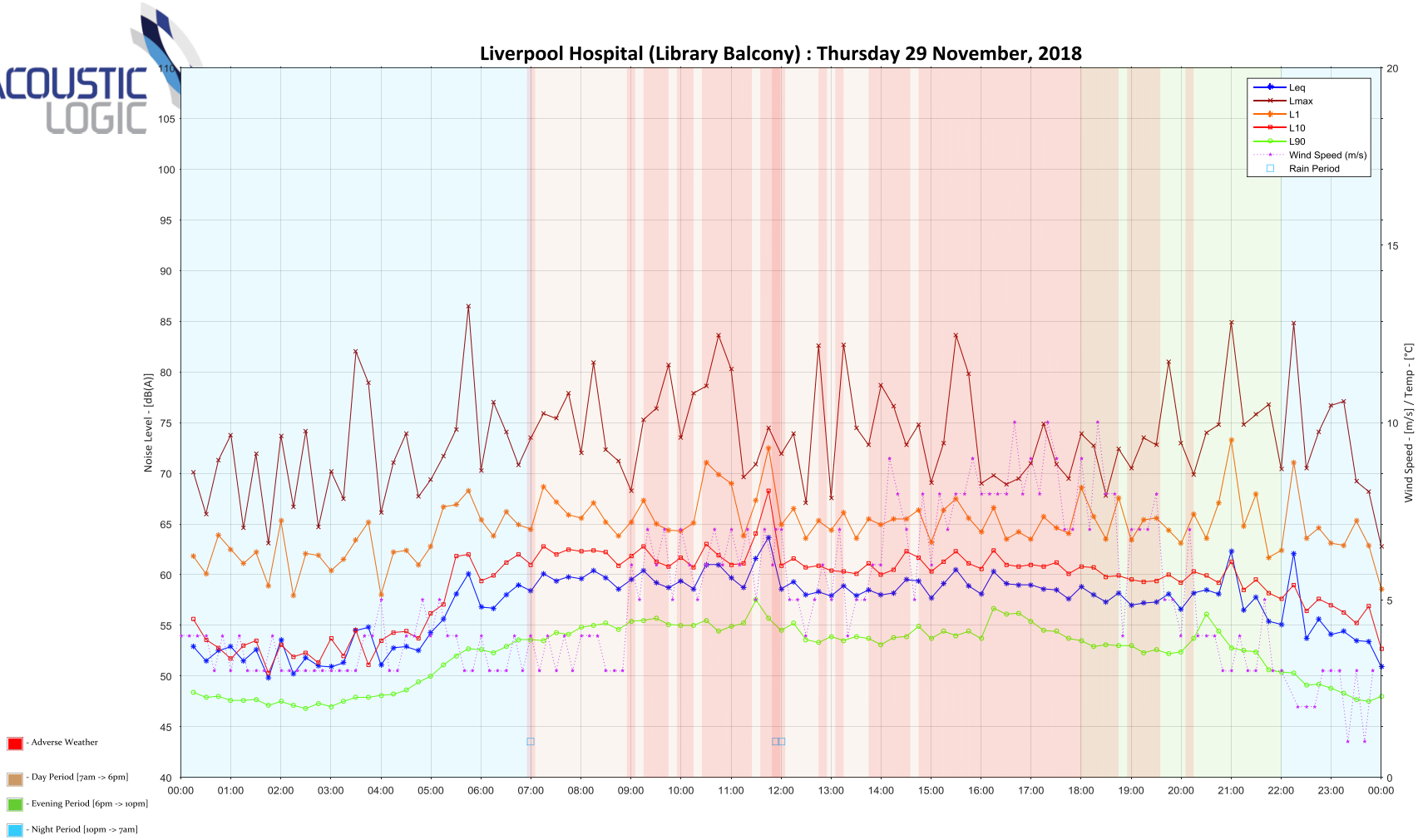
Yours faithfully,

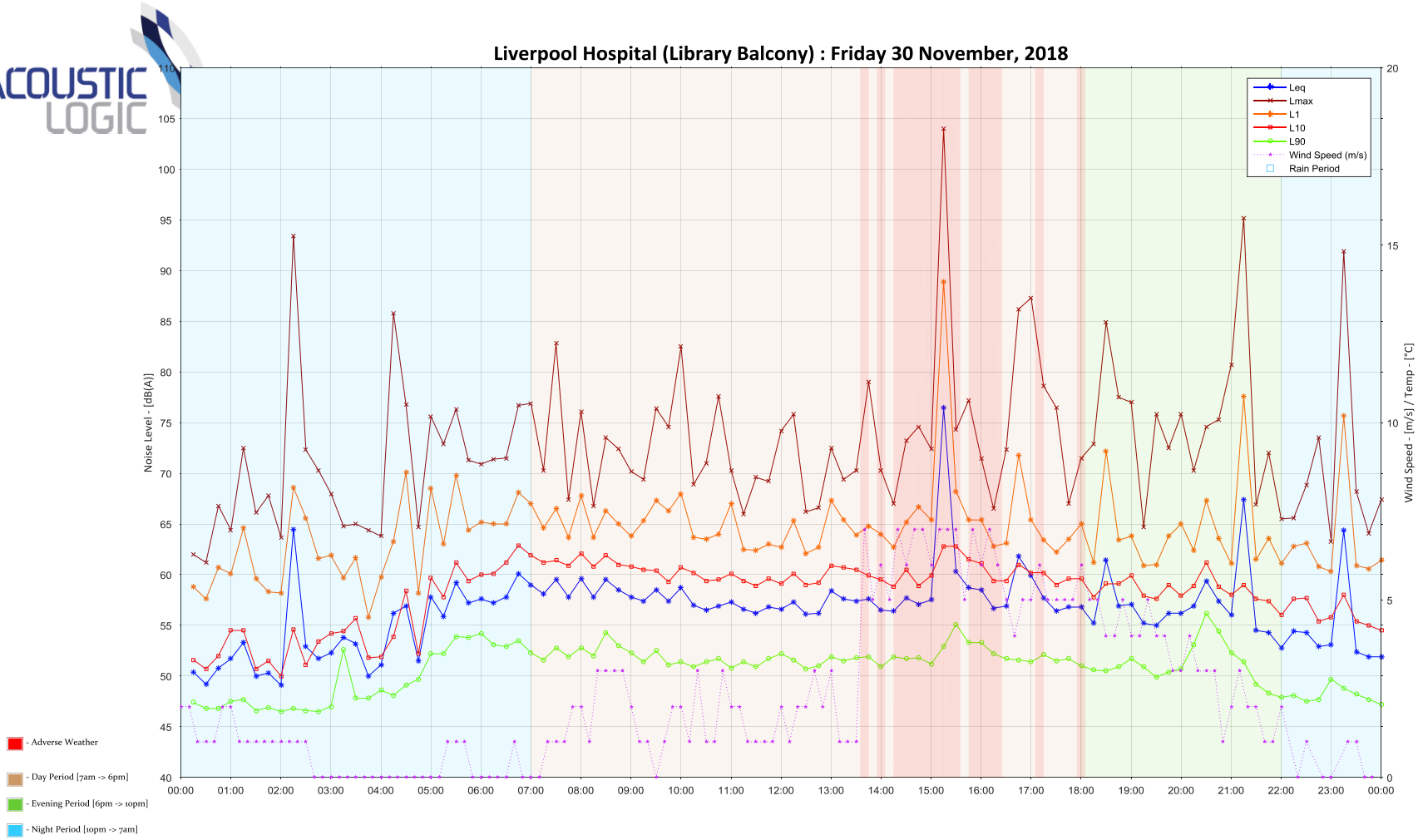
Acoustic Logic Consultancy Pty Ltd
Shane Nichols

APPENDIX 1 – UNATTENDED TRAFFIC NOISE MONITORING DATA (LOCATION 1)

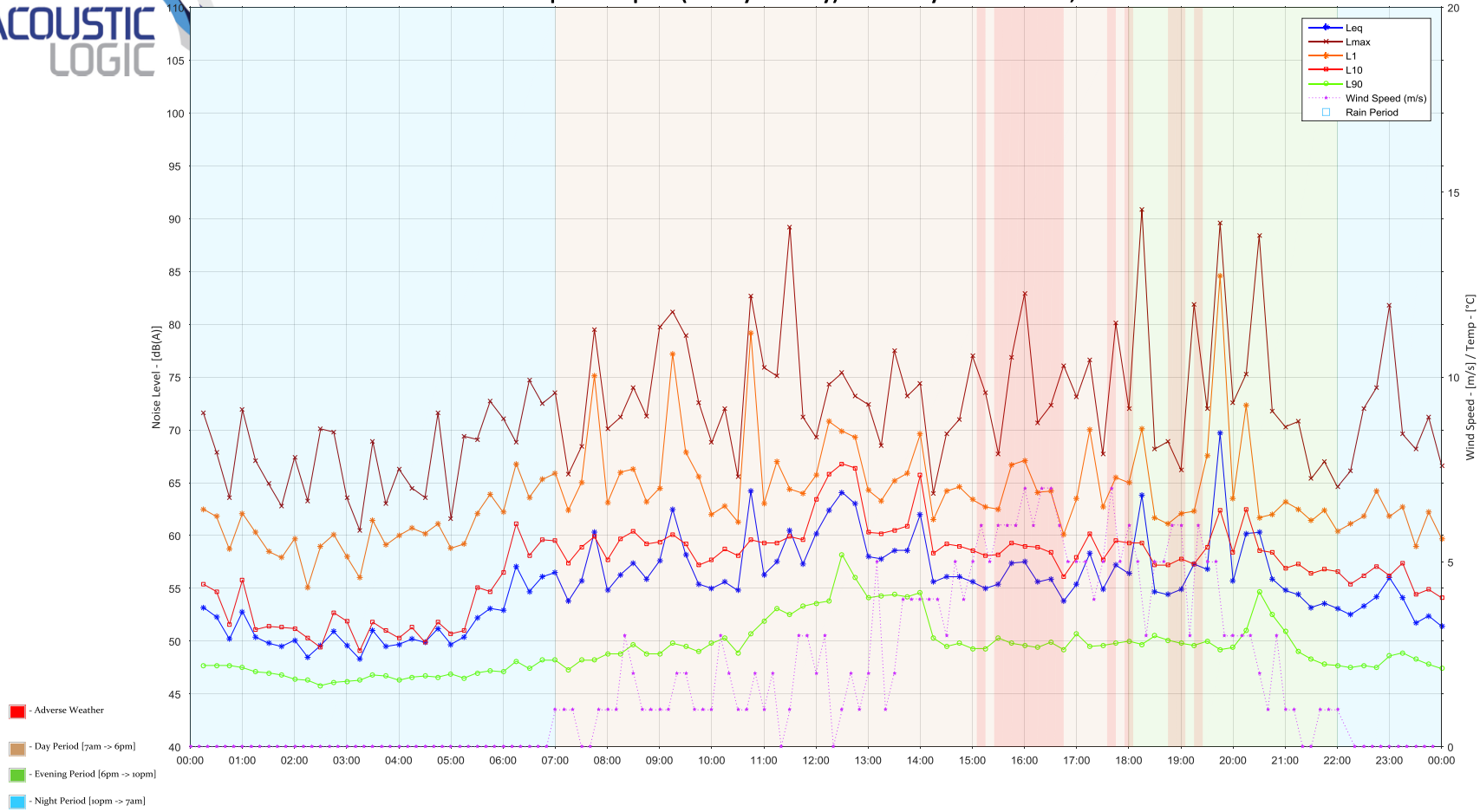
Liverpool Hospital (Library Balcony) : Wednesday 28 November, 2018



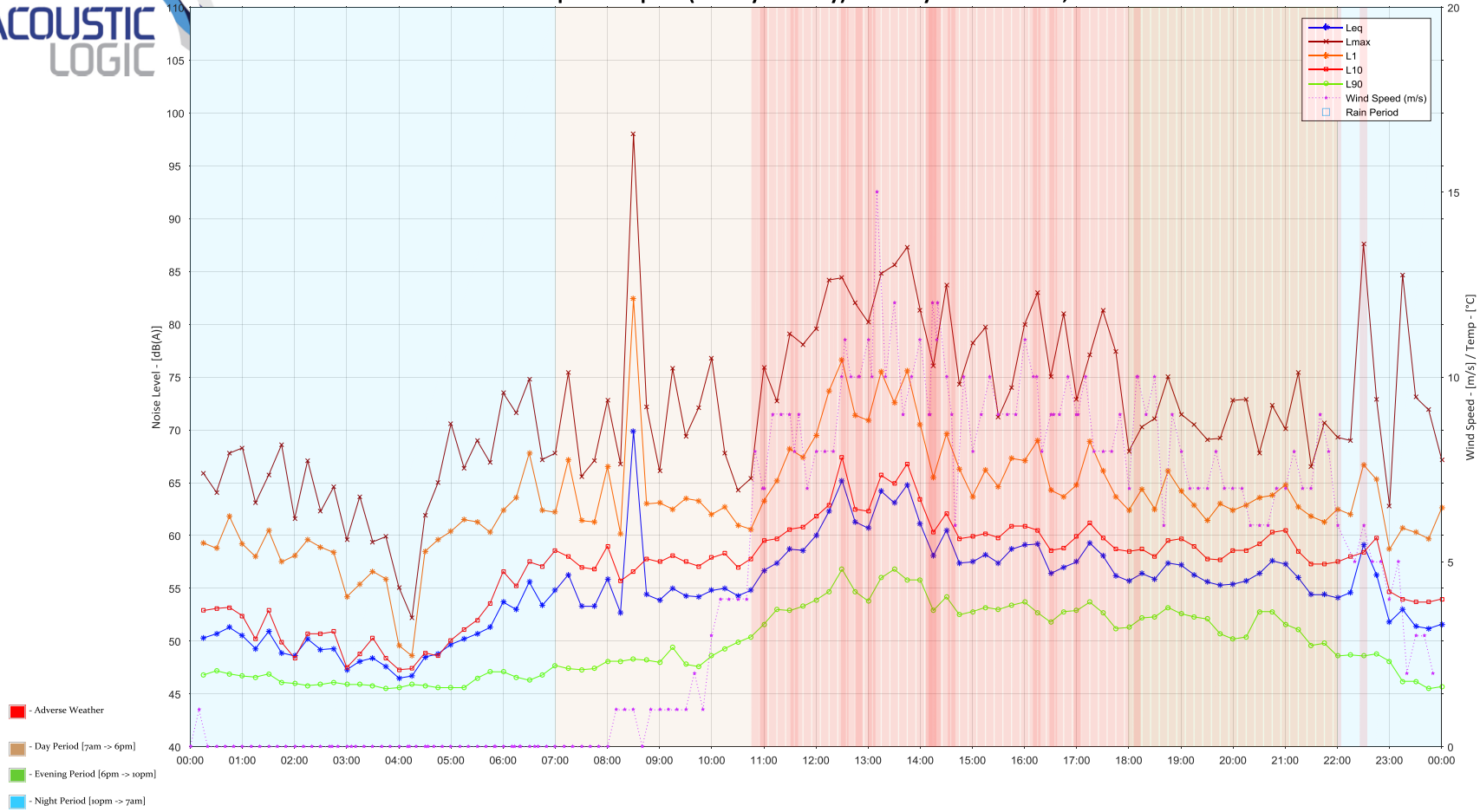

Liverpool Hospital (Library Balcony) : Thursday 29 November, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

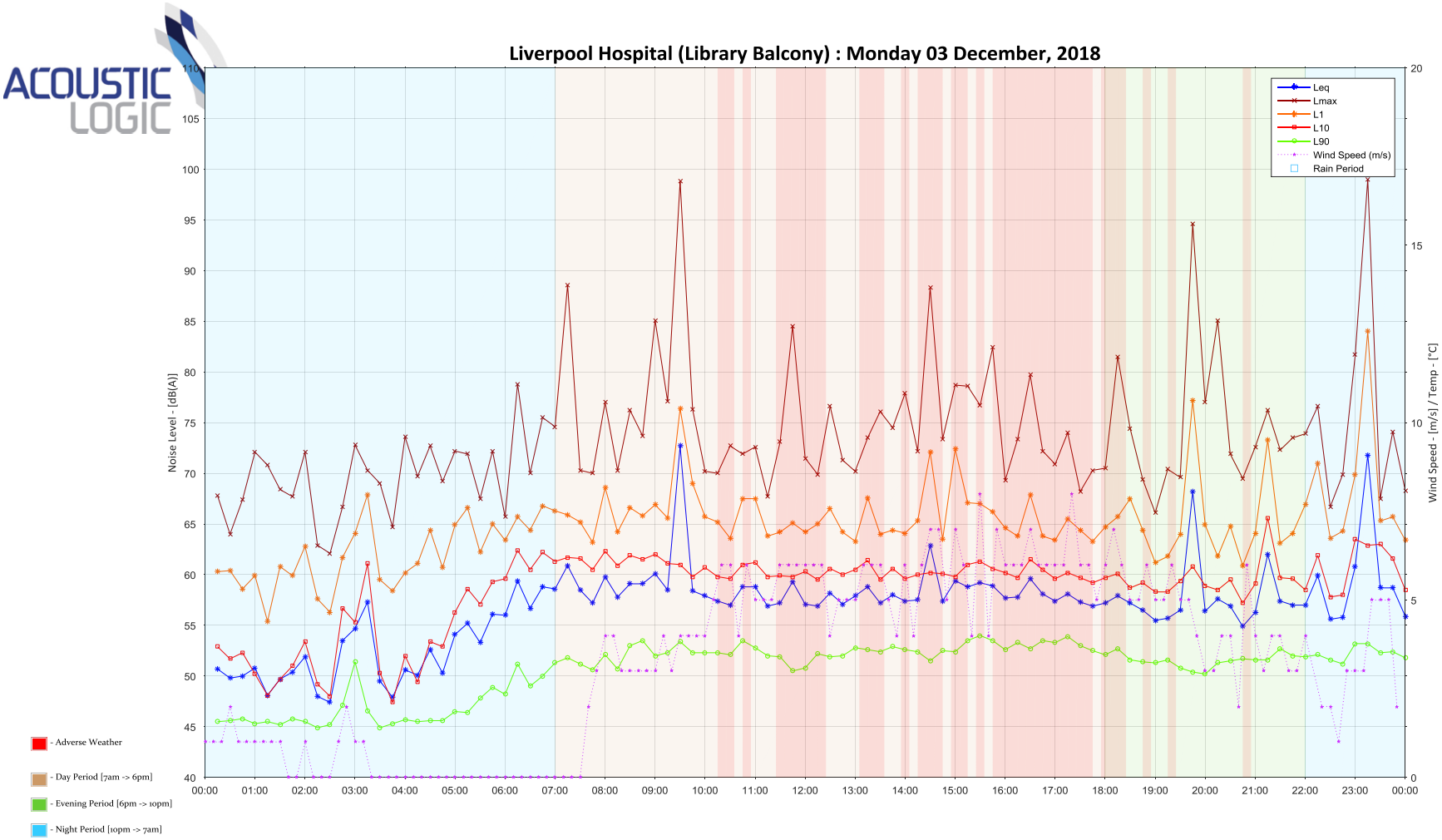

Liverpool Hospital (Library Balcony) : Friday 30 November, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

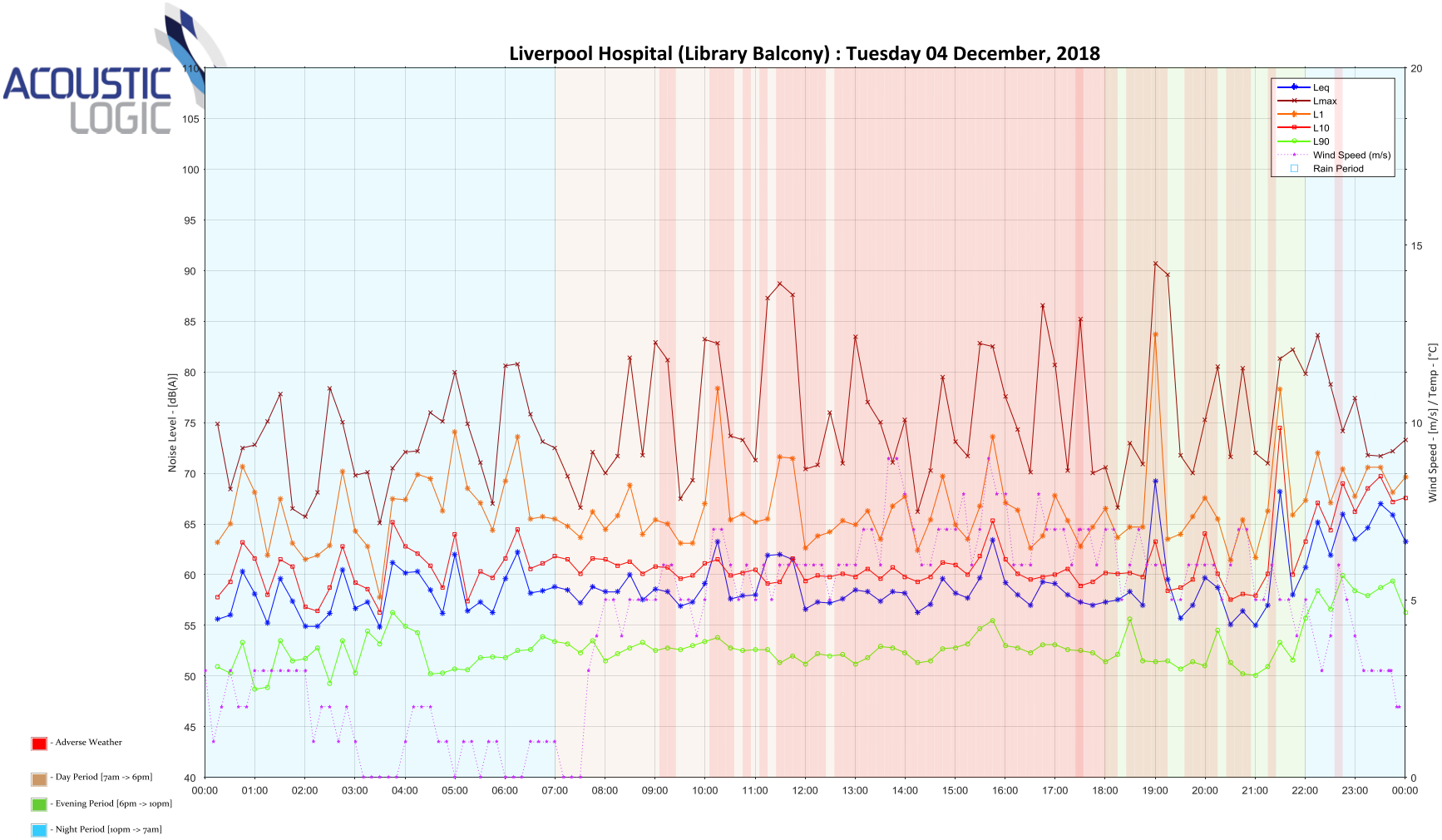
Liverpool Hospital (Library Balcony) : Saturday 01 December, 2018



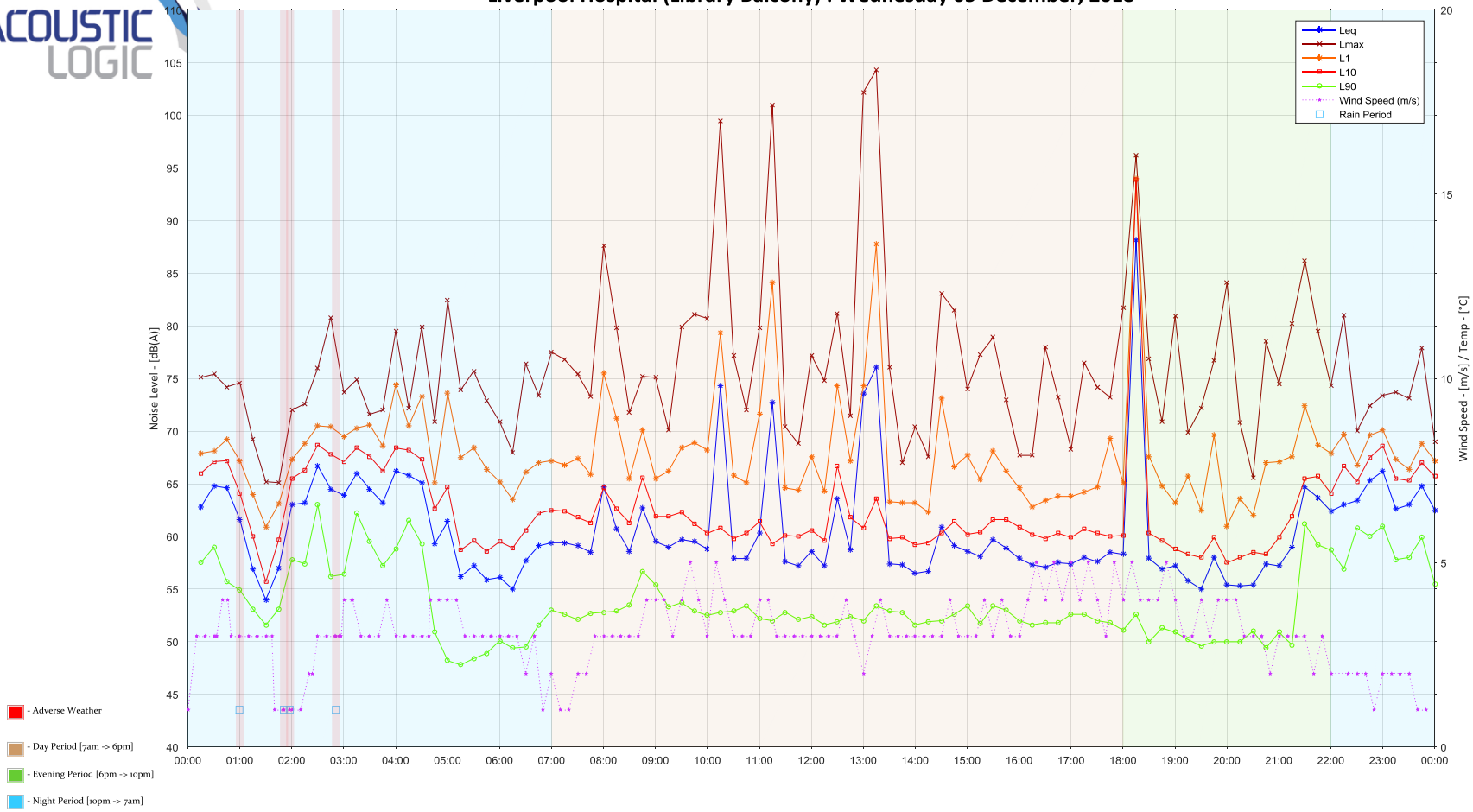
Liverpool Hospital (Library Balcony) : Sunday 02 December, 2018

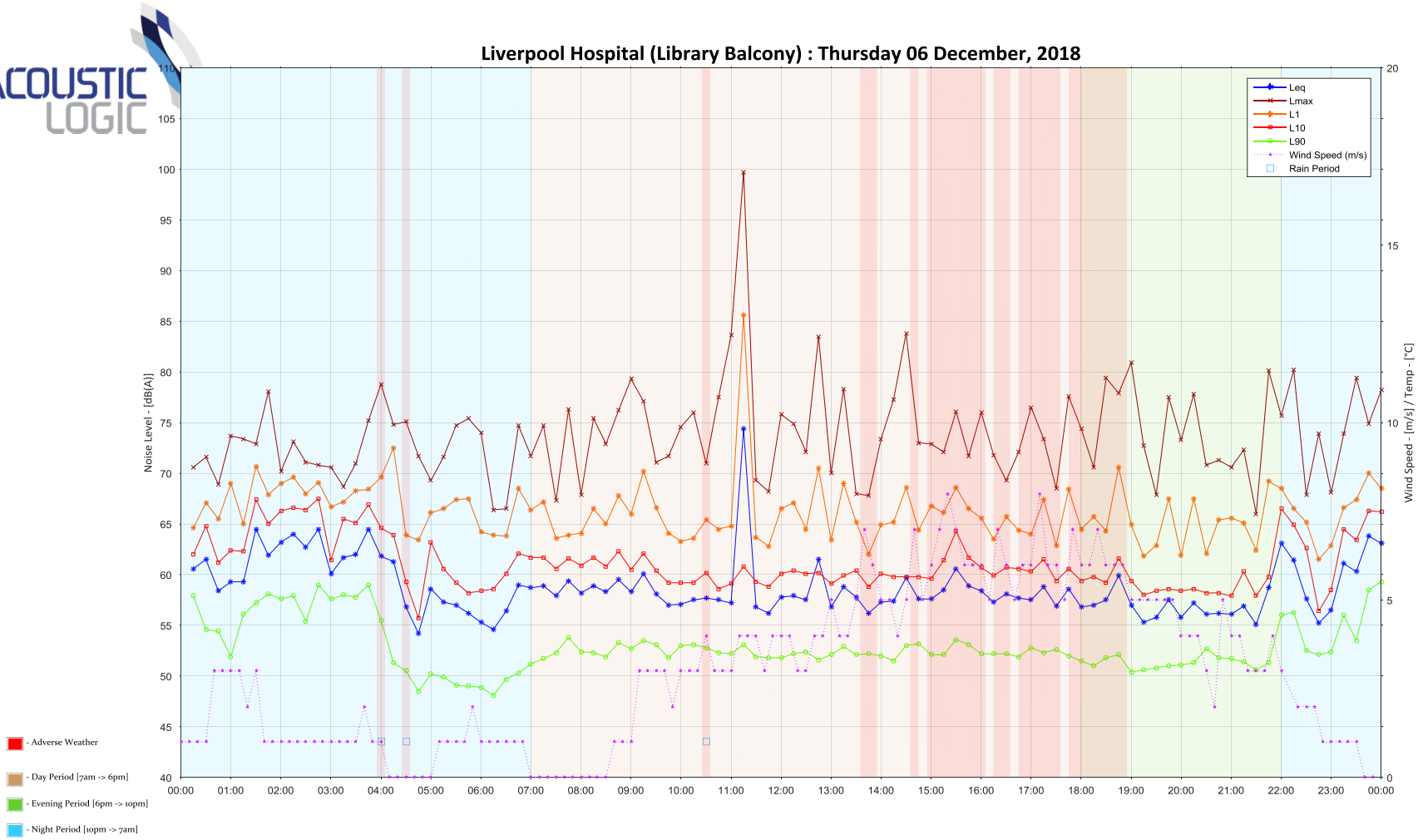


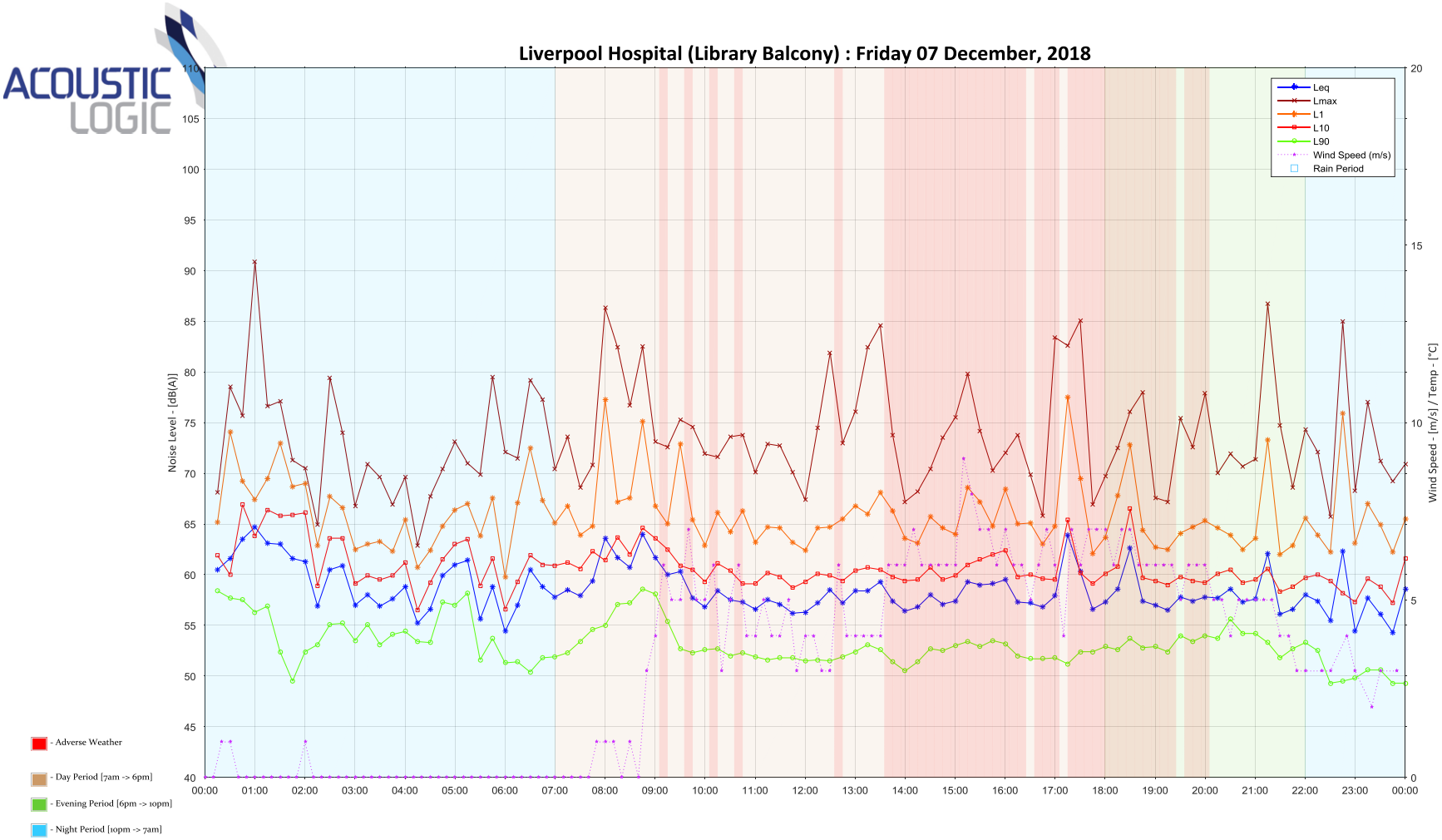

Liverpool Hospital (Library Balcony) : Monday 03 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Liverpool Hospital (Library Balcony) : Tuesday 04 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

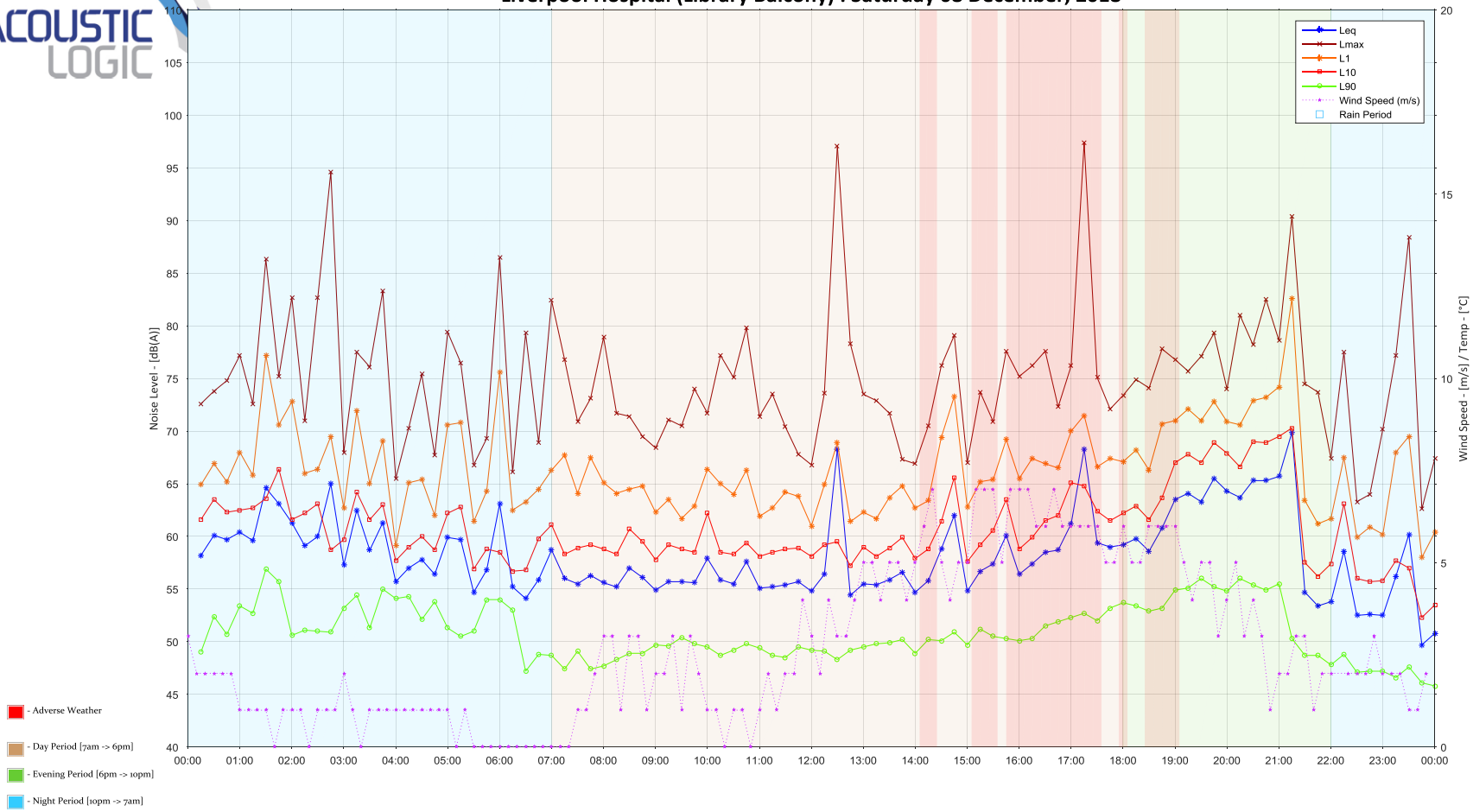
Liverpool Hospital (Library Balcony) : Wednesday 05 December, 2018

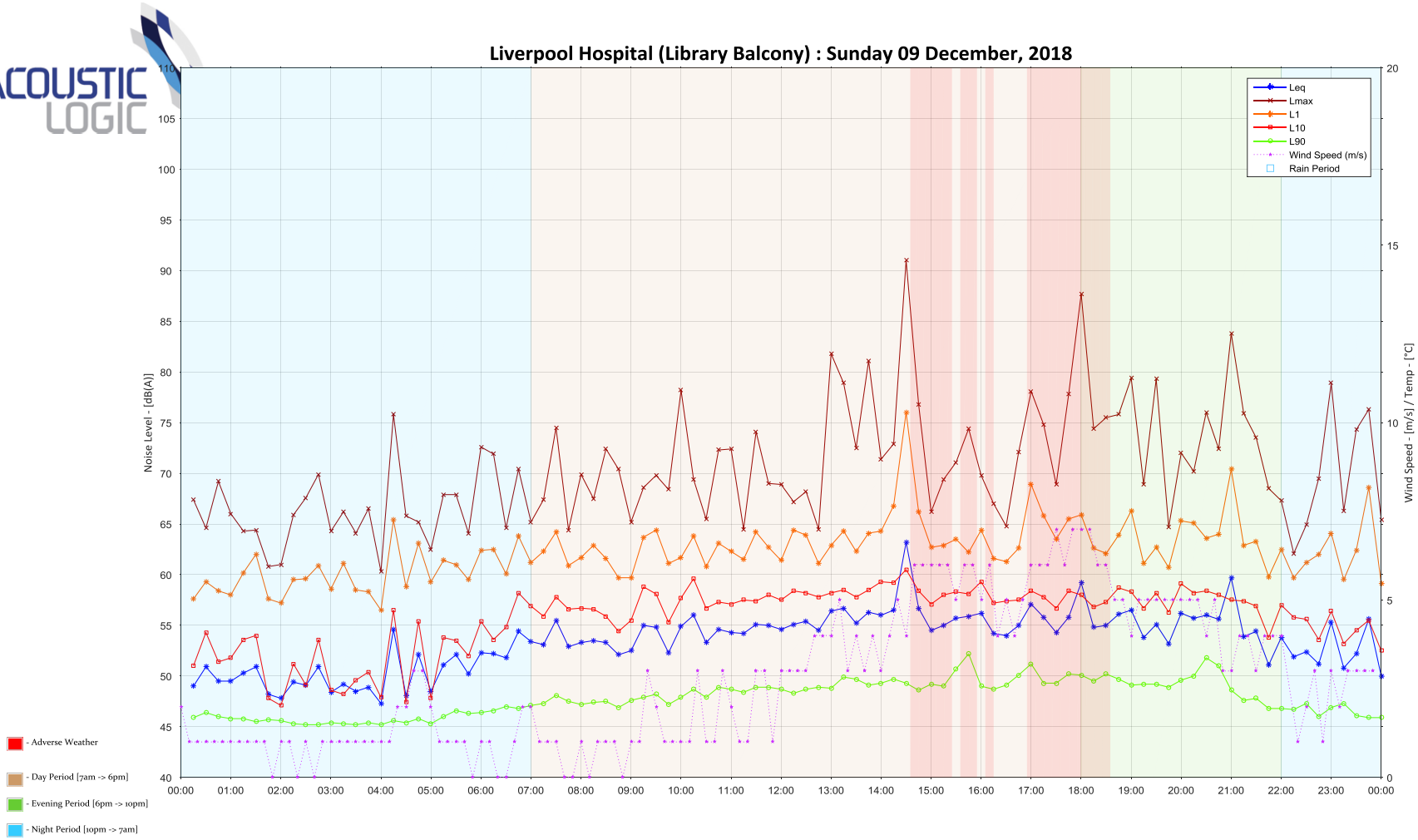


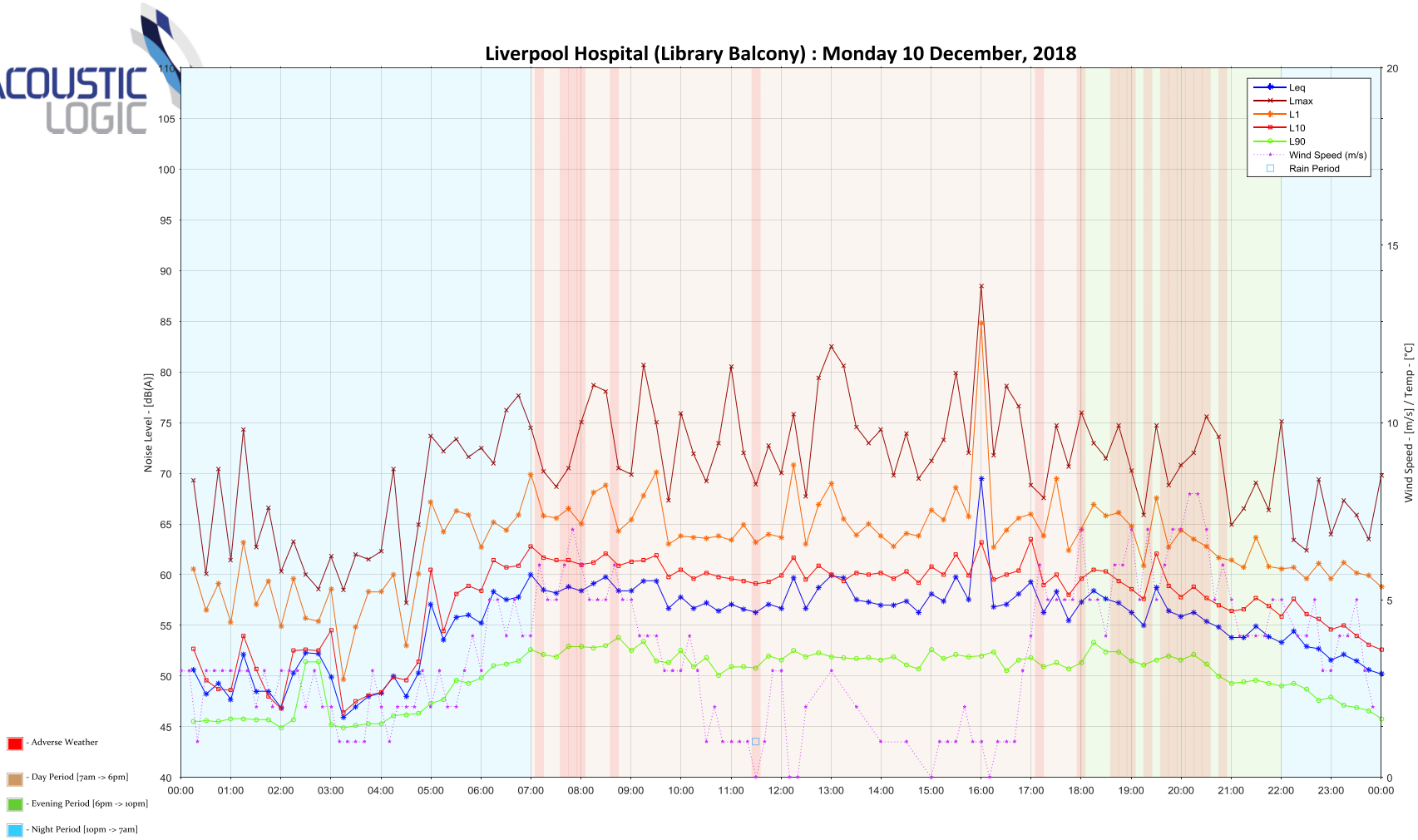

Liverpool Hospital (Library Balcony) : Thursday 06 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Liverpool Hospital (Library Balcony) : Friday 07 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

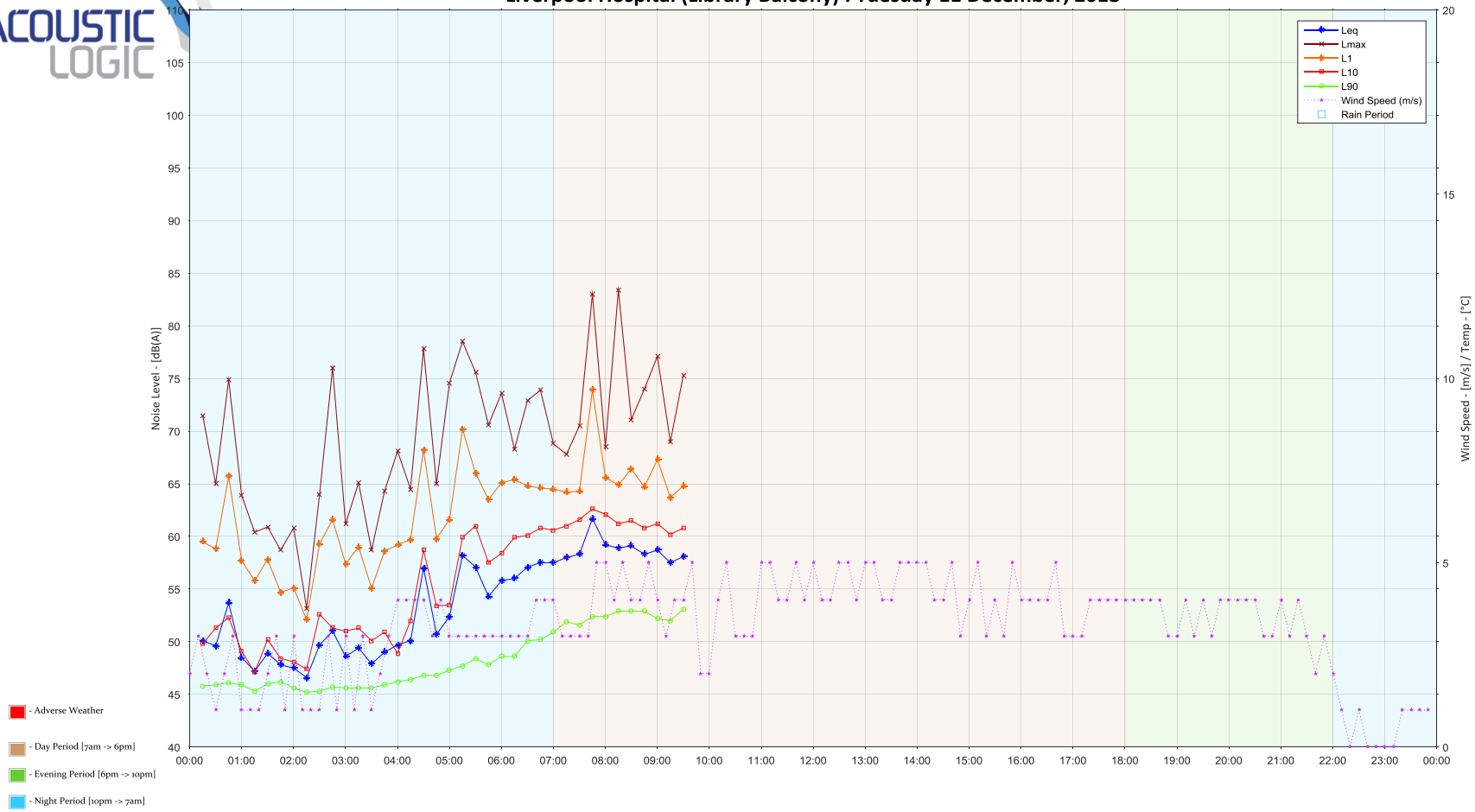
Liverpool Hospital (Library Balcony) : Saturday 08 December, 2018



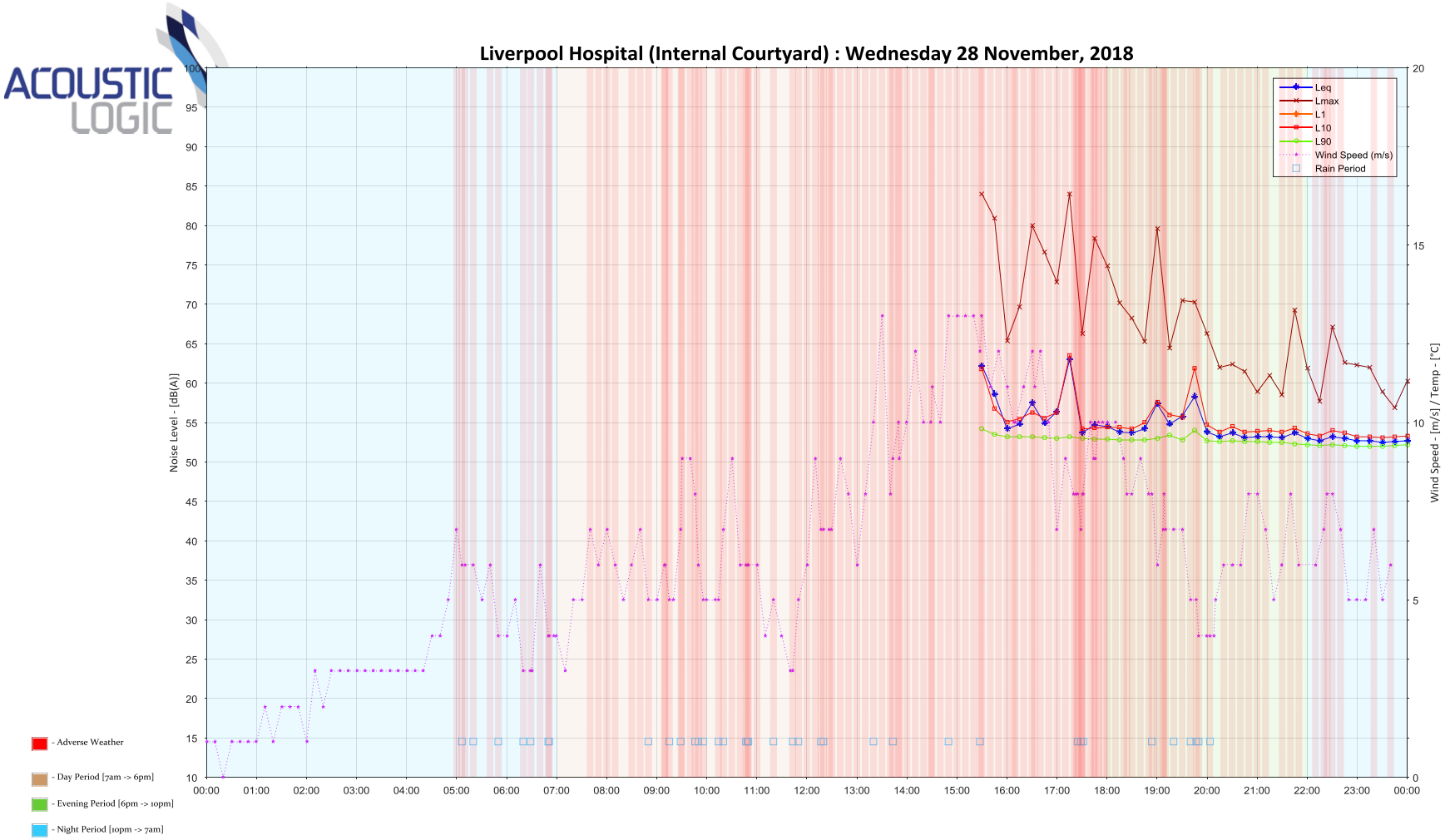

Liverpool Hospital (Library Balcony) : Sunday 09 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

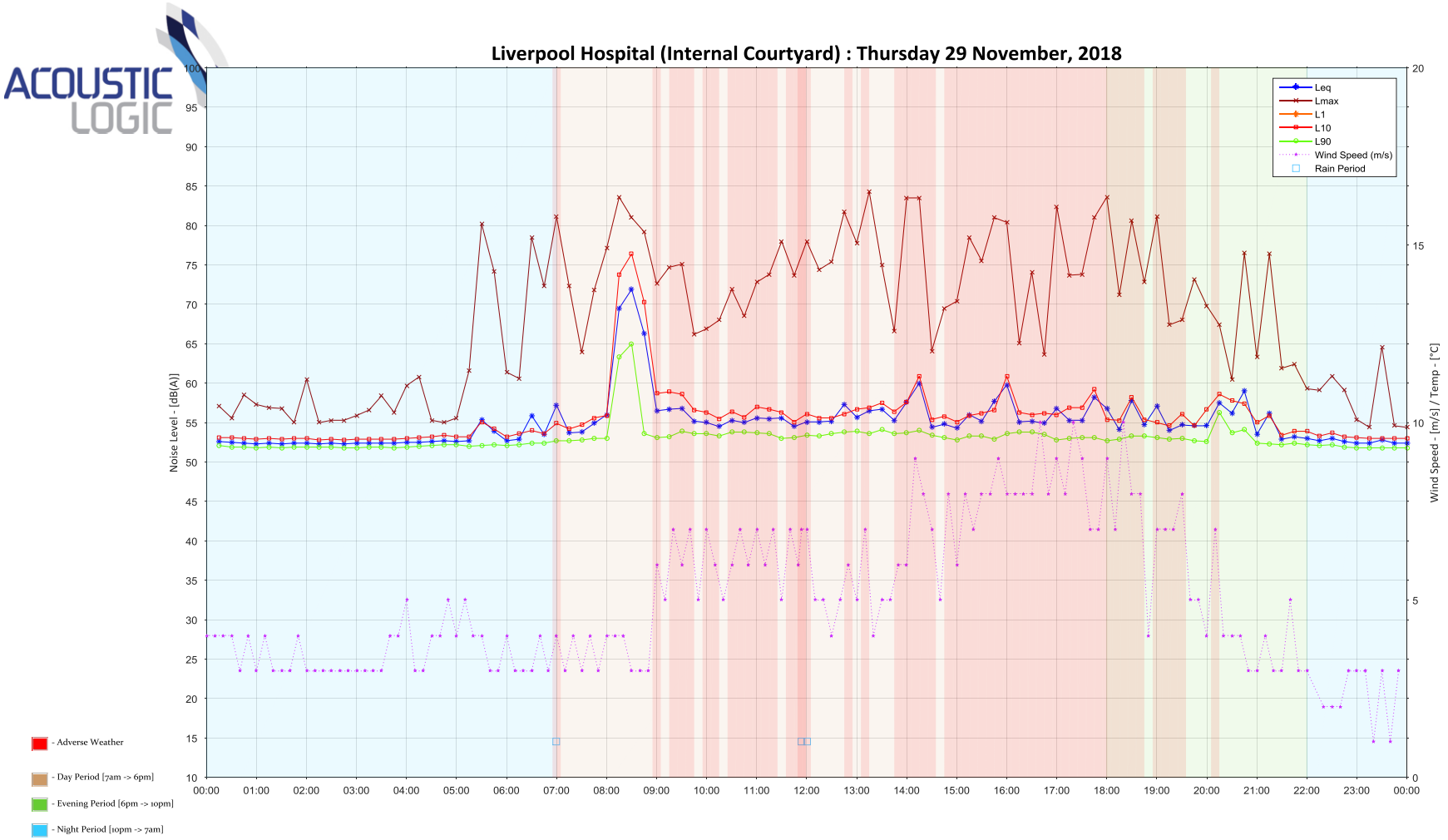

Liverpool Hospital (Library Balcony) : Monday 10 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

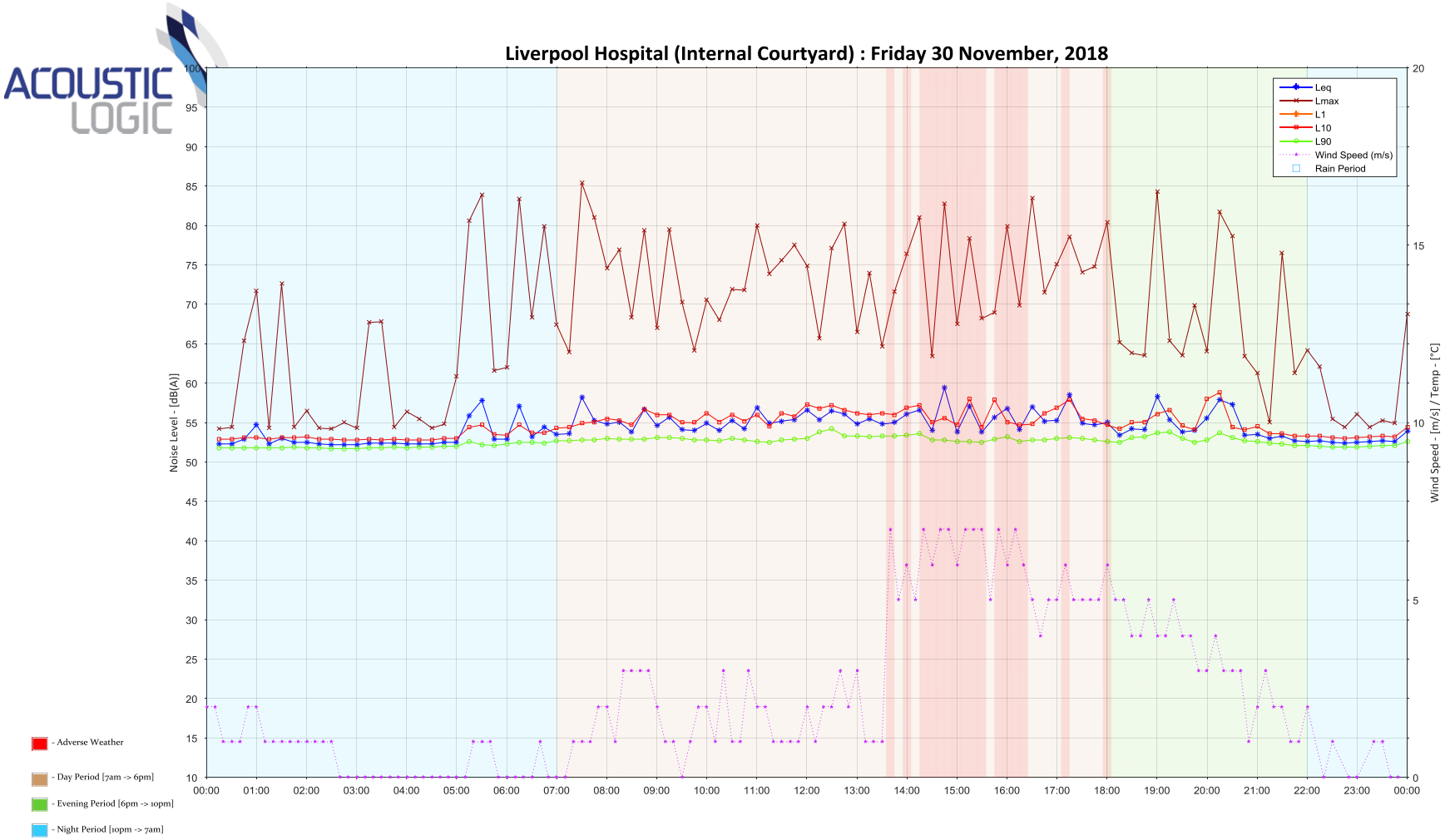
Liverpool Hospital (Library Balcony) : Tuesday 11 December, 2018

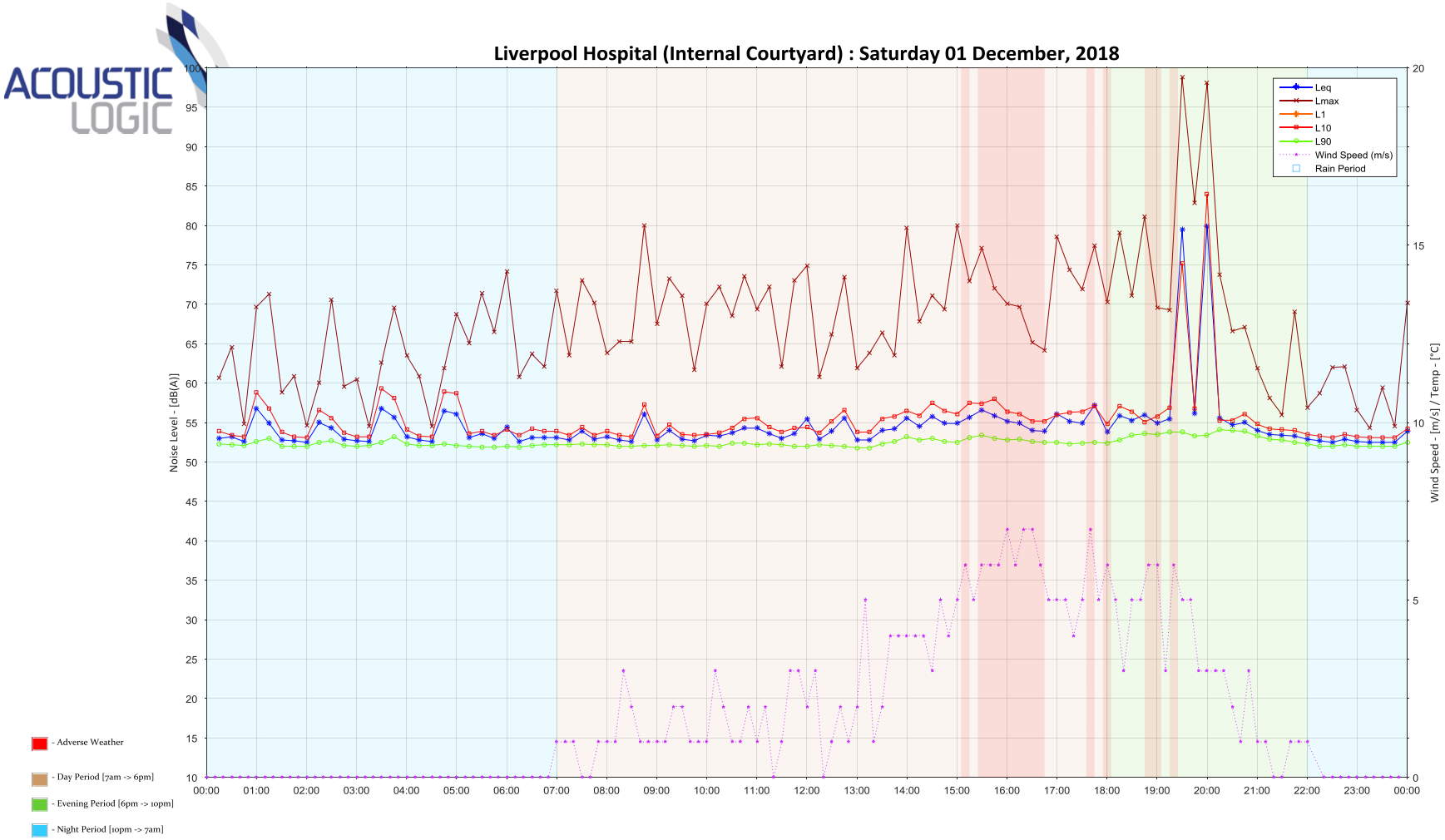


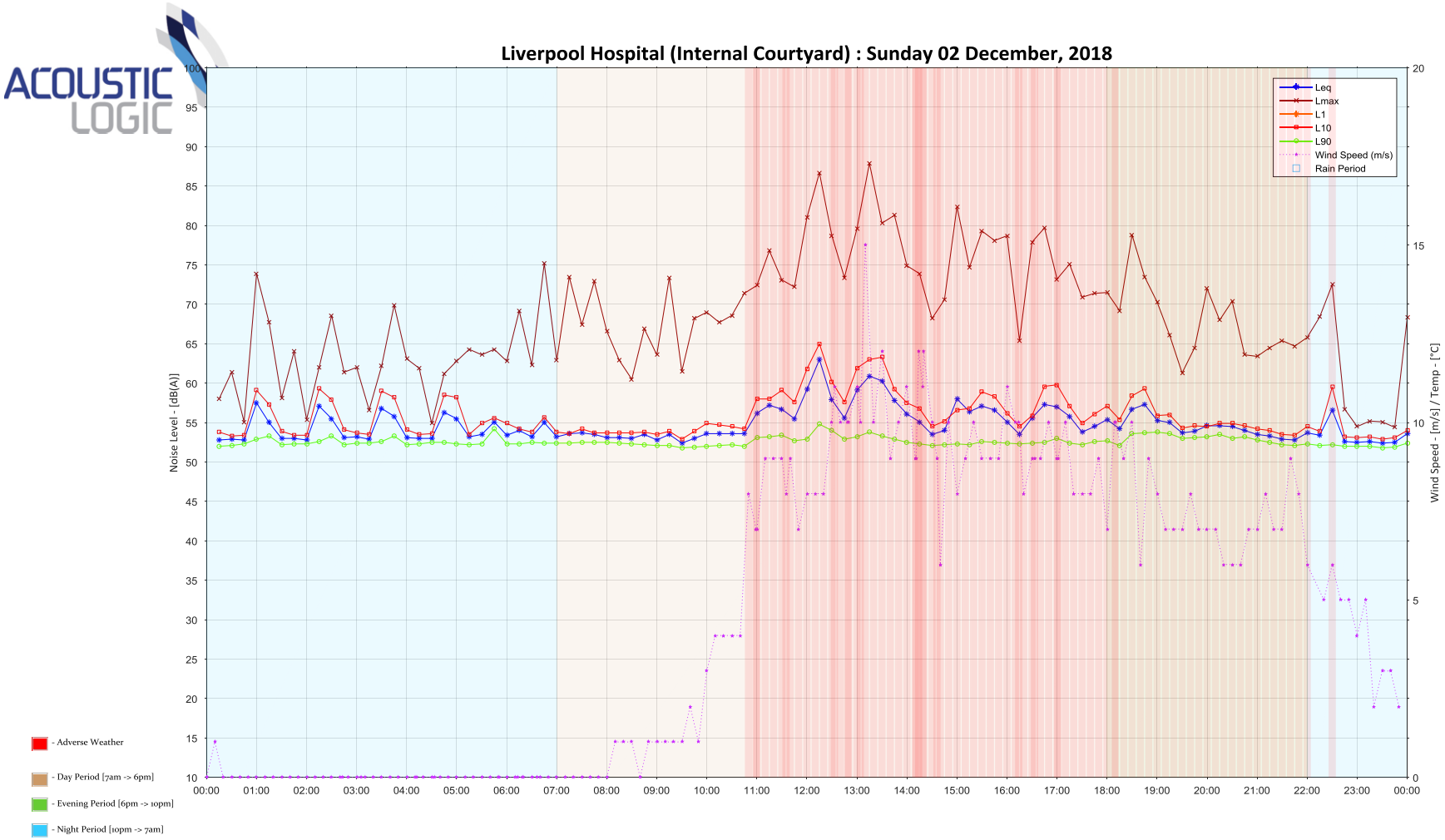
APPENDIX 2 – UNATTENDED BACKGROUND NOISE MONITORING DATA (LOCATION 2)

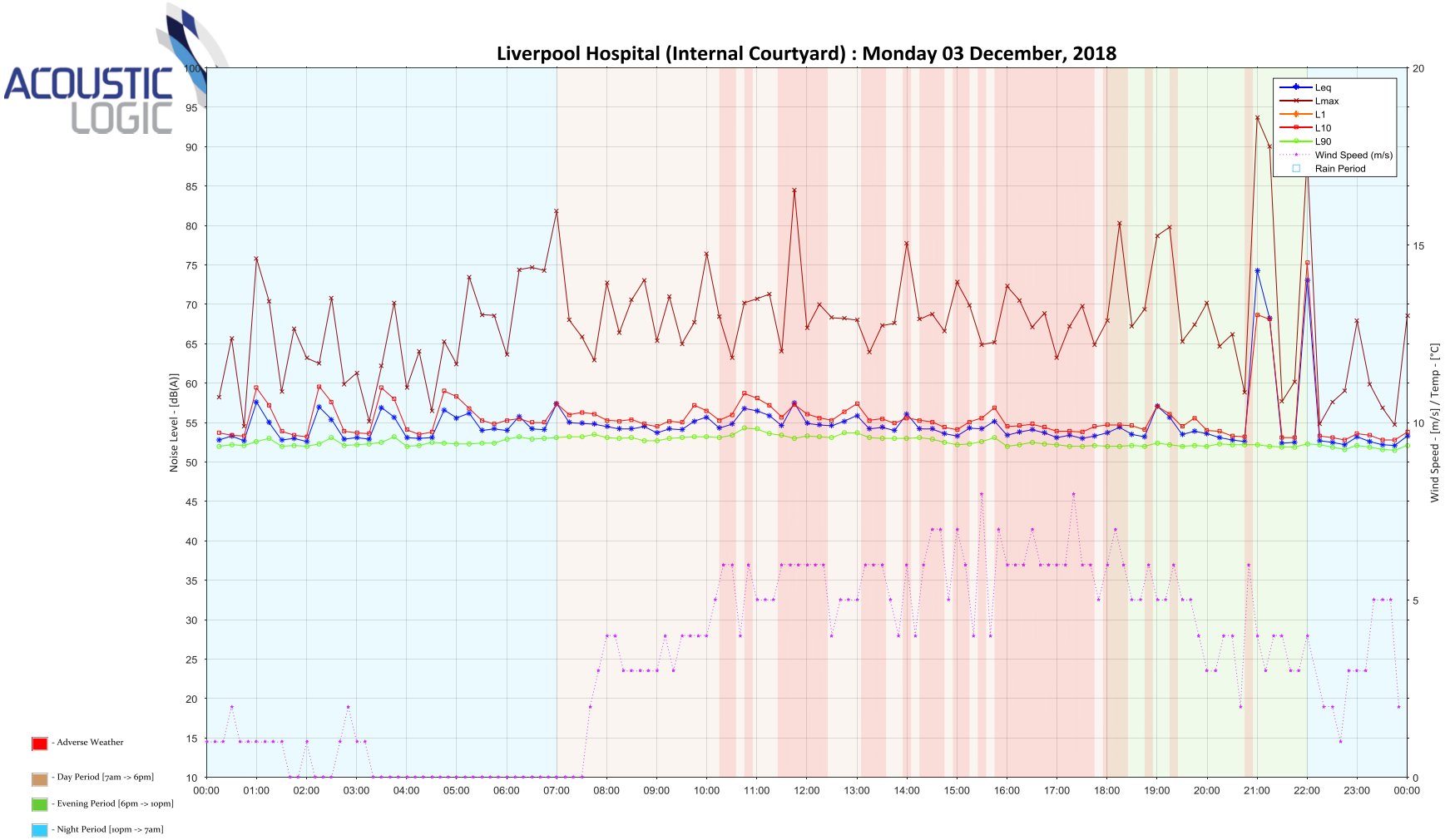

Liverpool Hospital (Internal Courtyard) : Wednesday 28 November, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

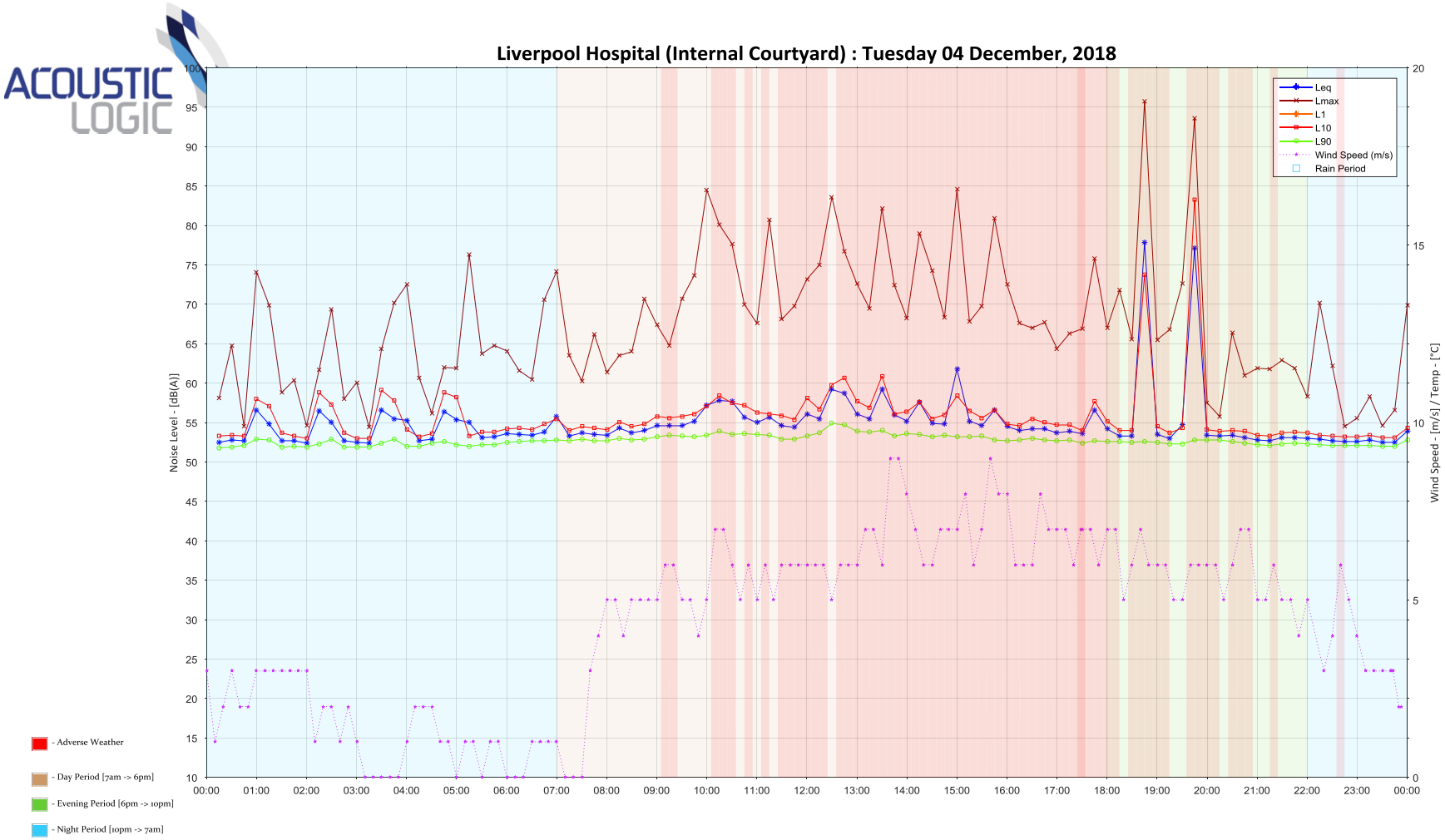

Liverpool Hospital (Internal Courtyard) : Thursday 29 November, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

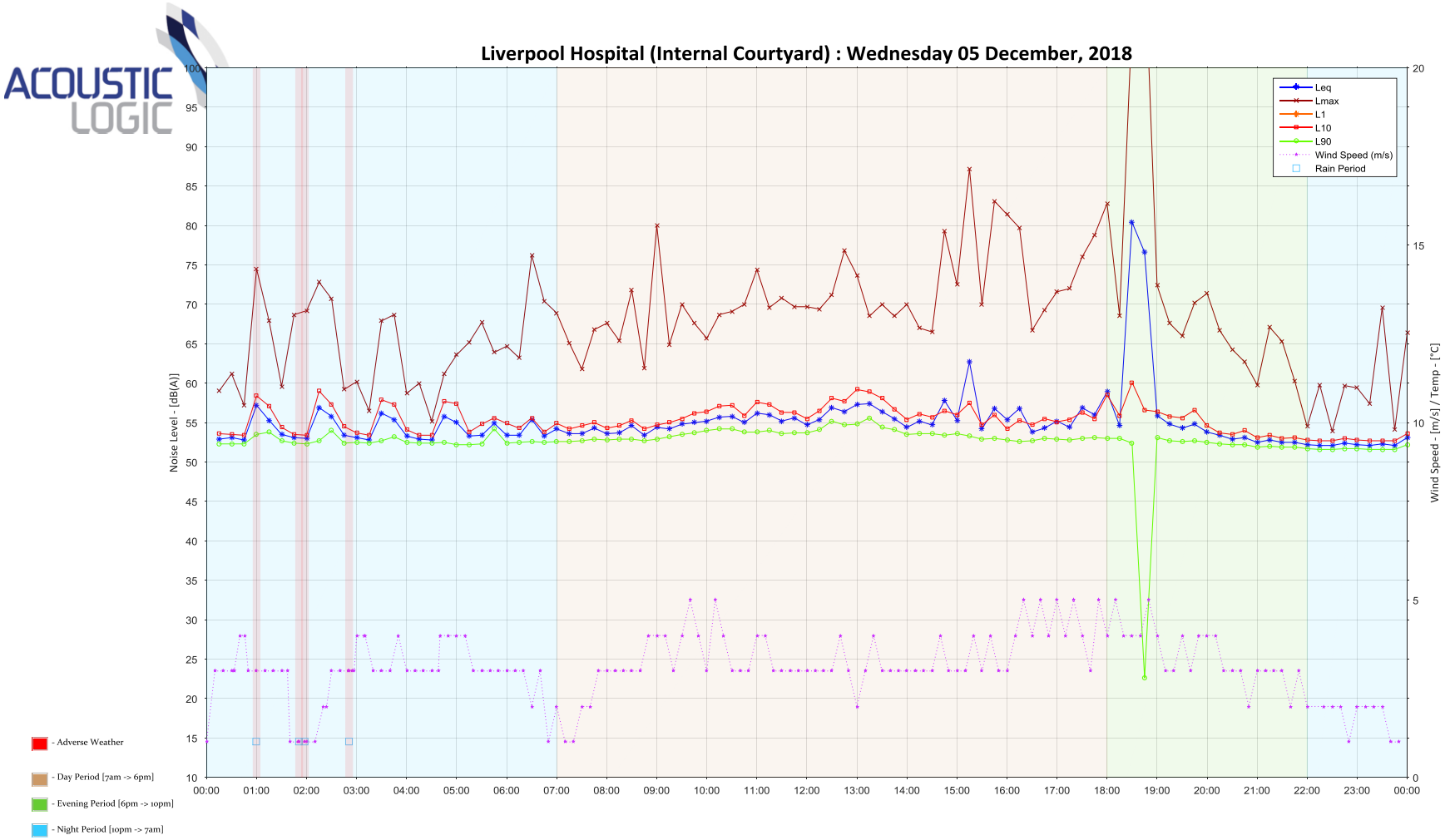

Liverpool Hospital (Internal Courtyard) : Friday 30 November, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

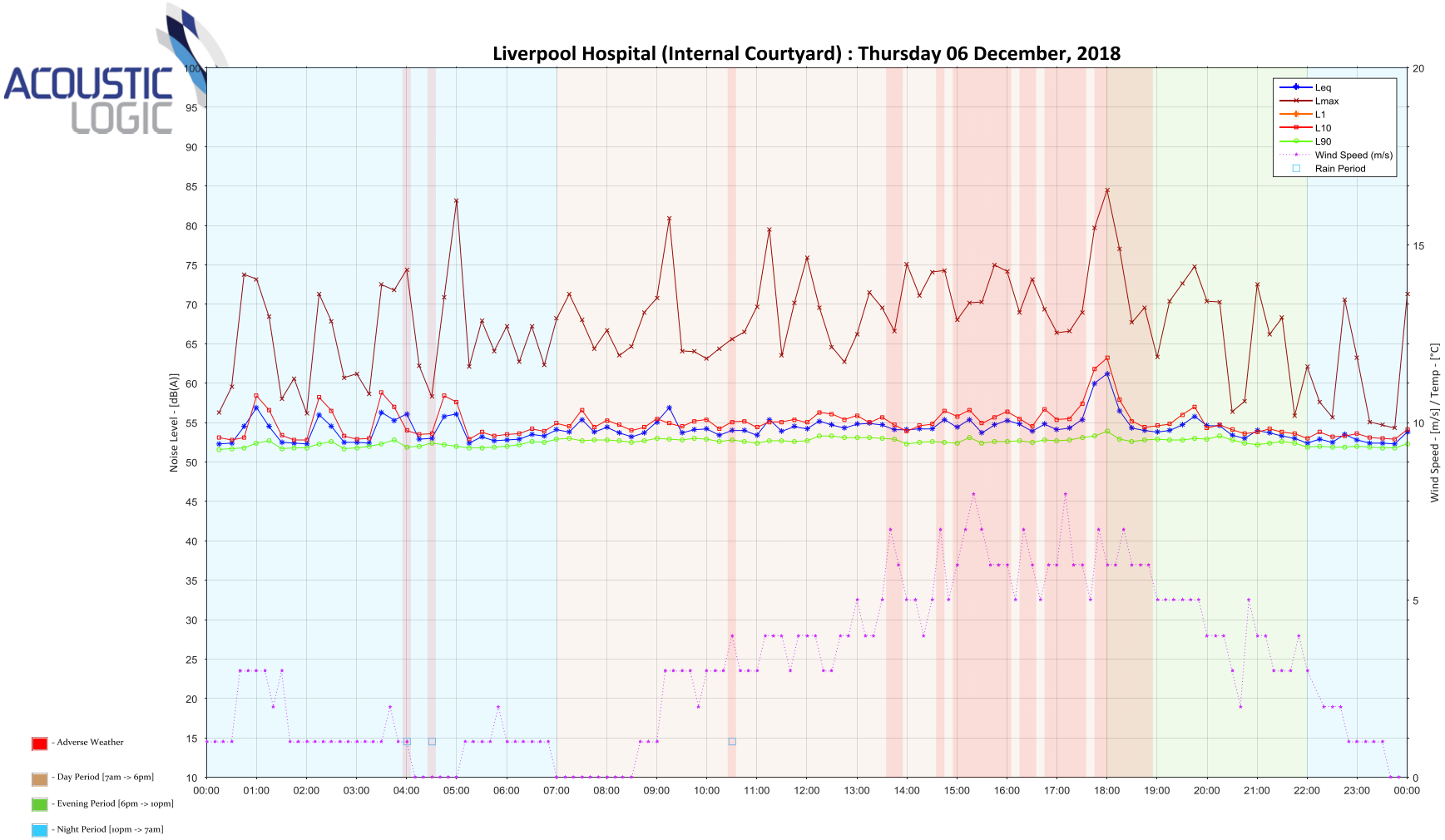

Liverpool Hospital (Internal Courtyard) : Saturday 01 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

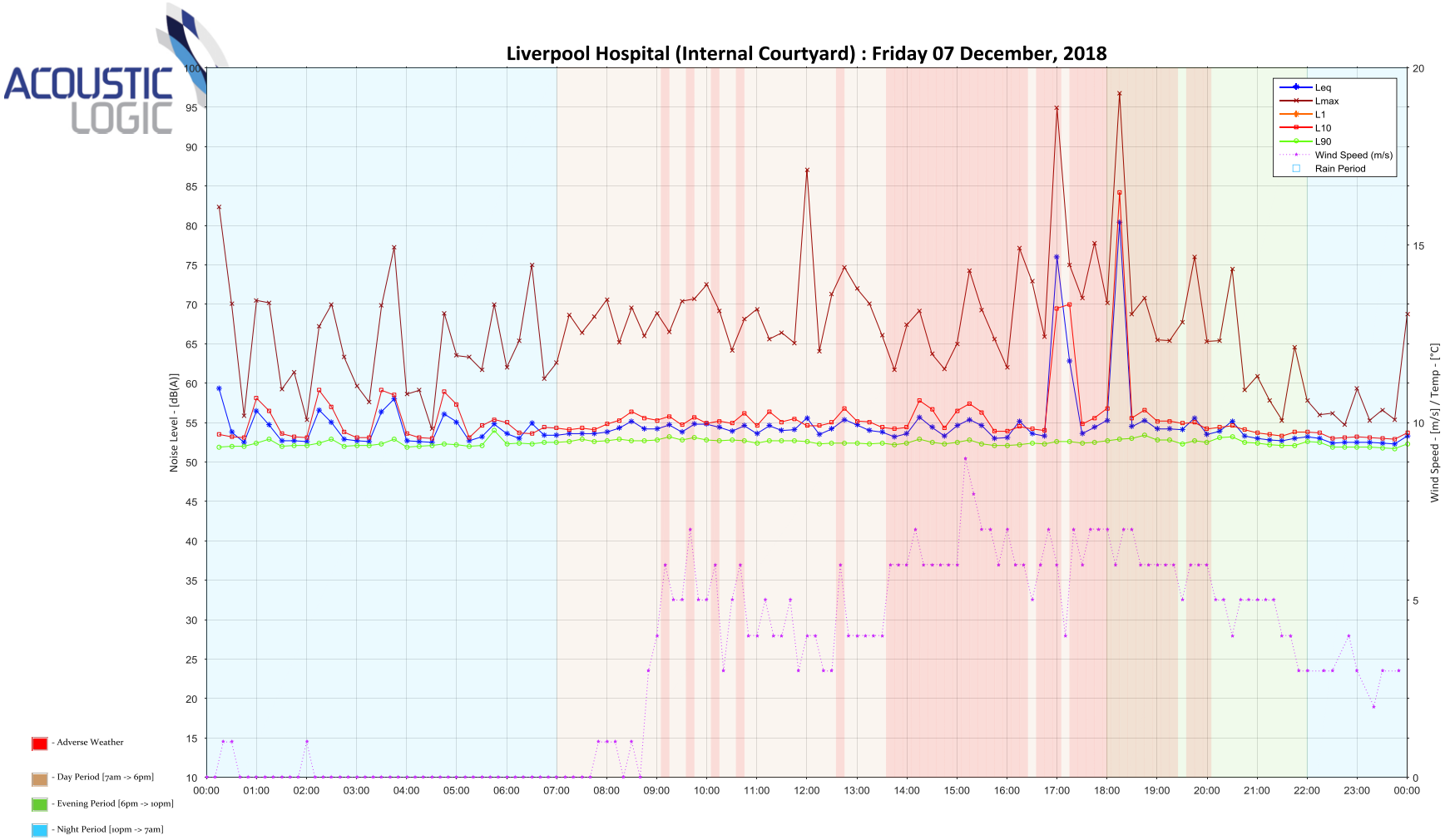

Liverpool Hospital (Internal Courtyard) : Sunday 02 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

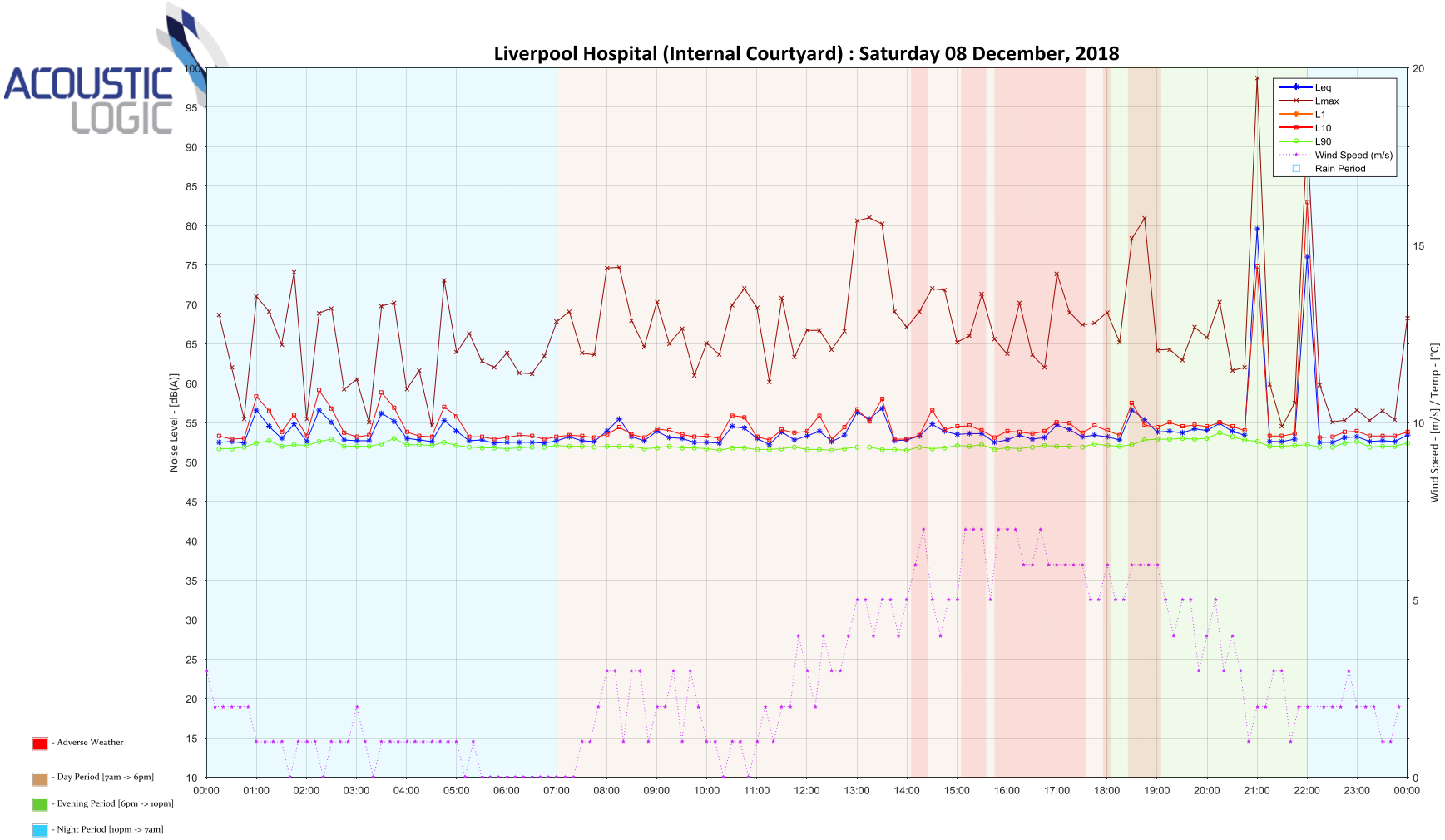

Liverpool Hospital (Internal Courtyard) : Monday 03 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

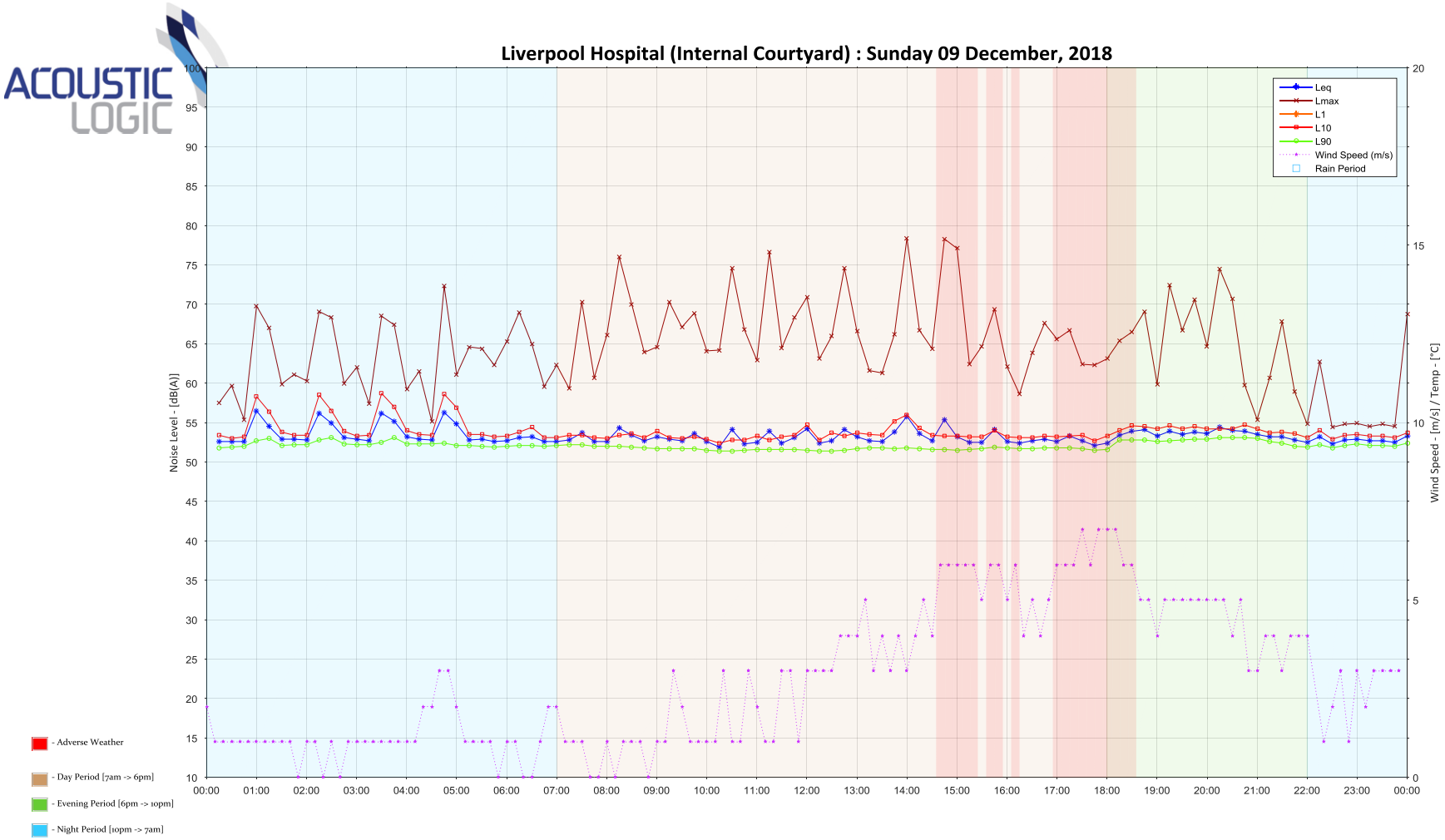

Liverpool Hospital (Internal Courtyard) : Tuesday 04 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

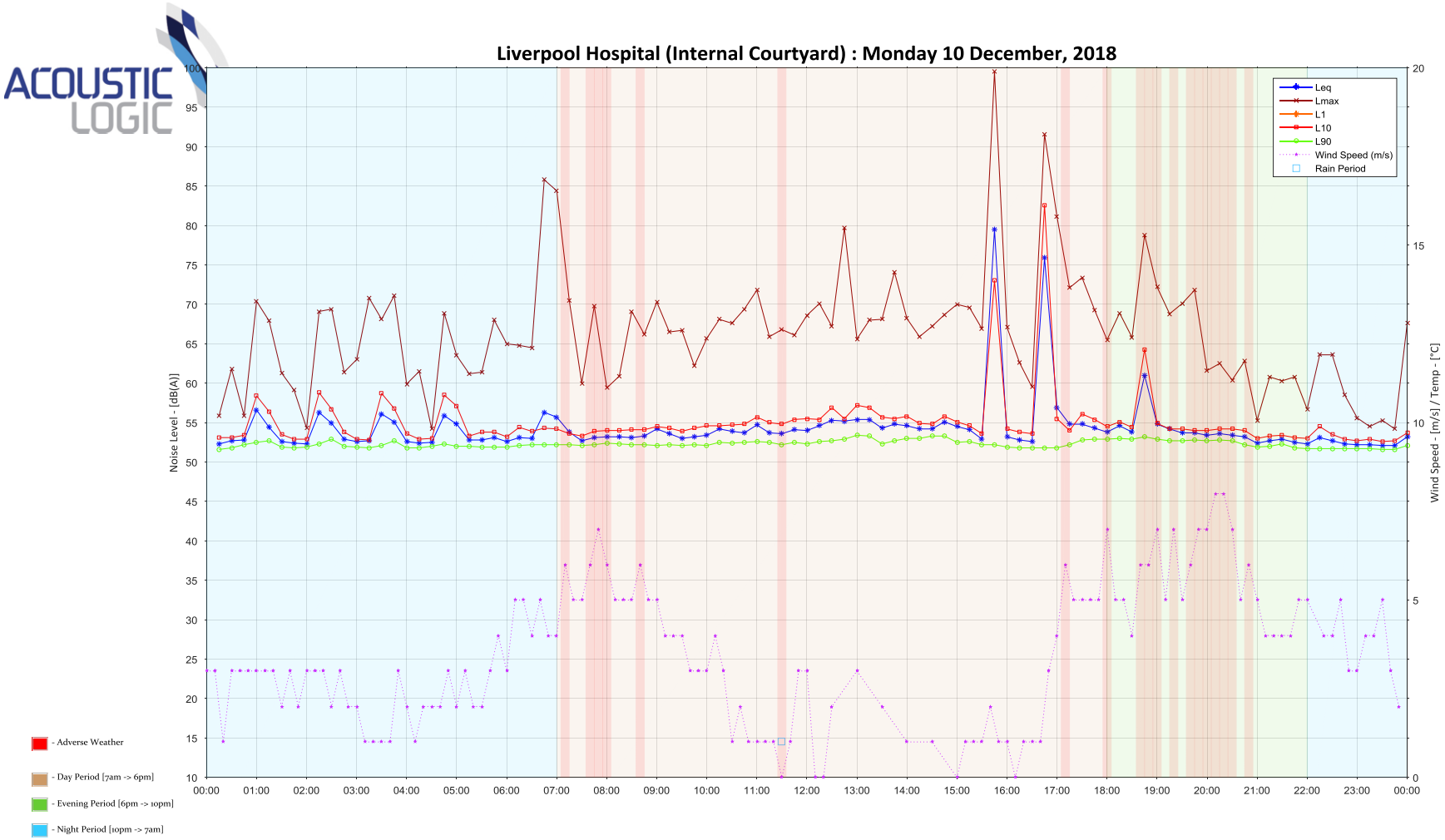

Liverpool Hospital (Internal Courtyard) : Wednesday 05 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

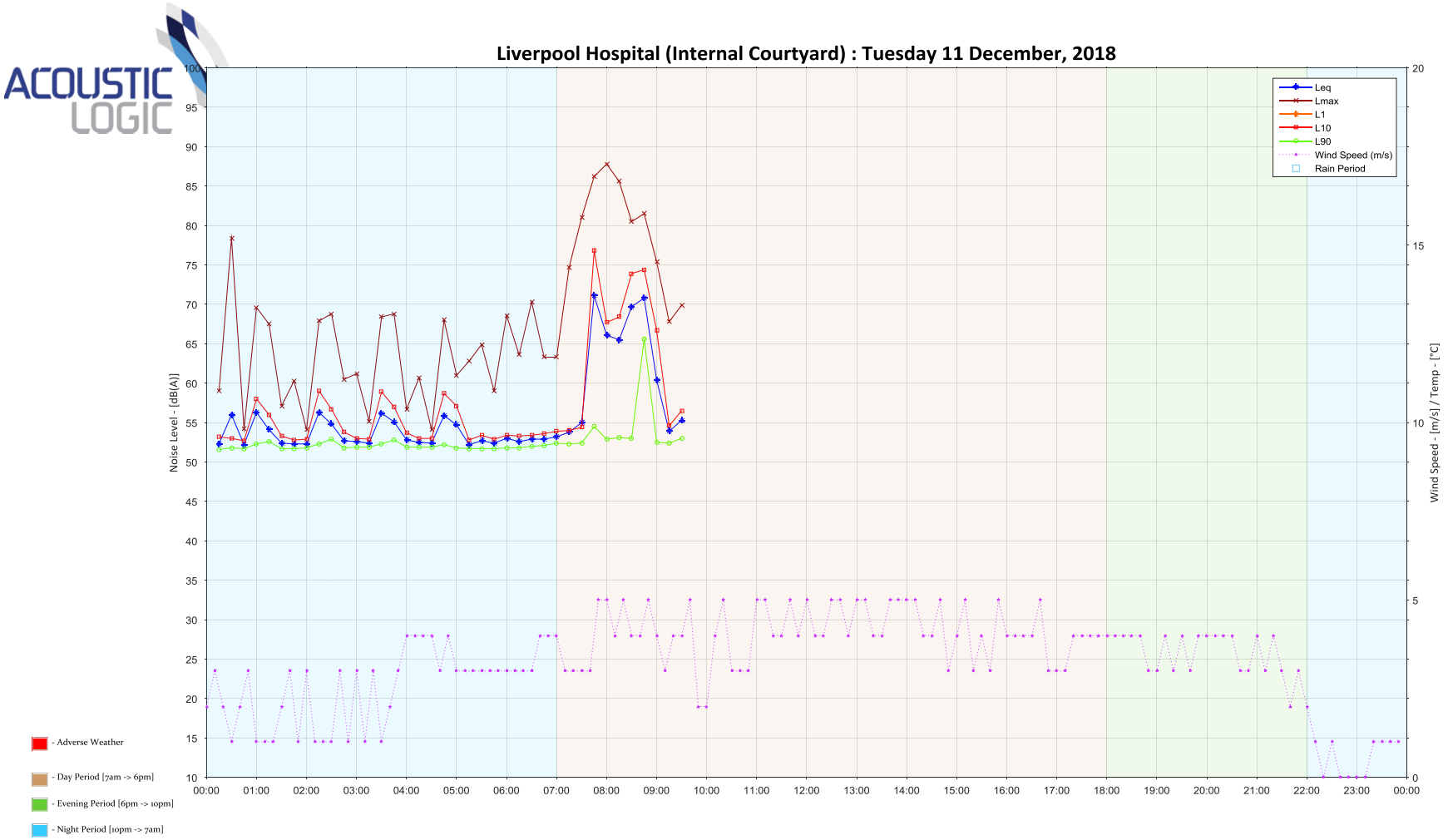

Liverpool Hospital (Internal Courtyard) : Thursday 06 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


Liverpool Hospital (Internal Courtyard) : Friday 07 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

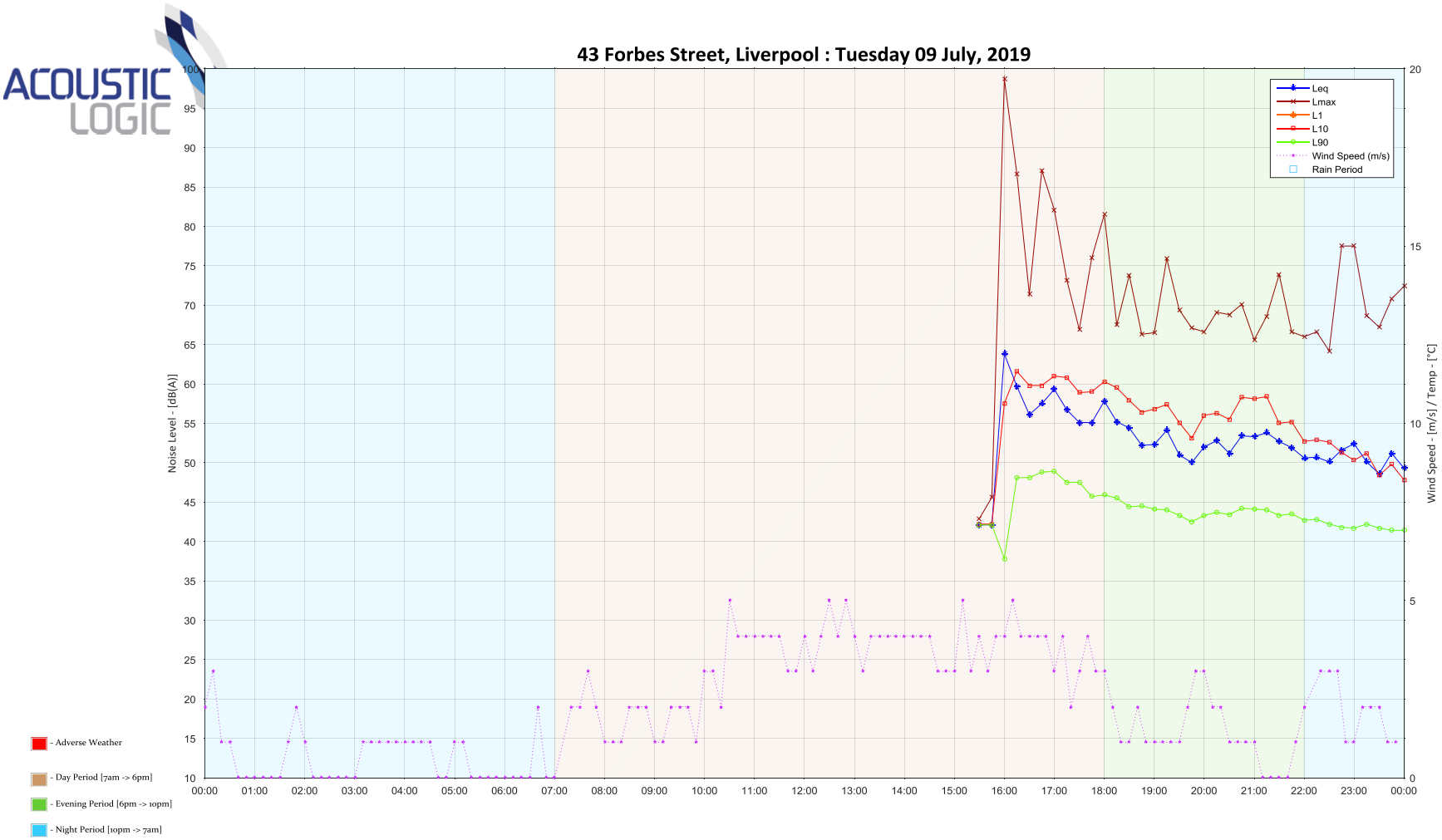

Liverpool Hospital (Internal Courtyard) : Saturday 08 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

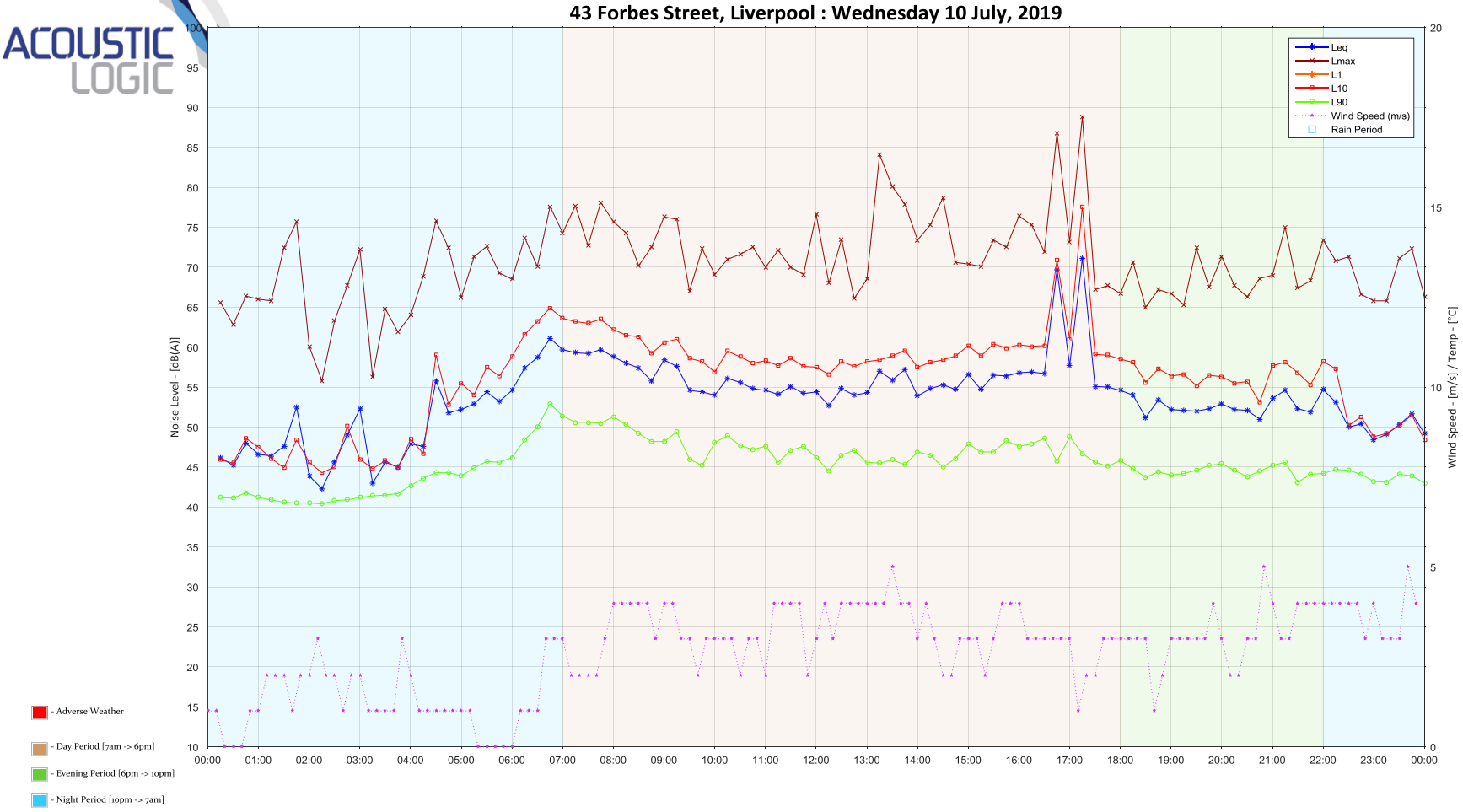

Liverpool Hospital (Internal Courtyard) : Sunday 09 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

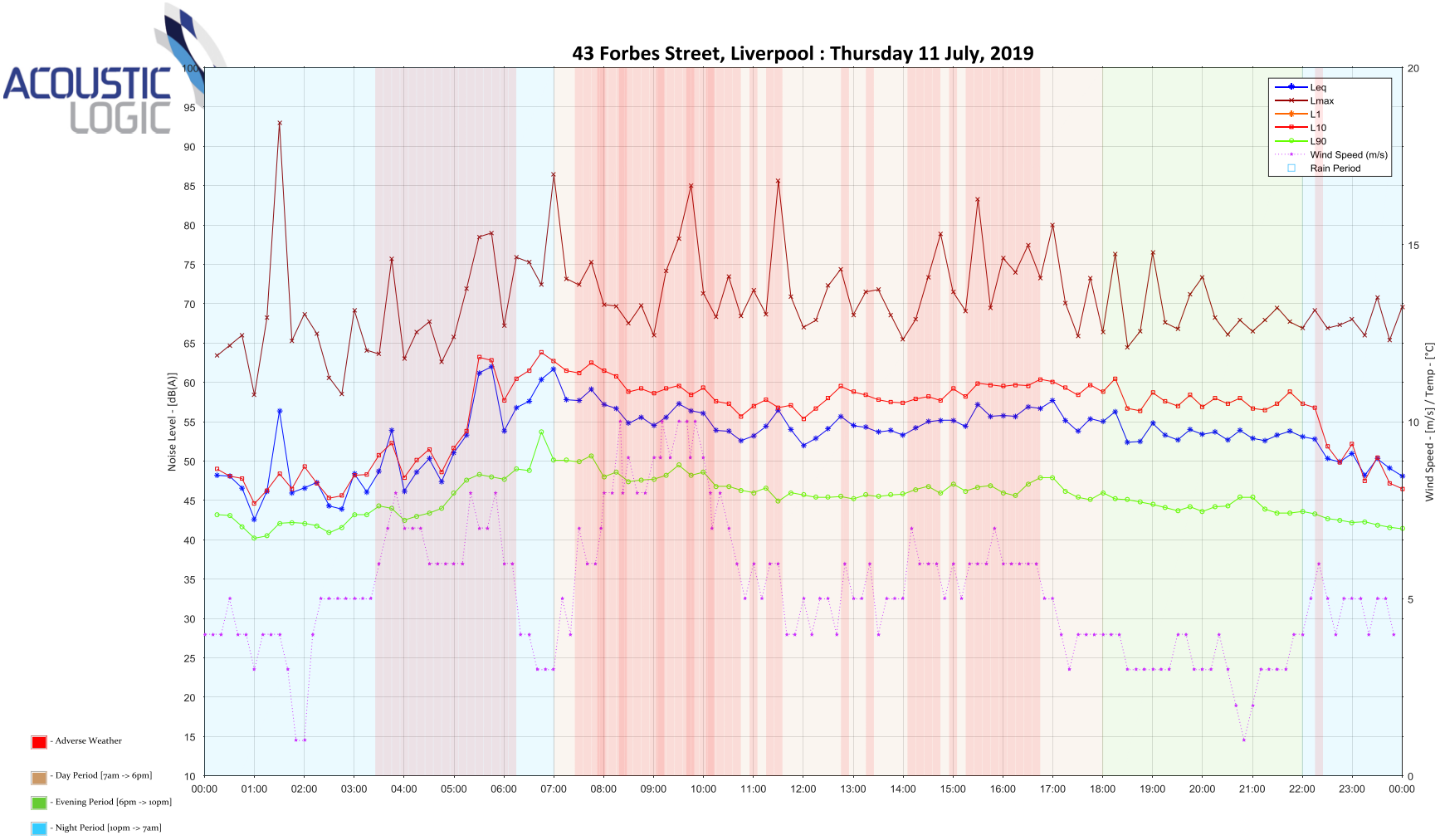

Liverpool Hospital (Internal Courtyard) : Monday 10 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

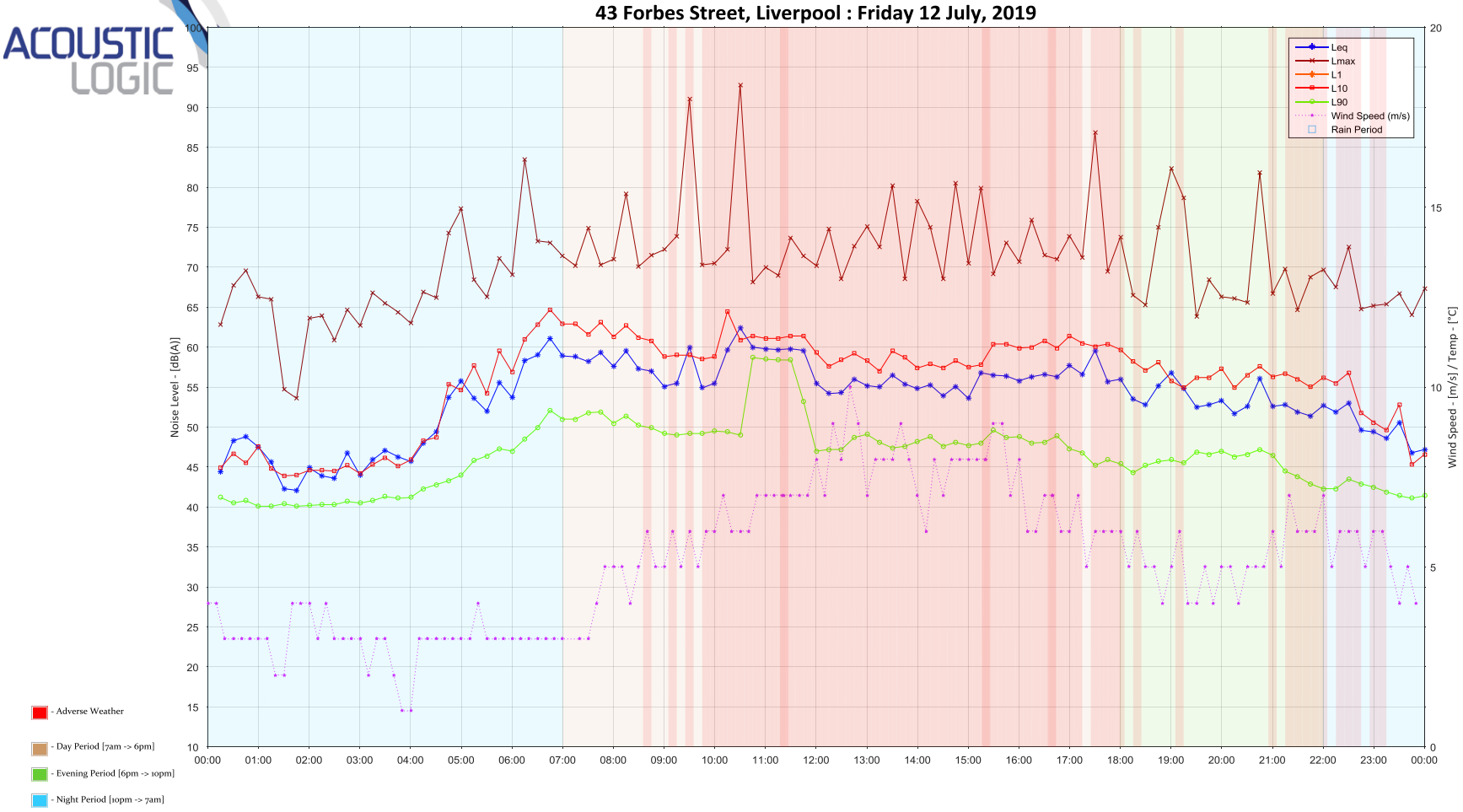

Liverpool Hospital (Internal Courtyard) : Tuesday 11 December, 2018
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

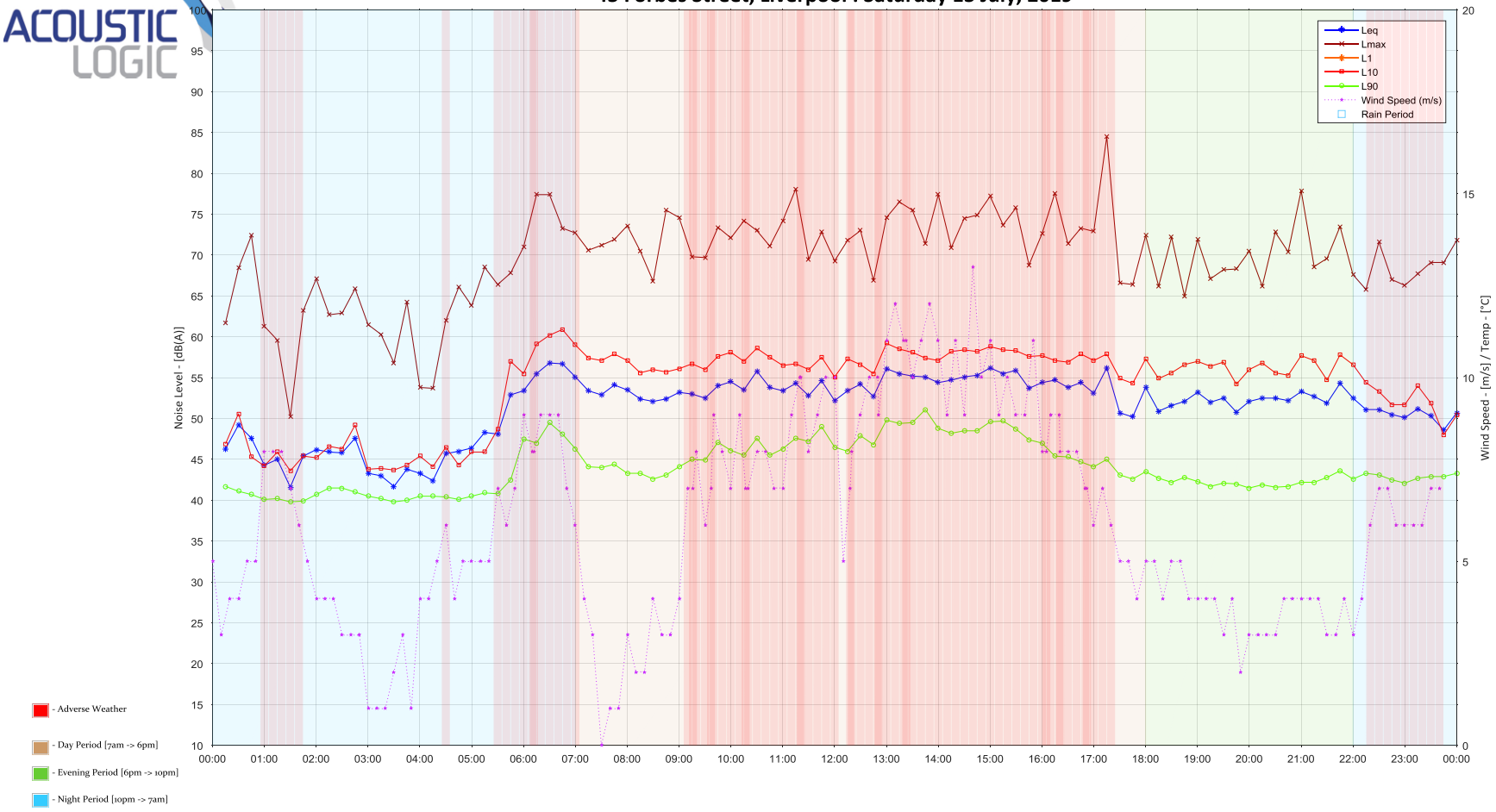
APPENDIX 3 - UNATTENDED BACKGROUND NOISE MONITORING DATA (LOCATION 3)

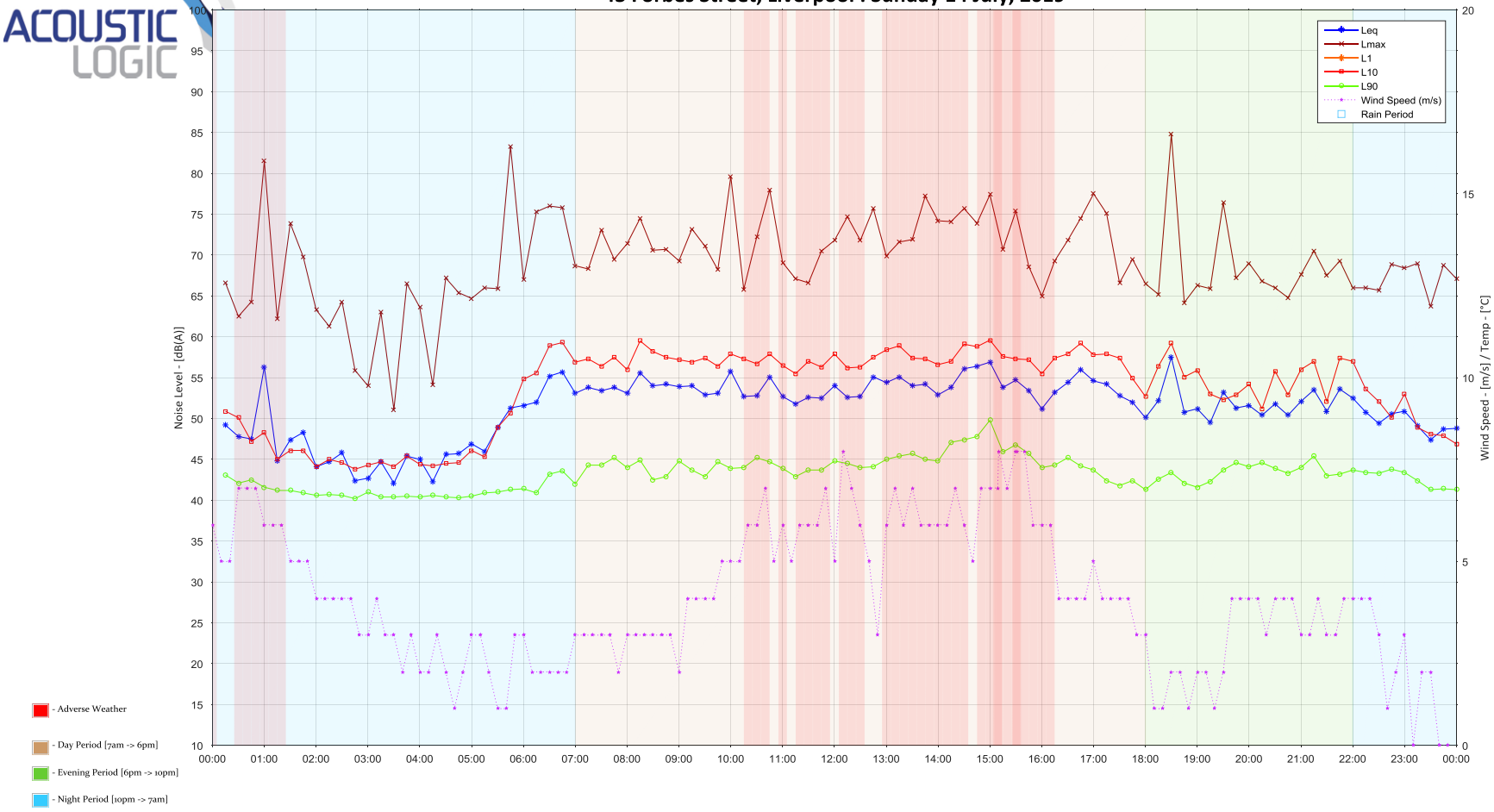

43 Forbes Street, Liverpool : Tuesday 09 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

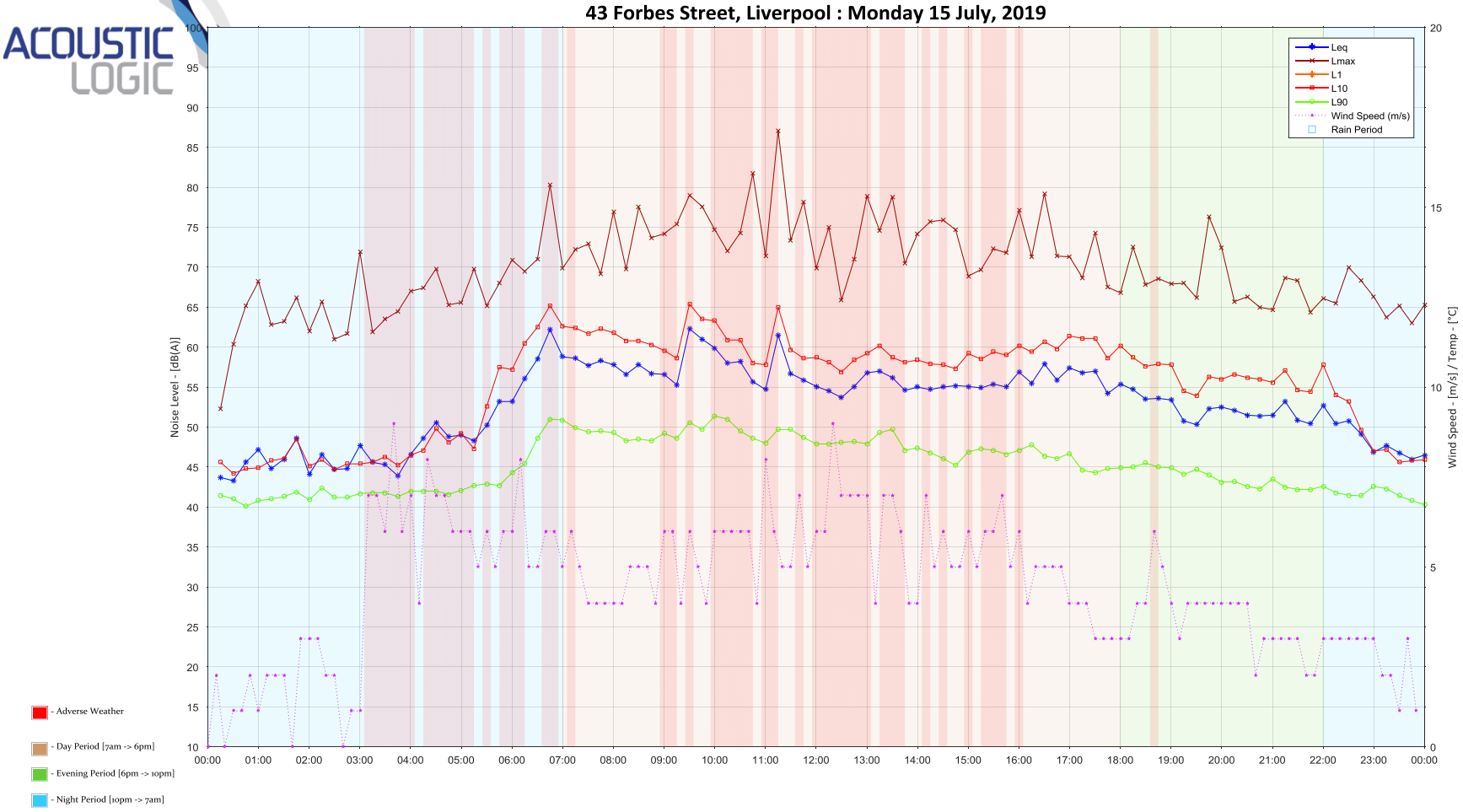

43 Forbes Street, Liverpool : Wednesday 10 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

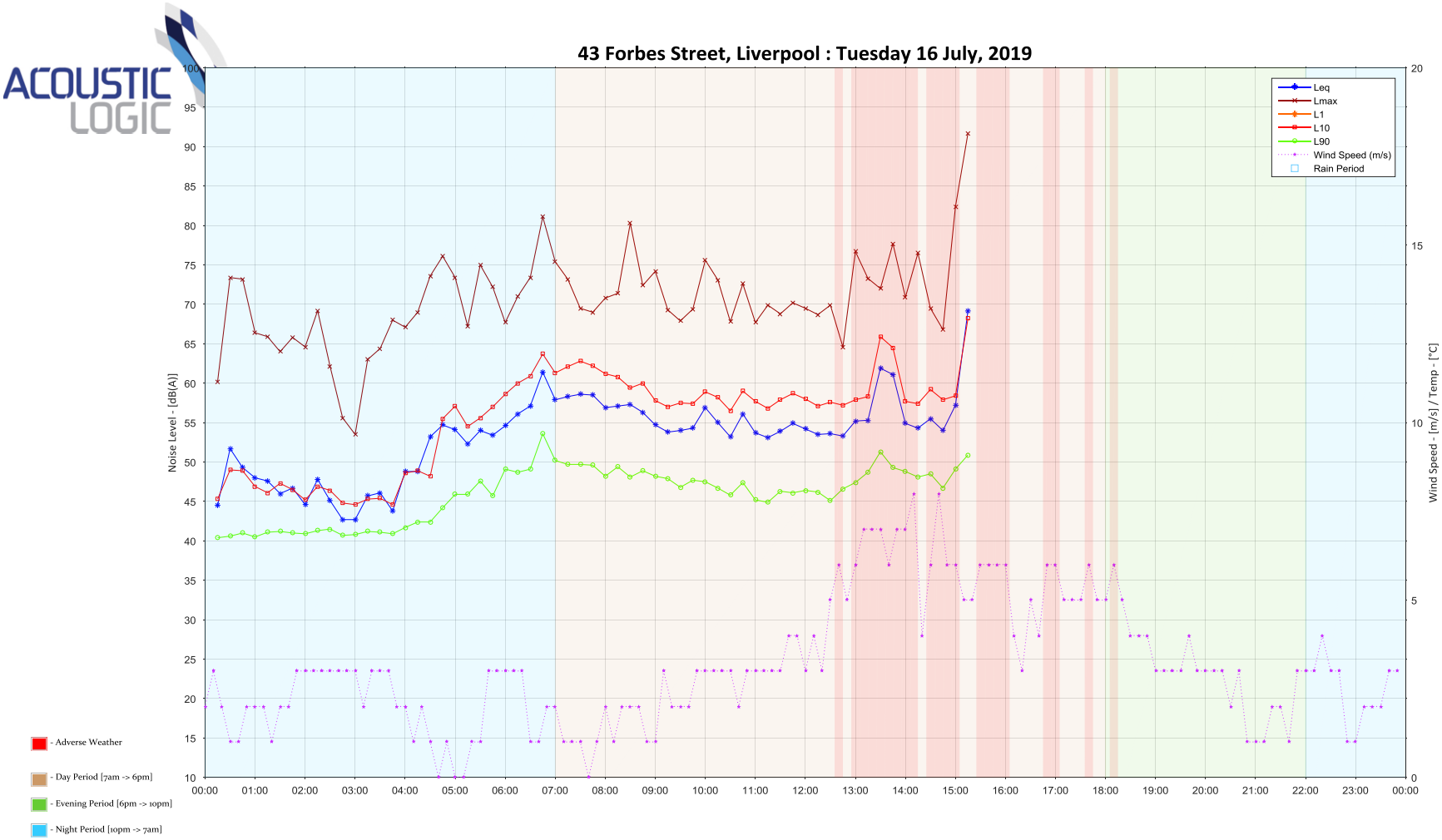

43 Forbes Street, Liverpool : Thursday 11 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


43 Forbes Street, Liverpool : Friday 12 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

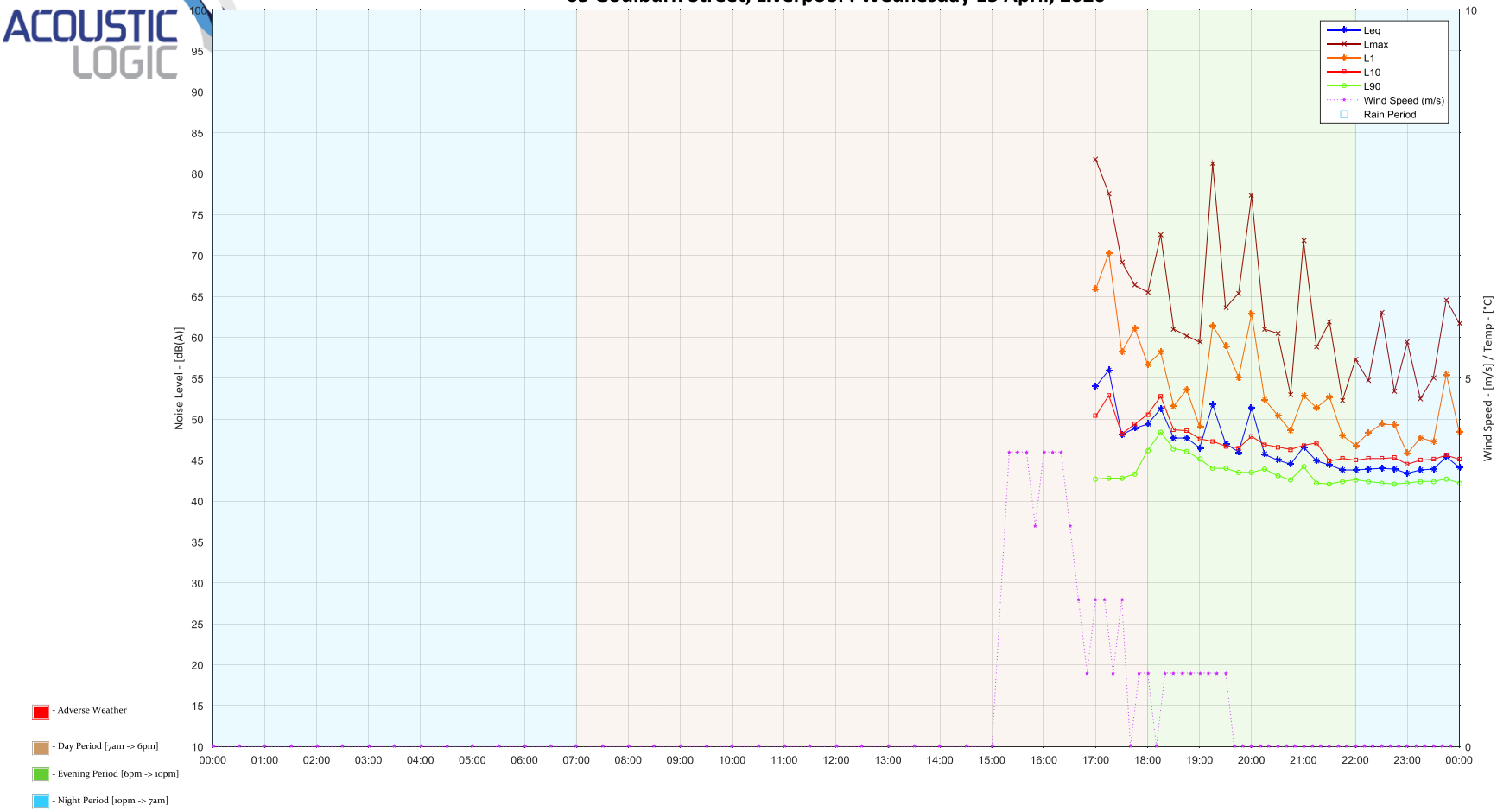

43 Forbes Street, Liverpool : Saturday 13 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

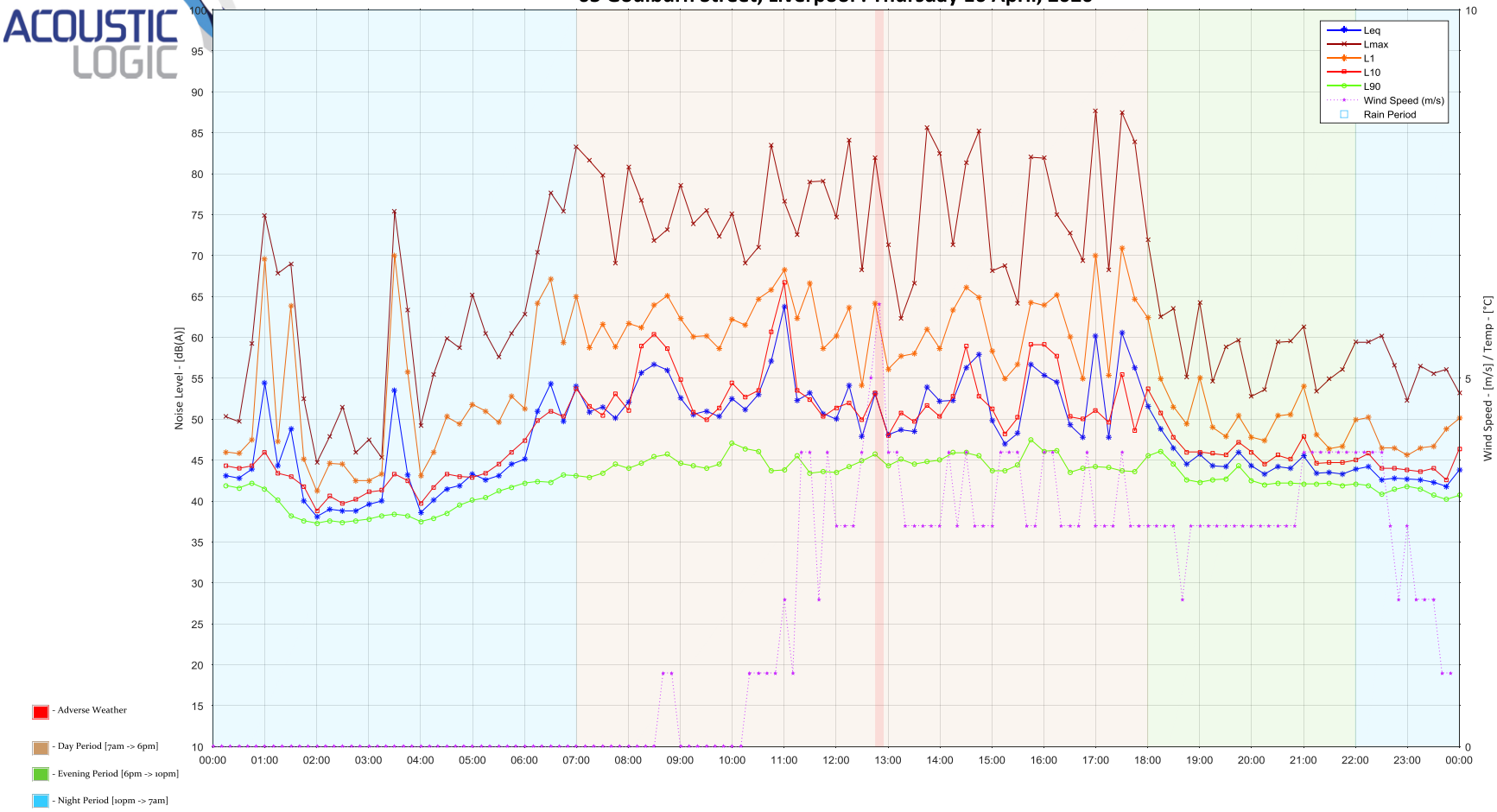

43 Forbes Street, Liverpool : Sunday 14 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


43 Forbes Street, Liverpool : Monday 15 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


43 Forbes Street, Liverpool : Tuesday 16 July, 2019
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]

APPENDIX 4 - UNATTENDED BACKGROUND NOISE MONITORING DATA (LOCATION 4)


63 Goulburn Street, Liverpool : Wednesday 15 April, 2020
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]


63 Goulburn Street, Liverpool : Thursday 16 April, 2020
Noise Level - [dB(A)]
Wind Speed - [m/s] / Temp - [°C]
Leq
Lmax
L1
L10
L90
Wind Speed (m/s)
Rain Period
- Adverse Weather
- Day Period [7am -> 6pm]
- Evening Period [6pm -> 10pm]
- Night Period [10pm -> 7am]