APPENDIX E ACOUSTIC REPORT

ACOUSTICS AND AIR

CAMMERAYGAL HIGH SCHOOL DEVELOPMENT APPLICATION

CONSTRUCTION & OPERATIONAL NOISE REPORT

REPORT NO. 17071
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PREPARED FOR

DEPARTMENT OF EDUCATION
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SURRY HILLS NSW 2010

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

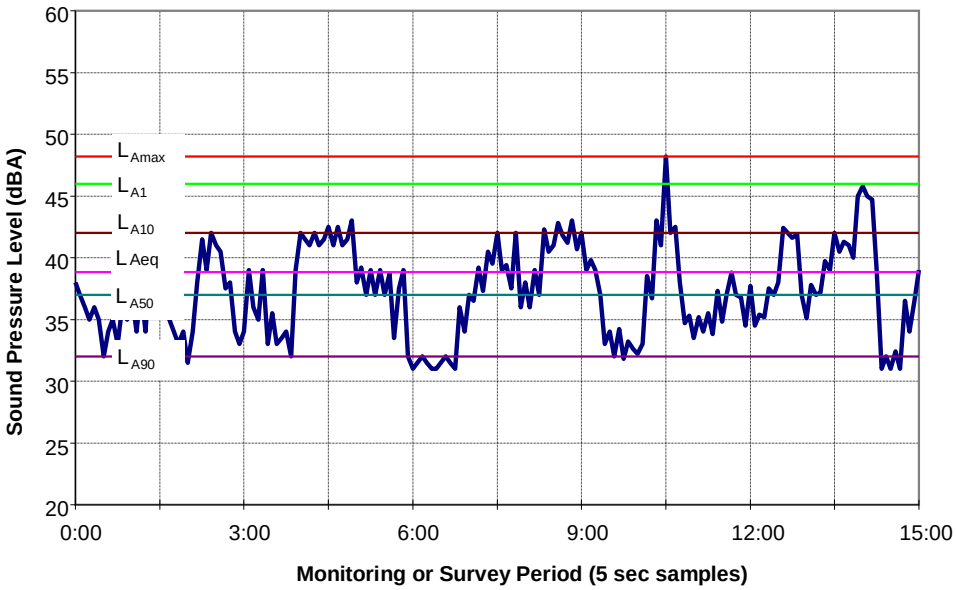
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

This has been prepared by Wilkinson Murray on behalf of the New South Wales Department of Education (the 'Applicant'). It accompanies an Environmental Impact Statement (EIS) prepared in support of conversion of the TAFE College in West Street, Crows Nest, into a senior high school.

The site, is located within the North Sydney Council district.

The purpose of this assessment is to assess potential noise and vibration impacts as detailed within the EIS.

This application seeks development approval comprising school buildings and shared new hall.

Relevant Policies and Guidelines

- *NSW Industrial Noise Policy (EPA);*
- *Assessing Vibration: A technical guideline (EPA);*
- *Interim Construction Noise Guideline (EPA);*

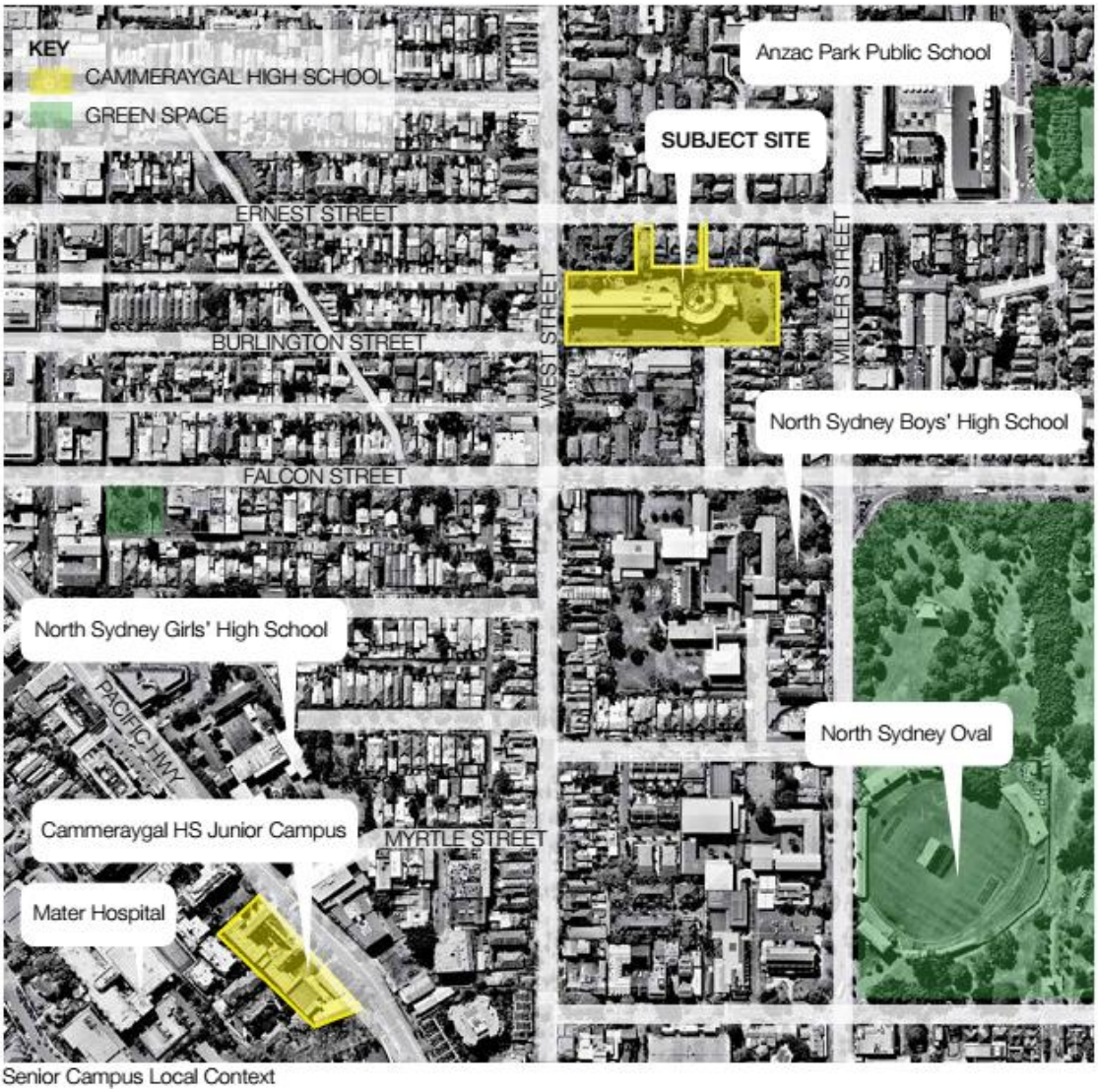
2 SITE DESCRIPTION

2.1 Location & Context

The Crows Nest Campus of TAFE NSW is located West Street, Crows Nest, as shown in Figure 2-1. The site is generally rectangular in shape, with access paths to Ernest Street.

Under the proposal the TAFE buildings will be refurbished. At the eastern end of the site a multi-purpose hall will be built, but otherwise building works will be largely internal.

Figure 2-1 Location and Context



Senior Campus Local Context

Figure 2-2 shows a closer view of the site context. Residential premises are on all sides of the site. Access to the school is currently through the main entrance on West Street to the car park which currently extends the full length of the site. A second entrance to Rodborough Avenue is currently blocked to the vehicular traffic but open to pedestrians.

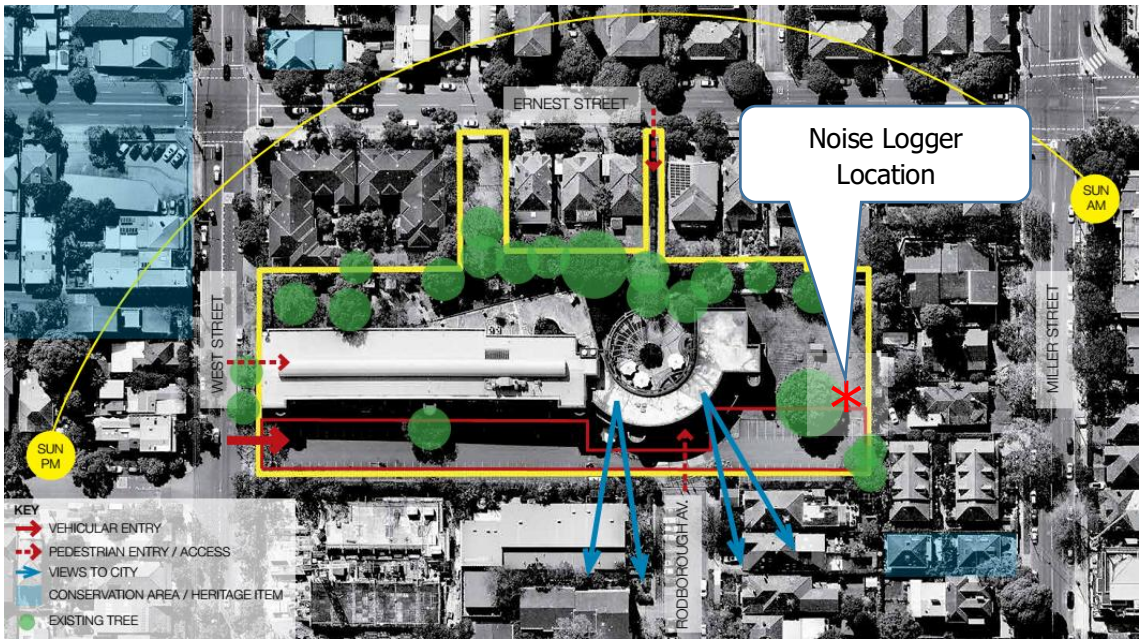
The proposed main entrance will remain the West Street entrance. The Rodborough Avenue entrance will continue as a pedestrian entrance, will be used for egress of buses from the site during operational mode, and may be used for egress of large trucks during construction.

A pedestrian entrance is proposed through the passage from the school to Ernest Street shown in Figure 2-2.

Drop off areas to the school will be on West Street.

Figure 2-2 also shows the location of the noise logger used to measure the existing ambient noise levels at the site. Results of those measurements will be used to set noise goals for construction and operation.

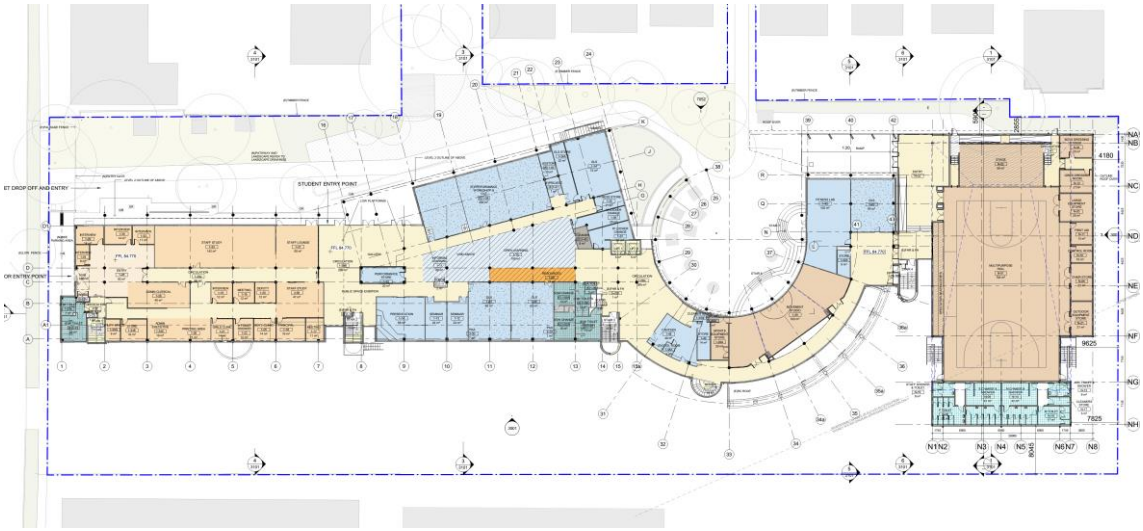
Figure 2-2 Site Context & Noise Logger



2.2 Proposed Design

An indicative floor layout is shown in Figure 2-3, showing the location of the proposed hall at the east of the existing buildings. The location of the hall presents potential operational noise issues to the adjacent residences immediately to the north, east and south of the hall.

Figure 2-3 Proposed Site Plan



2.3 Sports / Community Hall

The assumed operating hours of the shared facilities are 7.00am to 11.00pm each day. As discussed in Section 5.5, operation until midnight will be possible for some activities with appropriate noise mitigation.

Generally, the facilities will be used during school hours. The council and community groups may use the hall during evening when not required for school use.

2.4 Noise-Sensitive Receivers

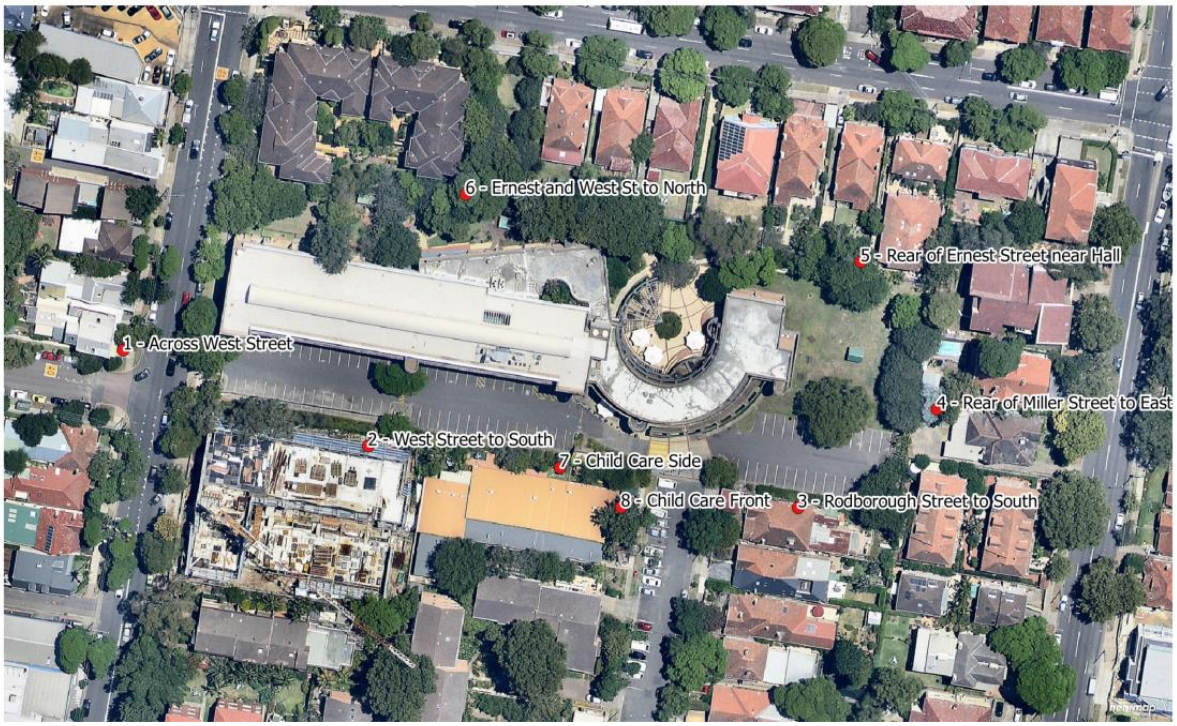
There are residential receivers on all sides of the site. The location and description of the representative receivers are described in Table 2-1. Figure 2-4 shows the location of the representative receivers.

The only nearby non-residential noise-sensitive receiver is the child care centre neighbouring the site at the northern end of Rodborough Avenue. Noise will be assessed at the side and front of the child care centre as those two facades will experience different noise environments.

Table 2-1 Description of Noise-Sensitive Receivers

Number & Description
1 – Across West Street
2 – West Street to South
3 – Rodborough Avenue to South
4 – Rear of Miller Street to East
5 – Rear of Ernest Street near Hall
6 – Ernest and West Street to North
7 – Child Care Side
8 – Child Care Front

Figure 2-4 Location of Noise-Sensitive Receivers



3 AMBIENT NOISE LEVELS

3.1 Ambient Noise Levels at Site

In order to quantify the existing noise environment, long-term ambient noise levels were monitored from 22 February to March 2017. The logger location was near the eastern boundary as shown on Figure 2-2, thus representing the receivers most potentially impacted by both construction and operation.

The noise monitoring equipment used for the Wilkinson Murray noise measurements consisted of an ARL Type EL-315 environmental noise logger set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{ea} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Glossary for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional pass-by of a heavy vehicle. The L_{A90} level is normally taken as the background noise level during the relevant period.

Detailed results for each monitoring location are shown in graphical form in Appendix A. The graphs show measured values of L_{ea}, L_{A90}, L_{A10} and L_{A1} for each 15-minute monitoring period.

Table 3-1 summarises the noise results, for daytime, evening and night time periods as defined in the EPA's *Interim Construction Noise Guidelines (ICNG)* and the NSW *Industrial Noise Policy (INP)*. A night time shoulder period from 10pm to midnight is also defined to allow assessments of hall operations beyond 10.00pm.

Table 3-1 Summary of Measured Ambient Noise Levels

RBL (dBA)				$L_{Aeq,period}$ (dBA)		
Daytime 7am-6pm	**Evening 6-10pm**	**Night Time 10pm-7am**	**Night Shoulder 10-pm-12 midnight**	**Daytime 7am-6pm**	**Evening 6-10pm**	**Night Time 10pm-7am**
43	42	35	41	51	52	44

4 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

This section of the assessment relates to typical construction activities that are to occur. Most construction will occur at the eastern end of the site where the hall will be built. Noise from other parts of the site will be due to passage of trucks and equipment through the site, and minor works on the facade and signage.

4.1 Construction Noise Criteria

The following sections detail the applicable site-specific noise and vibration criteria based on the EPA *Interim Construction Noise Guideline*.

4.1.1 Construction Noise Management Levels

The EPA released the "*Interim Construction Noise Guideline*" *(ICNG)* in July 2009. The guideline provides noise goals that assist in assessing the impact of construction noise.

For residences, the basic daytime construction noise goal is that the $L_{Aeq,\ 15min}$ noise management level should not exceed the background noise by more than 10dBA. This is for standard hours Monday to Friday 7.00am-6.00pm, and Saturday 8.00am-1.00pm. Outside the standard hours, where construction is justified, the noise management level would be background + 5dBA. Table 4-1 details the *ICNG* noise management levels.

Table 4-1 Construction Noise Management Levels at Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,(15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Management Level $L_{Aeq,(15min)}$	How to Apply
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the guideline.

Based on the above, Table 4-2 presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

There is a child care centre adjacent to the Rodborough Avenue Entrance to the site. The ICNG recommends the following NMLs for schools, and they are typically applied to child care centres:

- Internal in class rooms – $L_{Aeq,15min}$ 45dBA. This is approximately equivalent to a level of 55dBA outside, assuming a 10dBA noise reduction through open windows and doors;
- Active Recreation (typically applied to playground areas) – $L_{Aeq,15min}$ 65dBA.

As the playground is only a few meters wide, so an NML of 55dBA is considered appropriate to achieve internal levels of 45dBA.

Table 4-2 Site-Specific Construction Noise Management Levels

Receiver	Construction Noise Management Level, L_{Aeq} – dBA			Highly Noise-Affected Noise Level, L_{Aeq} dBA
	Day	Evening[1]	Night[1]	
Residential	53	47	40	75
Child Care Centre	55	55	55	75

Note 1: Out-of-hours work is not proposed and would be applied for separately. The NMLs are listed if required in future.

4.2 Hours of Operation

The proposed working hours for this project, detailed in the Construction Management Plan are as follows:

- Monday to Friday 7.00am to 5.00pm
- Saturdays 8.00am to 1.00pm
- Sundays and Public Holidays No work

If required, after hours' permits will be sought from the relevant authorities.

4.3 Vibration Criteria

Criteria for assessment of the effects of vibration on human comfort are set out in British Standard 6472-1992. Methods and criteria in that Standard are used to set "preferred" and "maximum" vibration levels in the document "*Assessing Vibration: A Technical Guideline*" (2006) produced by the NSW DECCW.

Acceptable values of human exposure to continuous vibration, such as that associated with drilling, are dependent on the time of day and the activity taking place in the occupied space (e.g. workshop, office, residence or a vibration-critical area). Guidance on preferred values for continuous vibration is set out in Table 4-3.

Table 4-3 Criteria for Exposure to Continuous Vibration

Place	Time	Peak Particle Velocity (mm/s)	
		Preferred	Maximum
Critical working areas (e.g. hospital operating theatres precision laboratories)	Day or night time	0.14	0.28
Residences	Daytime	0.28	0.56
	Night time	0.20	0.40
Offices	Day or night time	0.56	1.1
Workshops	Day or night time	1.1	2.2

In the case of intermittent vibration, which is caused by plant such as rock breakers, the criteria are expressed as a Vibration Dose Value (VDV) and are presented in Table 4-4.

Table 4-4 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime		Night Time	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Calculation of VDV requires knowledge of the number of events and their duration in the relevant time period.

4.3.1 Building Damage

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 *"Explosives – Storage and Use – Part 2: Use of Explosives"* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2"*, as they "are applicable to Australian conditions".

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table 4-5.

Table 4-5 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/s at 15 Hz	20mm/s at 15 Hz increasing to 50mm/s at 40 Hz and above

The Standard states that the guide values in Table 4-5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings.

The British Standard goes on to state that *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity"*. In addition, a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

4.4 Construction Equipment & Noise Source Levels

Sound Power Levels (SWLs) for typical construction plant are identified in Table 4-6. These SWLs have been measured at other similar construction sites. The table gives both Sound Power Level and Sound Pressure Levels (SPL) at 7m for the equipment. Sound Power Level is independent of measurement position.

Table 4-6 Typical Construction Plant Sound Levels – dBA

Plant	Sound Power Level	Sound Pressure Level at 7m
Concrete Truck	109	84
Angle Grinder	109	84
Concrete Pump – 120 mm diameter / 50 bar	112	87
Mobile Crane	98	73
Dump Truck	108	83
Compressor	100	75
Bobcat	103	78
Hand Tools	90	65
Bulldozer	114	89
Auger Piling Rig	112	87
Crawler Crane	98	73
Front End Loader	112	87
Excavator	107	82

4.5 Construction Schedule

Construction is scheduled to commence in December 2017 and take approximately 40 weeks. Much of the work will be internal, including demolition and refit on all levels. Noise emission from the site will be due to construction traffic, and use of hand tools outside.

Noisy works will generally be limited to construction of the hall:

- Excavation: 2 weeks;
- Construction: 20 weeks.

Large construction vehicles may need to exit the site through Rodborough Avenue.

4.6 Construction Noise Predictions

Assessment of likely construction noise at surrounding receivers has been conducted for the proposed construction works.

Site-related noise emissions were modeled with the "CadnaA" noise prediction program using the ISO 9613 noise prediction algorithms. Factors that are addressed in the noise modeling are:

- Equipment sound level emissions and location;
- Receiver locations;
- Ground topography;
- Noise attenuation due to geometric spreading;
- Ground absorption; and
- Atmospheric absorption.

Modelling has been conducted for a number of construction scenarios. The three works scenarios considered are summarised in Table 4-7.

Table 4-7 Construction Scenarios for Construction Works

Scenario	Description	Works	Duration
A	Bulk Excavation	Bulk Excavation including of hall site. Excavators and truck movements – loaded into trucks sent off site. Trucks exit through Rodborough Ave.	2 weeks
B	Building Construction	This scenario includes concreting and lifting. 1 concrete pump, 2 forklifts, 1 compressor, 1 crane, a boom truck are assumed to operate in 15minutes. Also, concrete trucks and normal delivery trucks. 2 truck movements in 15 minutes assumed.	20 weeks
C	Façade / General Fitout	In the event that the construction of the facade occurs in isolation. Forklift, truck, mobile crane and power tools assumed. 2 truck movements in 15 minutes assumed.	40 Weeks

Noise modelling has been conducted for each of the above construction scenarios with plant located across the western side of the site.

The modelling assumes a "typical worst-case" scenario whereby all plant, is running continuously. As such, the modelling represents likely noise levels that would occur during intensive periods of construction. Therefore, the presented noise levels can be considered in the upper range of noise levels that can be expected at surrounding receivers when the various construction scenarios occur.

Once noise sources have been applied to the model, the resultant noise levels at identified surrounding receivers are predicted. These results are then compared with established site-specific noise criteria. Table 4-8 details results of construction noise modelling for each scenario.

Table 4-8 Predicted Construction Noise Levels at Residence – $L_{Aeq(15\ min)}$ – dBA

Receiver	A Excavation	B Building	C Façade, Fitout
1	48-53	50-55	50-55
2	57-62	58-64	58-63
3	64-69	58-71	53-58
4	62-67	65-78	61-66
5	63-68	42-54	40-45
6	42-47	31-41	31-36
Child Care Side	55-60	57-69	55-60
Child Care Front	47-52	48-57	48-53

4.7 Discussion of Results

The greatest potential noise impact is during the construction of the hall at the eastern end of the site. This is due to the close proximity of these works to the nearest eastern residences. The greatest noise will be from earthworks, however, this will only last approximately two weeks.

A review of noise levels of other construction indicates exceedances of up to 18 dBA can be expected during excavation. This magnitude of exceedance is not unusual for construction works in a relatively quiet residential area and can be managed by construction noise management procedures detailed in the following sections.

Based on these findings, the adoption of reasonable and feasible noise management and mitigation will be required. These measures should be determined in detail when a contractor, with defined construction techniques, has been engaged on the project. However, "in-principle" mitigation measures are detailed in the following sections.

4.8 Construction Vibration Assessment

Operation of piling rigs or rock breakers and the like generate ground vibration that has the potential to transmit to nearby buildings.

Table 4-10 sets out the typical ground vibration levels at various distances for safe working distances.

Table 4-9 Recommended Safe Working Distances for Vibration-Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Small Hydraulic Hammer	(300kg – 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600kg – 18 to 34t excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

- Construction Noise Strategy, 2012, Transportation Construction Authority

Vibration impact would only be expected during excavation of the haul at the eastern end of the site.

A review of the site plant and surrounding receivers indicates that the minimum distance between the vibration generating activities and surrounding residences will be in the order of 8-10 metres. Therefore, the use of medium to any rock-breakers or vibratory rollers should be carefully managed at distances closer than 20 metres from these residences.

Structural damage vibration criteria in residential buildings are much higher than human comfort criteria, and predicted vibration levels are within these criteria under most circumstances. The exception, should heavy rock-breakers be used, is for areas near the hall excavation. If hammers are required, test vibration monitoring is recommended to ensure that vibration levels at residences are not excessive.

4.9 Construction Noise & Vibration Mitigation Measures

Without mitigation, noise levels from construction activities have been predicted to exceed the noise management levels nominated in the guidelines at some surrounding receivers. Therefore, noise control measures are recommended to ensure that noise is reduced where feasible.

The following project-specific mitigation measures are recommended:

- Selection of quietest feasible construction equipment;
- Use of rock saws and ripping in preference to rock breakers if rock removal is required;
- Localised treatment, such as barriers, shrouds and the like around fixed plant, such as pumps, generators and concrete pumps;
- Provision of respite periods, particularly if out of standard hours work is required; and
- Trial testing of vibration levels is conducted where equipment is identified as having the potential to exceed the human comfort criteria.

In addition, the following measures should be included in a Noise and Vibration Management Plan.

- *Plant Noise Audit* – Noise emission levels of all critical items of mobile plant and equipment should be checked for compliance with noise limits appropriate to those items prior to the equipment going into regular service. To this end, testing should be established with the contractor.
- *Operator Instruction* – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission.
- *Equipment Selection* – All fixed plant at the work sites should be appropriately selected, and where necessary, fitted with silencers, acoustical enclosures and other noise attenuation measures in order to ensure that the total noise emission from each work site complies with EPA guidelines.
- *Site Noise Planning* – Where practical, the layout and positioning of noise-producing plant and activities on each work site should be optimised to minimise noise emission levels.

The adoptions of the above measures are aimed at working towards achieving the noise management levels established at surrounding receivers.

4.10 Community Liaison & General Approaches to Mitigation

An effective community relations programme should be put in place to keep the community that has been identified as being potentially affected appraised of progress of the works, and to forewarn potentially affected groups (e.g. by letterbox drop, meetings with surrounding owners / tenants, etc.) of any anticipated changes in noise and vibration emissions prior to critical stages of the works, and to explain complaint procedures and response mechanisms. This programme should include a *Community and Stakeholder Engagement Strategy* developed specifically for the Project.

Close liaison should be maintained between the communities overlooking work sites and the parties associated with the construction works to provide effective feedback in regard to perceived emissions. In this manner, equipment selections and work activities can be coordinated where necessary to minimise disturbance to neighbouring communities, and to ensure prompt response to complaints, should they occur.

4.11 Noise & Vibration Management Plan

A construction Noise and Vibration Management Plan, consistent with the preliminary construction management plan, for the site is recommended which should be prepared by the successful contractor. The plan should reference the findings of this assessment. Areas that should be addressed in plan include:

- Noise and vibration mitigation measures
- Noise and vibration monitoring;
- Response to complaints**;**
- Responsibilities;
- Monitoring of noise emissions from plant items;
- Reporting and record keeping;
- Non-compliance and corrective action; and
- Community consultation and complaint handling.

5 OPERATIONAL NOISE

Operational noise from the proposed facilities will be from the following activities:

- Services noise from plant;
- School announcements and bells;
- Outdoor play;
- Sporting events and concerts in the hall;

5.1 Operational Noise Objectives

Noise impact from the general operation of the proposed facilities is to be assessed with respect to the site-specific noise criteria based on site monitoring and the NSW *Industrial Noise Policy (INP)* intrusive noise criteria.

Table 5-1 presents the intrusiveness criteria for all surrounding residential receiver areas. This was calculated by adding 5dB to the period background noise levels.

Noise criteria for children playing is typically background +10dBA. Depending on the situation, the application of this limit may be time limited, however, it is usually seen as appropriate for up to 2 hours per day.

Table 5-1 Operational Intrusive Noise Criteria (All residences)

Intrusiveness Criterion $L_{Aeq,15min}$ (dBA)			
Daytime	**Evening**	**Night Time**	**Night Shoulder**
7am-6pm	**6-10pm**	**10pm-7am**	**10-pm-12 midnight**
48	47	40	46
53 (children playing)			

5.2 Design Goals for Child Care Centre

The *INP* recommends two criteria for schools. For assessing child care centres, it is usual to consider play areas as active recreation area playgrounds, and internal areas such as sleeping areas and activity rooms/classrooms. Further recommendations are given in the *Guideline for Child Care Centre Acoustic Assessment* (2010) published by the Association of Australasian Acoustical Consultants (AAAC).

The relevant criteria are:

- Outdoor play areas L_{Aeq} 55dBA when in use; and
- Classrooms (internal) 35-40dBA (the AAAC guideline recommends 40dBA).

The classroom noise goal is internal, however it is more convenient to predict noise to external areas. The typical noise reduction of a façade with open windows is 10dBA, therefore an internal goal of 40dBA corresponds to an external goal at the window of 50dBA. This will be used as the appropriate operational noise goal for noise emissions from the school to the child care centre.

5.3 Operational Mechanical Noise Assessment

Detailed specifications of new mechanical services equipment that would otherwise allow an acoustic assessment of noise emission from the site are not available at this stage of the project as selection and design is conducted after project approval. In line with the approvals for other development, detailed assessment of operational noise emission should form a conditional requirement of the development to be satisfied prior to the issue of the construction certificate.

To mitigate noise from mechanical plant, silencers could be incorporated in the outlets of the exhaust fans and any possible roof top plant would be housed in a louvered acoustic barrier if required. The mechanical plant noise emission would be designed to meet the criteria presented in Table 5-1 at the closest receivers.

5.4 School Announcements & Bells

Announcements and school bells are typical activities associated with school operations. Typically, these are produced by the school PA system and can vary significantly depending on the final volume settings of the system.

At this stage, no design of the PA system has been determined. However, the following measures should be adopted to ensure that their impact at all surrounding residences is minimised:

- Speakers should be located and orientated to provide good coverage of the school areas while being directed away from residences. The coverage of the system should be subject of the detail design of the sound system.
- The volume of the system should be adjusted on site so that announcements and bells are clearly audible on the school site without being excessive. The system should initially be set so that noise at surrounding residences does not exceed the ambient noise levels by more than 5dBA.
- Once the appropriate level has been determined on site, the system should be limited to the acceptable level so that staff cannot increase noise levels.
- The system bell should be set so that it only occurs on school days.

5.5 Noise from Hall Operations

Noise from normal school activities in class hours are not considered to be acoustically significant however the use of the hall for larger events, such as concerts and sporting contests, particularly outside school hours, has the potential to adversely impact on residences.

Preliminary calculations have been conducted based on internal noise levels of between 95-100dBA which is considered typical noise levels for larger events. Table 5-2 presents predicted noise levels at residences during these events with windows and doors open or closed.

Table 5-2 Predicted Noise Levels at Residences from Major Events in the Hall – $L_{Aeq,15min}$ dBA

Receivers	Windows / Doors	
	Open	Closed
Northern Residences	60-65	38-43
Eastern Residences	70-75	42-47
Southern Residences	62-67	40-45

A review of the above noise levels indicates that doors and windows of the hall should be closed during major out-of-school hours events to protect the acoustic amenity of surrounding existing and future residences.

Based on the assumptions, a potential minor exceedance is predicted at the eastern residences for activities between 10.00pm and midnight. If the hall is to be used after 10.00pm, noise limits should be placed on activities and the following assumptions concerning materials should be reviewed at detailed design stage:

- Doors and windows should be able to be closed and have a minimum acoustic rating of R_W 34. Indicative glazing of 10.38mm laminated glass should be allowed.
- Any glass ventilation louvres should have an indicative rating of R_W 32, for example the Jalousie Louvred Window System from Safetyline Jalousie.
- Walls and roof should have an acoustic rating of at least R_W 45.

The sound system should have a noise limiter included in the system control so that internal noise levels, particularly low frequency noise, can be controlled. The predictions allow for 4x 900mm diameter roof mounted ventilators. The ventilators should be located as close to the centre of the roof as possible.

5.6 Noise from Outside Play

An outdoor play area is proposed at the south-east corner of the site. The play area is covered in part by the hall. Noise levels at neighbouring receivers will vary depending on the number of children and the games they play. The predicted noise levels Table 5-2 in show noise to be expected.

Table 5-2 Predicted L_{Aeq} Levels from Children Playing

Receiver	Noise Level	Criterion
3 (ground floor)	43-48	53
3 (upper floor)	55-60	53
4	33-38	53
8 (Child Care Centre)	47-52	50

Figure 5-1 View from Play Area

In general noise is predicted to comply at residences with fences high enough to provide acoustic shielding. However, residences adjacent to the play area, represented by Receiver 3, have windows visible above the fence line from the play area. This can be seen in Figure 5-1 which shows a view from the future play area to the southeast corner of the site.

Noise levels exceeding the noise goal can be expected during play time.

Noise mitigation could be provided in the following way;

- Acoustic absorption material should be applied to the soffit of the hall floor slab that provides the cover to the play area; and
- Play time should be restricted to recess periods.

A minor exceedance is predicted at the front of the child care centre, however, as the duration of the exceedance is short, and the noise is similar to that produced by the child care centre, no significant impact is predicted due to this exceedance.

6 CONCLUSION

A development application construction and operational noise and vibration assessment of the proposed Cammeraygal Senior High School has been conducted. Site-specific noise criteria that are applicable to the entire project have been established.

A noise and vibration assessment has been conducted for the proposed construction activities associated with the development to determine the potential for noise and vibration impact at surrounding receivers. Exceedances of noise management levels are expected at nearby surrounding receivers.

Vibration associated with on-site construction activities has the potential to impact on residences to the west of the site should large equipment, such as rock breakers be used. Trial monitoring and selection of less vibration intensive equipment is recommended.

Therefore, management of noise and vibration from construction activities will be required to be included in the Site Construction Environmental Management Plan.

Operational noise criteria for mechanical services and hall operations have been determined for the project. A review of all plant with respect to site specific noise criteria is required at detailed design stage. At that stage, any necessary noise mitigation can be determined and included in the detailed design of mechanical service so that compliance with site specific noise criteria is achieved.

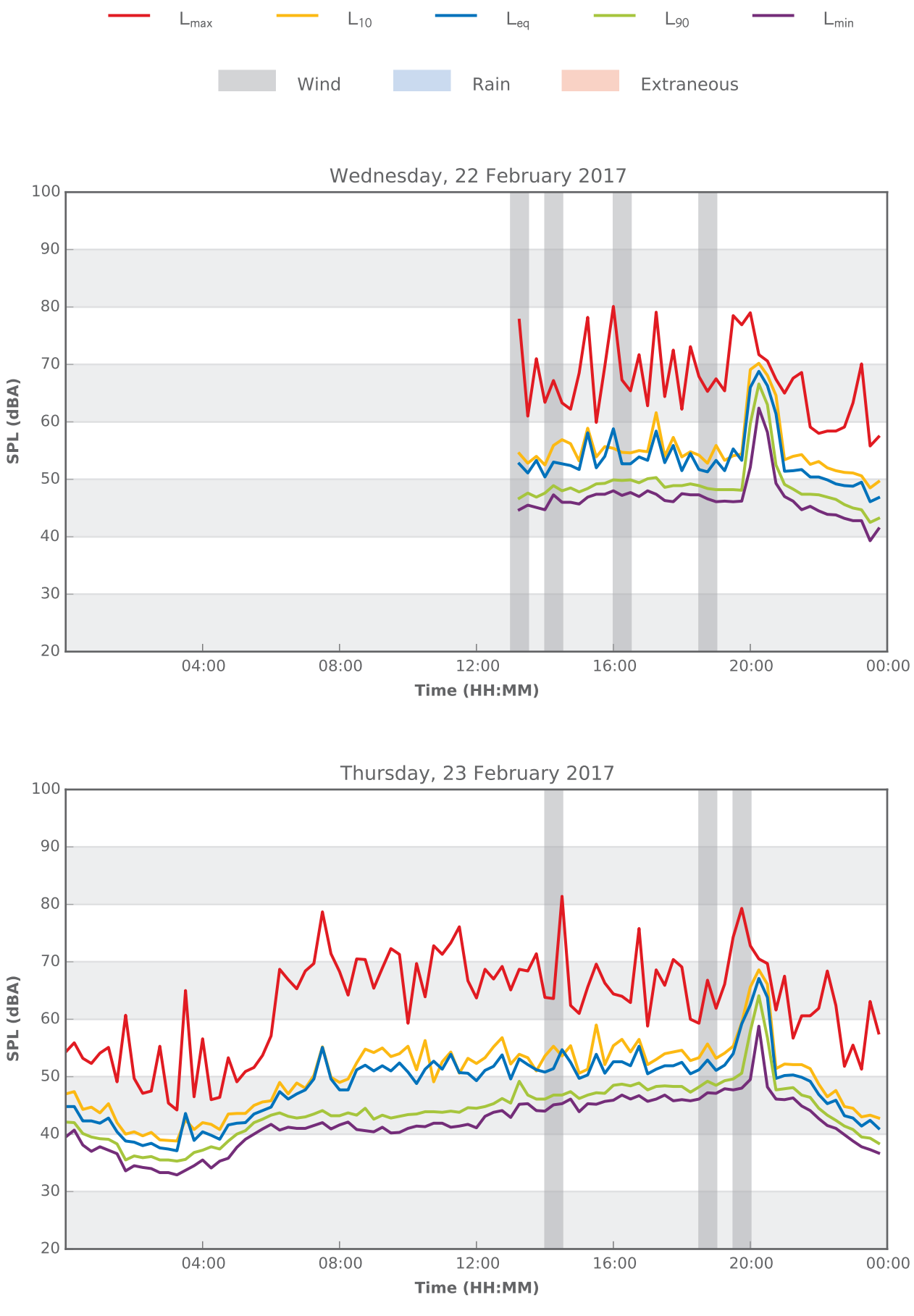
Operation of the hall outside of normal school hours for major sporting activities and concerts will require doors and windows to be enclosed. In addition, walls and roof areas will require improved constructions that should be determined at detailed design stage. Preliminary allowances have been recommended in the report

Other school related noise producing activities have been reviewed and recommendations for management of these sources has been provided.

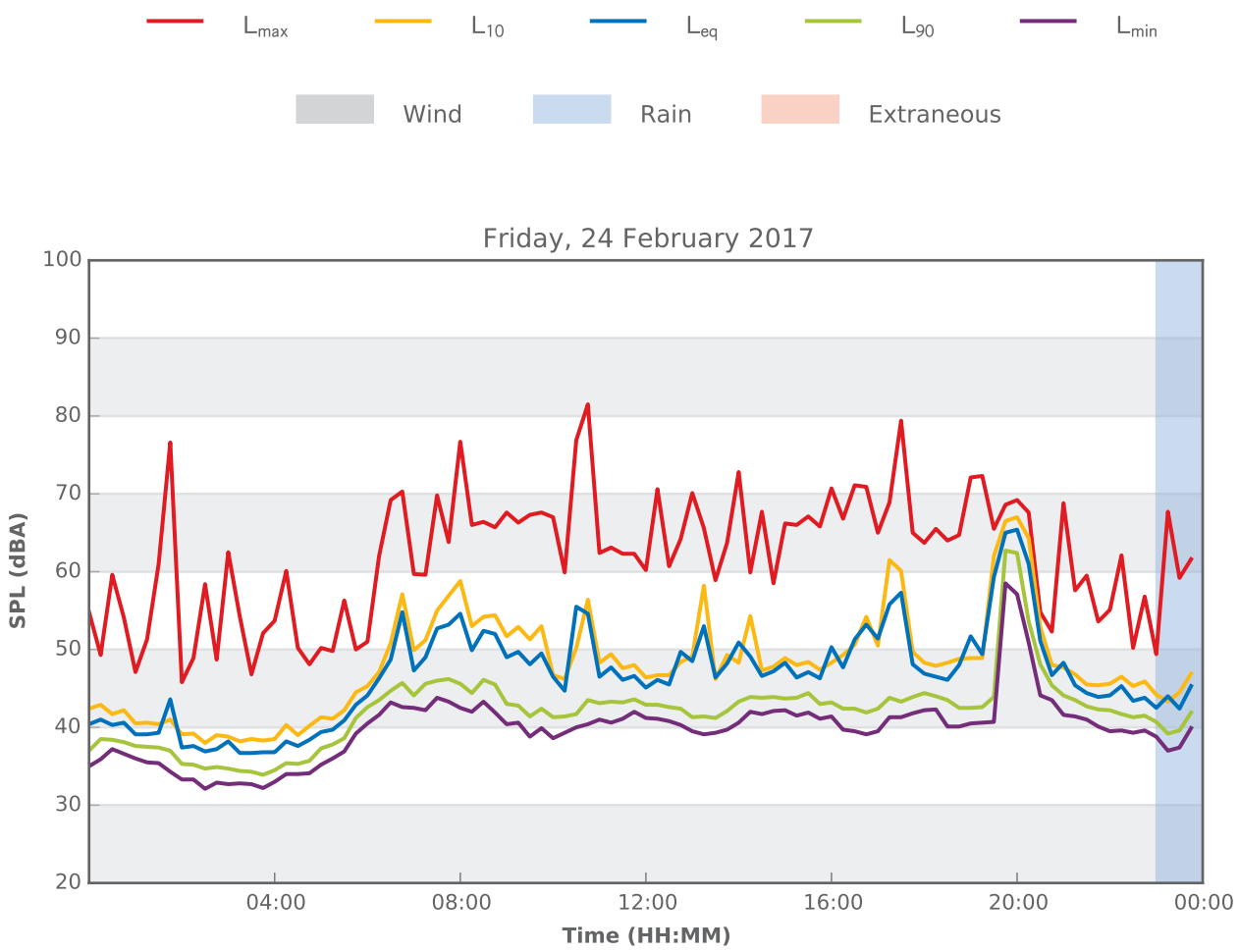
APPENDIX A

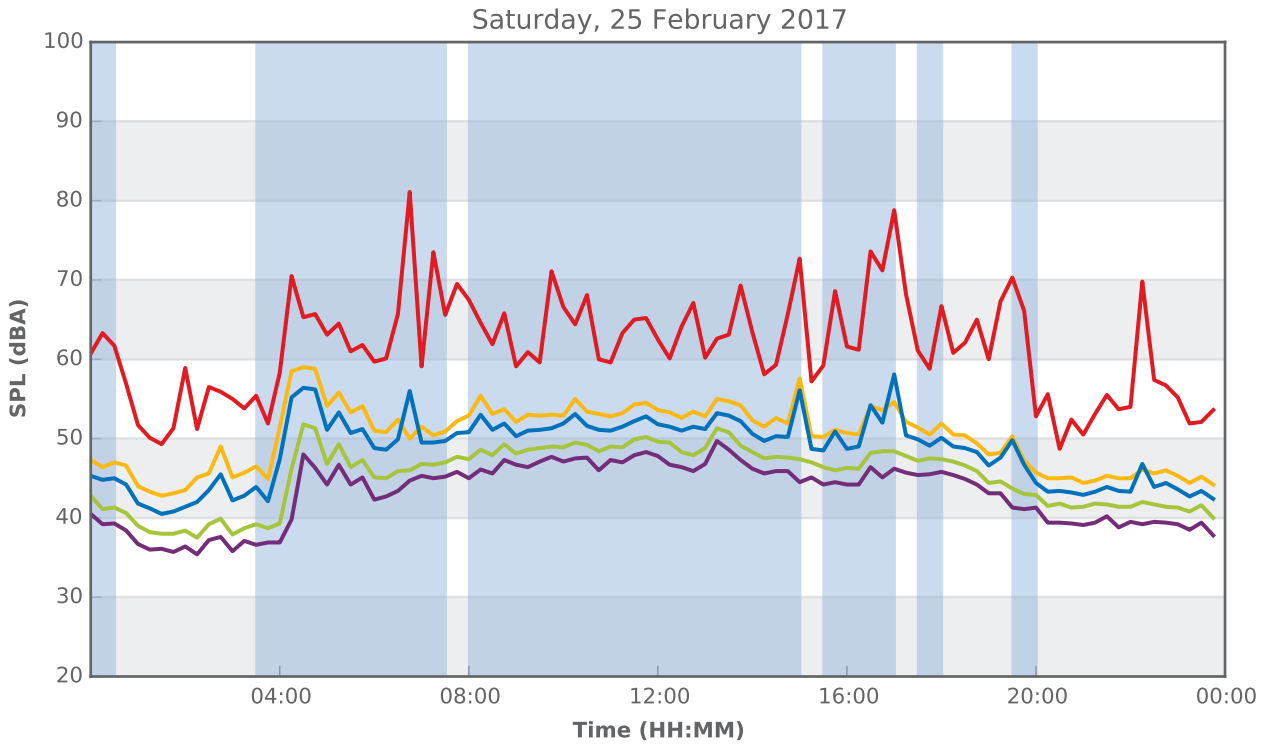
NOISE MEASUREMENT RESULTS

West Street North Sydney, North Sydney Council



West Street North Sydney, North Sydney Council





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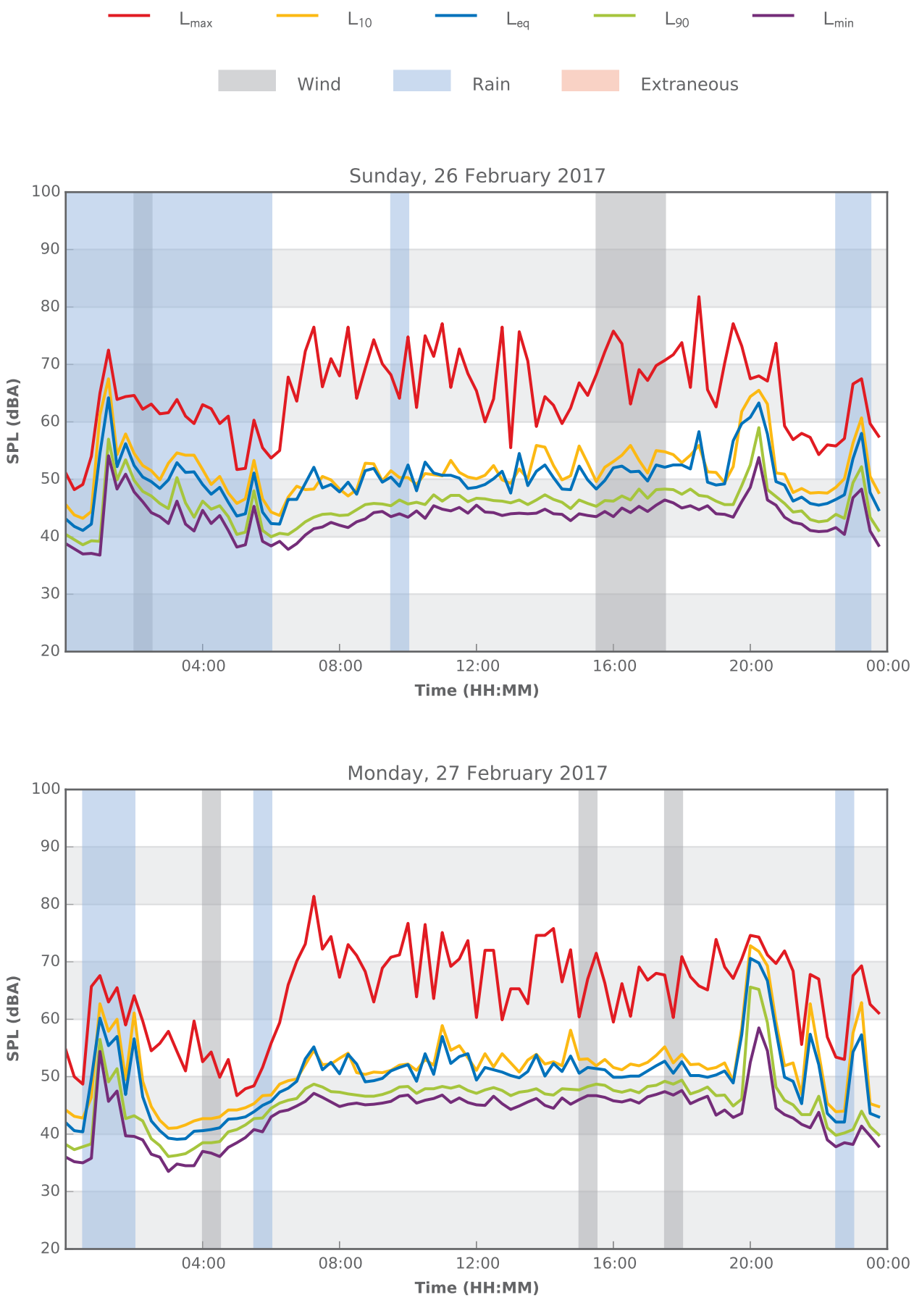

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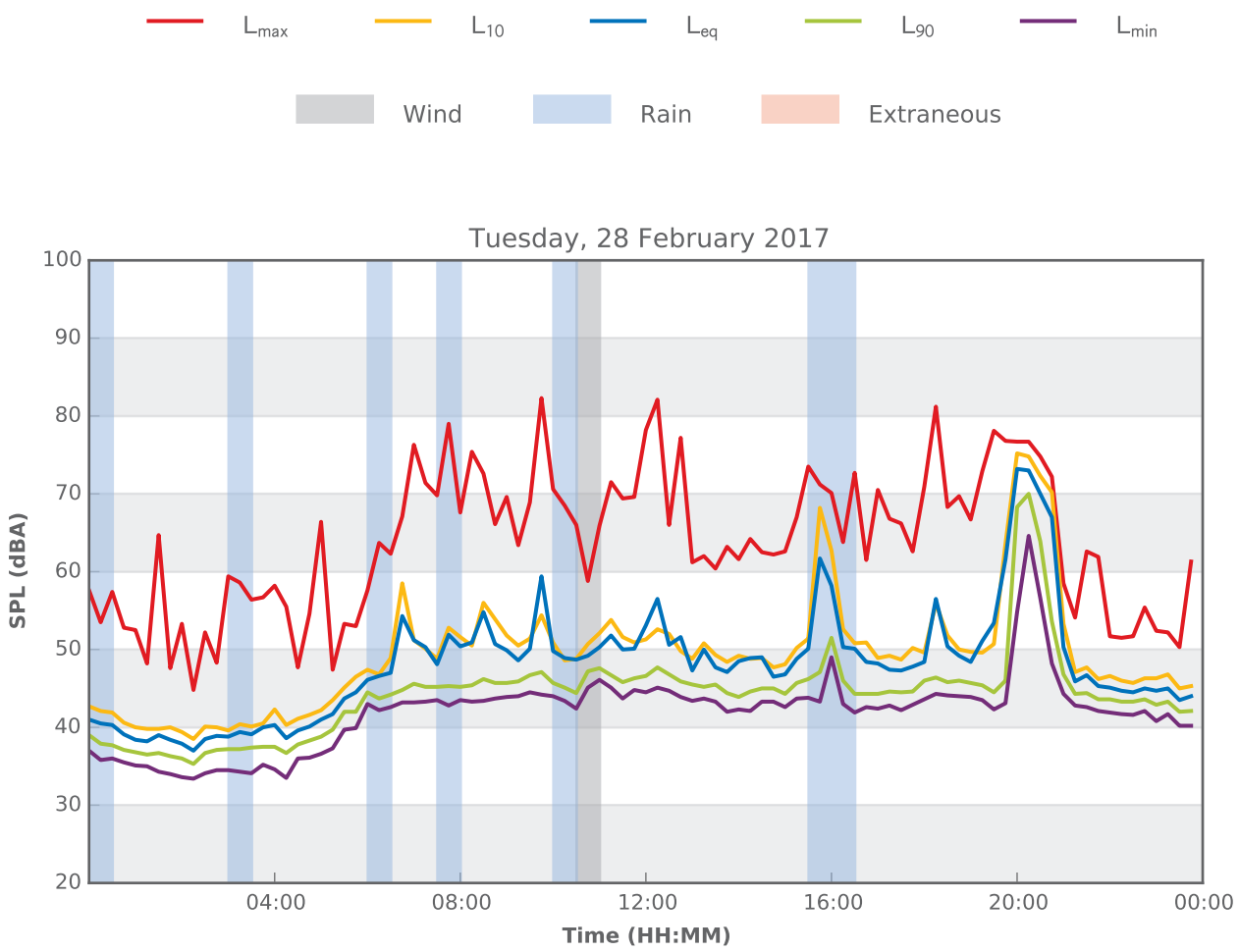

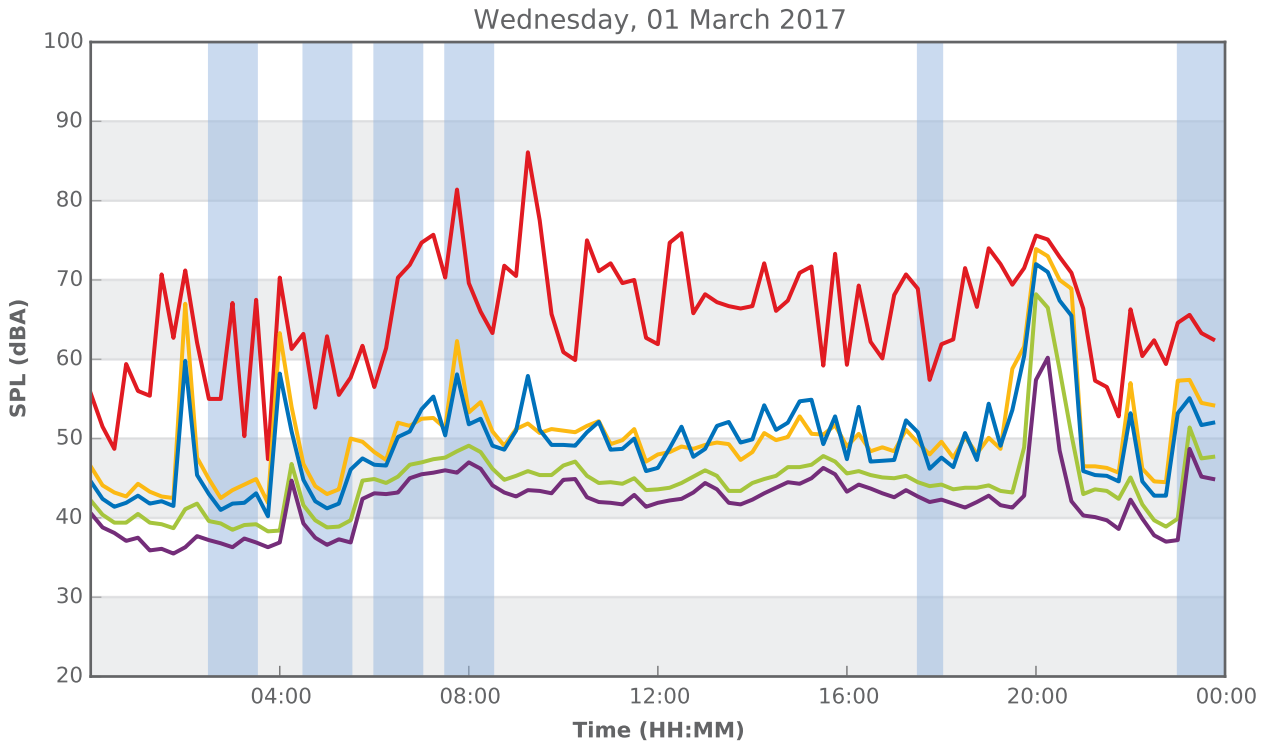

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