ACOUSTICS AND AIR

ALEXANDRIA PARK COMMUNITY SCHOOL

DEVELOPMENT APPLICATION ACOUSTIC ASSESSMENT

AC-REP-16283R1
VERSION A

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PREPARED FOR

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TABLE OF CONTENTS

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.

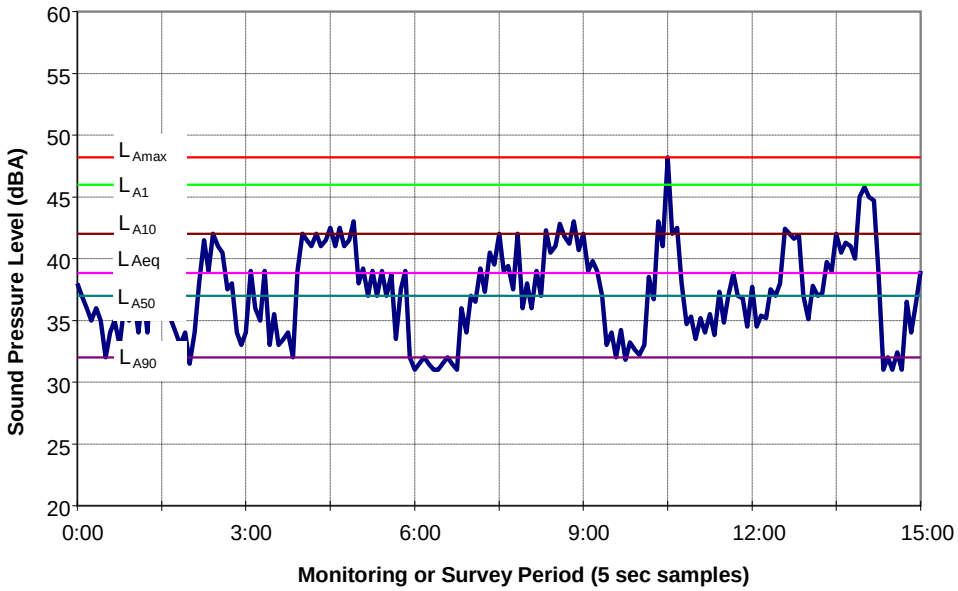
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

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 Acoustic Assessment has been prepared by Wilkinson Murray Pty Limited on behalf of the NSW Department of Education (the 'Applicant'). It accompanies an Environmental Impact Statement (EIS) prepared in support of State Significant Development Application SSD 17_8373 for the redevelopment of 'Alexandria Park Community School' at 7-11 Park Road, Alexandria (the 'Site'). The EIS seeks development consent for the following works:

The redevelopment of the Alexandria Park Community School ('the School') will address issues of capacity for schools in the inner city areas of Sydney and is also driven by the population growth resulting from the large number of residential developments that are transforming the former industrial precincts of Zetland, Waterloo and Alexandria.

The new school has been briefed to accommodate up to 1,000 primary school students and up to 1,200 secondary school students on one campus in an integrated and fully connected school building.

Specifically, this project includes:

- Demolition of all existing buildings on-site, including the temporary pop-up schools;
- Remediation of specific areas of the site containing contaminated fill;
- Construction of multiple school buildings of up to five stories, arranged along the western and southern parts of the site comprising:
    - Classroom home bases;
    - Collaborative learning spaces;
    - Specialist learning hubs;
    - Learning support spaces;
    - Offices for teachers and administrative staff;
    - Library; and
    - Student canteen.
- Construction of a sports hall and multiple outdoor sports courts;
- An all-weather multipurpose synthetic sports field;
- Informal play spaces and Covered Outdoor Learning Space or COLA;
- A community centre;
- A pre-school for 39 children;
- Site landscaping including green links, community garden and open space;
- Construction of a new on-site car park and associated vehicular access point off Belmont Street; and
- Augmentation and construction of ancillary infrastructure and utilities as required.

Delivery of the project will be undertaken in sequential phases to maintain an operational school on the Park Road Campus and will involve enabling works separate to this application followed by three main construction phases for the new building and external works.

The purpose of this report is to provide an assessment of the proposal as described above and detailed within the EIS.

This report specifically determines the potential impacts of operational noise generated by school activities and mechanical plant and equipment upon nearby residential receivers. The potential impact of existing sources of environmental noise upon the future educational facilities has also been considered. Noise and vibration generated during construction works and road traffic noise generated by the project are also addressed.

The acoustic assessment was conducted generally in accordance with the following environmental planning instruments, policies and guidelines:

- *SEPP (Infrastructure) 2007* (iSEPP);
- *NSW Industrial Noise Policy (EPA 2000);*
- *Interim Construction Noise Guideline (DECC 2009);*
- *Assessing Vibration: A Technical Guideline (DECC 2006);*
- *Development near Rail Corridors and Busy Roads – Interim Guideline* (DP&E 2008);
- *NSW Road Noise Policy (DECCW 2011).*

The key issues to be addressed as identified in the Secretary's Environmental Assessment Requirements (SEARS), together with the relevant cross-reference, are documented in Table 1-1.

Table 1-1 SEARS – Key Issues

4. Environmental Amenity	Report Reference
Detail amenity impacts including solar access, **acoustic impacts**, visual privacy, view loss, overshadowing and wind impacts. A high level of environmental amenity for any surrounding residential land uses must be demonstrated.	Sections 4.5, 4.6, 4.7, 5.2, 5.3.
Detail any proposed use of the school grounds out of school hours (including weekends) and any resultant amenity impacts on the immediate locality and proposed mitigation measures.	Sections 2.2, 5.2.4, 5.2.8.

11. Noise and Vibration	
Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation, including consideration of any public address system, school bell and use of any school hall for concerts etc. (both during and outside school hours), and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.	Sections 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 5.2, 5.3.

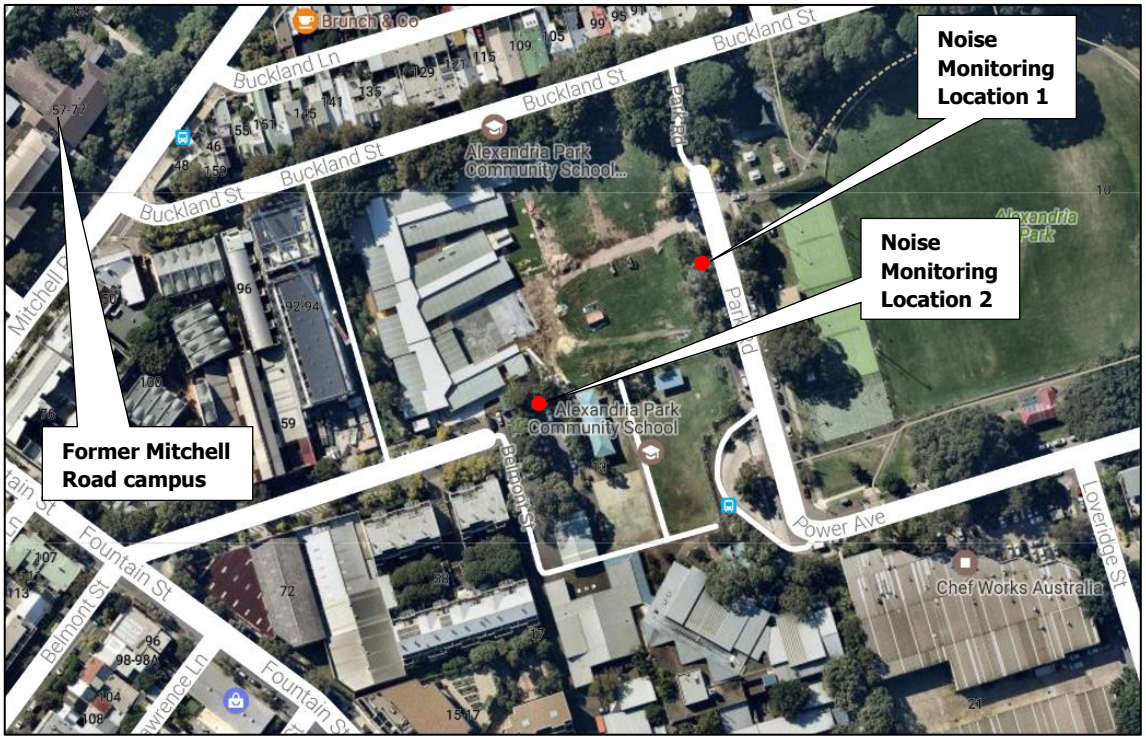
This report presents the assessment methodology, regulatory criteria relevant to operational noise, construction works and road traffic. Where required, recommendations have been included to ensure operations do not result in any adverse noise impacts upon the surrounding community.

2 PROJECT OVERVIEW

2.1 Site Location

The redevelopment of the Alexandria Park Community School will involve the staged construction of new school buildings and outdoor play/sports facilities on the Park Road campus site. The north-western section of Alexandria Park, on the western side of Park Road will be integrated to the redeveloped school grounds. The site location is shown in Figure 2-1.

Figure 2-1 Alexandria Park Community School Redevelopment Location



Aerial image courtesy of ©2017 nearmap

The former Alexandria Park Community School secondary campus was located on the western side of Mitchell Road. The existing Alexandria Park Community School campus is located on Park Road. The temporary school campus has been established on the Park Road site and staff and students from the Mitchell Road campus have been relocated.

Surrounding development is generally residential. Some light industrial premises are located along Power Avenue and Belmont Street. The nearest residences to the redevelopment location are those adjacent the western boundary of the site (92 – 94 Buckland Street currently under construction), on the northern side of Buckland Street opposite the site and on the southern side of Belmont Street, to the south of the site.

2.2 Proposed Development

The NSW DoE is committed to redeveloping the Alexandria Park Community School Park Road campus to cater for up to approximately 1,000 primary students and up to approximately 1,200 secondary school students. The redevelopment may comprise a combination of new buildings and refurbishment of existing facilities. The resulting new school will be a multi-storey construction that maximises open space and provided state-of-the-art facilities to meet the future educational needs of the surrounding community. A temporary school has been established on the Park Road site and staff and students from the Mitchell Road campus have been relocated.

The intention is for the redevelopment project to be staged approximately as follows:

Delivery of the project will be undertaken in sequential phases to maintain an operational school on the Park Road Campus and will involve enabling works separate to this application followed by three main construction phases for the new building and external works. These phases are defined as follows:

- Enabling Works – Construction of 2 temporary demountable schools on Buckland Street side of the school (not part of this application);
- Phase 1 – Demolition of the existing Park Road building and construction of the southern part of the new building, including new COLA and associated external works;
- Phase 2 – Demolition of Pop up School 1 and construction of the remaining part of the new building, carpark and two outdoor sport courts;
- Phase 3 – Demolition of Pop up School 2 and construction of the new synthetic sports field and completion of the entry forecourt.

The proposed phasing strategies are shown in Figure 2-2, Figure 2-3 and Figure 2-4.

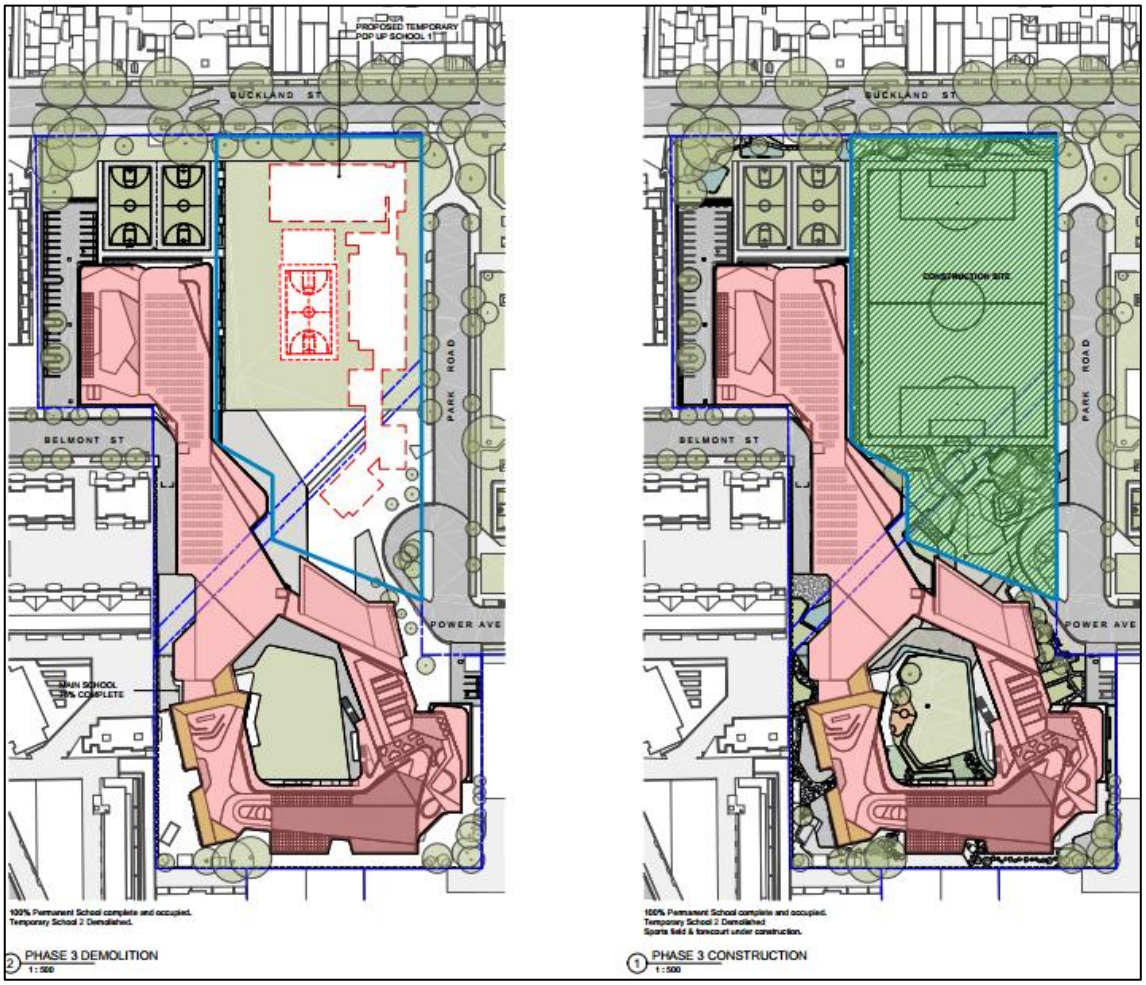
Figure 2-2 Phase 1

Drawing courtesy of TKD Architects

Figure 2-3 Phase 2

Drawing courtesy of TKD Architects

Figure 2-4 Phase 3



Drawing courtesy of TKD Architects

The proposed school layout presents the secondary school generally on the northern half of the site with the primary campus occupying the southern area.

The secondary campus will essentially be contained over three levels with a future fourth level proposed.

- Ground Level principally includes the gym/hall, fitness workshop (and associated amenities areas located in the northern hub), OOSH and food technology unit along with the canteen, ancillary support facilities and amenities.
- Level 1 is principally dedicated to the PDHPE unit, performing arts facilities including band and music practice rooms.
- Level 2 contains general learning space and the visual arts and multimedia units which flow through into the Design and Technology units.
- Level 3 contains general learning space in the northern hub which flow through into the science unit.
- Proposed future Level 4 is contained in the northern hub and includes general learning space.

The primary campus includes three storey buildings arranged around a central courtyard. Kindergarten and student services including canteen are located at ground level, library, administration, executive staff offices on first floor levels with special program and staff facilities at second level. Learning and support spaces are located over the three levels throughout the southern hub units.

A limited number of new carparking spaces (indicatively 28 space) will be located on the school site.

The redeveloped campus will continue to operate during the current school hours. A community centre and preschool currently operate on the site during school hours. The existing school facilities are currently used out of hours by an extensive group of community users including Aboriginal organisations, sports organisations and community organisations. The school intends to continue this shared community use following redevelopment. Use of the sporting facilities, teaching spaces and hall may be used out of hours. No specific details are currently available however the organisations that currently have arrangements to use the school facilities appear to meet the requirements of the SEPP (Education Establishment and Child Care Facilities) 2017 (Education SEPP). Community use will be subject to the approved hours of operation. Hours of operations will be from 7.00am to 10.00pm when activities will cease. Pack-up and clean-up will follow, with the site vacated prior to, and no later than 11.00pm.

The proposed floor plans for the educational redevelopment are included in Appendix B.

This assessment considers noise emissions associated with the redevelopment, and their potential impact on nearby residences, including:

- Noise and vibration generated during construction works;
- Noise from mechanical plant associated with the new buildings to nearby residences; and
- Noise from activities associated with the new buildings and facilities at the school to nearby residences.

Potential impacts associated with noise emissions from road traffic, on-site car parking and outdoor activities are considered to be of marginal significance, given the proximity of the former secondary school and the existing Park Road primary campus to the redevelopment site and the interim operation of the temporary school on the site.

3 EXISTING NOISE ENVIRONMENT

3.1 Ambient Noise Survey

In order to characterise the existing acoustical environment in the area, ambient noise monitoring was carried out from Tuesday 17 January 2017 to Friday 20 January 2017 (during school holiday period). The location, adjacent to eastern boundary of the redevelopment site (adjacent Alexandria Park), was selected to quantify the potential exposure of future school buildings to any prevailing environmental noise sources, and to determine the minimum background sound levels likely to be experienced for the purpose of establishing environmental emissions criteria for the assessment of operational noise.

Instrumentation for the survey comprised an Acoustic Research Laboratories (ARL) Environmental Noise Logger Type EL-215 (serial number 194505) fitted with microphone windshield. Calibration of the logger was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

A second survey of ambient noise to supplement the data obtained from the initial monitoring was conducted from Thursday 25 May 2017 to Saturday 3 June 2017 (during school term). The logger location, east of the Belmont Street entry and to the rear of the temporary school buildings (refer Figure 2-1), was selected to minimise the contribution from construction noise. This location was generally quite well-shielded from the works on the neighbouring site on 92 -94 Buckland Street.

Instrumentation for the survey comprised an Acoustic Research Laboratories (ARL) Environmental Noise Logger Type EL-215 (serial number 194622) fitted with microphone windshield. Calibration of the logger was checked prior to and following measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

The loggers continuously sampled noise levels over the entire survey period, and calculated relevant statistical indices for each 15-minute interval. Data measured during periods of adverse weather, established through consultation with historical weather reports provided by the Bureau of Meteorology (BOM), has been excluded. The results from both survey periods are contained within Appendix A.

3.2 Noise Monitoring Results

The results of the unattended noise logging have been processed in accordance with the NSW SEPP *(Infrastructure)* 2007 and NSW *Road Noise Policy* time periods to determine the levels of road traffic noise experienced at the site during the daytime and night-time. Table 3-1 details the $L_{Aeq(15hour)}$ daytime, the $L_{Aeq(9hour)}$ night-time and the $L_{Aeq,1hr}$ road traffic noise levels recorded during the survey.

Table 3-1 Measured Road Traffic Noise Levels

Measurement Location	Noise Level - dBA re 20 µPa		
	$L_{Aeq(15hour)}$	$L_{Aeq(9hour)}$	$L_{Aeq(1hour)}$
Location 1	58	47	58[1]
Location 2	60	47	61

Note 1: Estimated due to the influence of nearby construction noise.

To determine project specific criteria on which to base assessment of operational noise emissions, the measured data was processed according to the NSW Environment Protection Authority's (EPA) *Industrial Noise Policy* (INP) assessment time periods. Table 3-2 details the RBL (background) noise levels and the L_{Aeq} noise levels recorded during the daytime, evening and night-time periods.

Table 3-2 Measured Ambient Noise Levels Corresponding to NSW INP Assessment Time Periods

	Noise Level – dBA re 20 µPa					
	Daytime 7.00am – 6.00pm		Evening 6.00pm – 10.00pm		Night-time 10.00pm – 7.00am	
	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
Location 1	49	59	43	52	39	47
Location 2	46	60	43	50	37	45

The noise environment is dominated by traffic on Mitchell Road and the surrounding road network with construction works occurring on the temporary school site and neighbouring residential apartment development.

Short-term attended measurements of background noise, conducted in Buckland Street during the first ambient noise survey period resulted in an L_{A90} noise level of 49dBA (as reflected in the unattended long-term monitoring). This level included contributions from surrounding construction works. The L_{A90} background sound level in Belmont Street west of Fountain Street was 46dBA. This level was considered representative of the background noise environment typically encountered in inner suburban residential areas and is supported by the results of the second ambient noise survey. The lower night-time RBL measured during the second survey can be attributed to the more shielded monitoring location. This level would more closely align with the night-time environment in Belmont Street whilst the RBL measured during the first survey is reflective of Buckland Street receivers.

4 CONSTRUCTION NOISE & VIBRATION

This section of the assessment relates to typical construction activities expected to occur during redevelopment works on the site, and their impact on residential receivers to the north and west.

4.1 Construction Noise Criteria

The following sections detail the applicable site-specific noise and vibration criteria based on the EPA's *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 LAeq, 15min noise management level should not exceed the background noise by more than 10dBA. This applies to construction works conducted during standard hours which are defined as 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 applicable is 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 + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 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.

The applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

On the basis of the background noise logging results presented in Section 3.2, a summary of the noise management levels adopted for construction activities at residential receivers are presented in Table 4-2.

Table 4-2 Site-Specific Construction Noise Management Levels

Construction Noise Management Level, $L_{Aeq,15\ min}$ – dBA			Highly Noise-Affected Noise Level, L_{Aeq} dBA
Day	Evening	Night	
56	48	42/44[1]	75

Note 1: Belmont Street/Buckland Street

4.2 Hours of Operation

The proposed working hours for this project are as follows:

- Monday to Friday 7.00am to 6.00pm
- Saturdays 8.00am to 1.00pm
- Sundays and Public Holidays No work

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 (L_W) for typical construction plant are identified in Table 4-6. These L_w are based upon archival data from measurements at other similar construction sites. The Sound Power Level and Sound Pressure Levels (L_p) at 7m are listed 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	103	84
Concrete Pump	103	87
Mobile Crane	99	73
Dump Truck	107	83
Compressor	103	78
Hand Tools	100	75
Bulldozer	107	89
Auger Piling Rig	107	87
Excavator	102	82

4.5 Construction Noise Predictions

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

Site-related noise emissions were calculated addressing the following factors:

- Equipment sound level emissions and location;
- Receiver locations;
- Ground topography;
- Distance between source and receiver;
- Ground absorption;
- Atmospheric absorption.

Modelling has been conducted for the three major works scenarios as summarised in Table 4-7.

Table 4-7 Construction Works Scenarios

Scenario	Description	Works
A	Demolition & Excavation	Minor demolition works and excavation – mainly using excavators with dozers. Truck movements.
B	Building Construction	Bored piling, concreting and lifting. Bored piling rig, concrete pump & boom, compressor, crane are assumed to operate in 15minutes. Also, concrete trucks and normal delivery trucks.
C	Facade / Fitout	In the event that the construction of the facade occurs in isolation. Mobile crane and power tools assumed.

Calculations have been conducted for each scenario with plant operating in "worst case" and "typical" locations across the construction site.

In all instances has been assumed plant operates continuously and simultaneously. As such, predictions represent the noise levels that would likely occur during intensive periods of construction. The resulting noise levels can be considered in the upper range expected at surrounding receivers throughout the course of construction works.

The results of construction noise predictions are shown in Table 4-8. Exceedances of the NML (56dBA) are listed applicable to works during recommended standard hours. Exceedances of the "Highly Noise-Affected" 75dBA limit are identified in bold.

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

	R1 Buckland Street - North						
Scenario	**Phase**	**Activities**	**Total L_w dBA**	**Maximum Noise Level**		**Exceedance NML**	
				Closest	**Typical**	**Closest**	**Typical**
1	2, 3	Demolition and Excavation	114	67	62	11	6
2	2, 3	Building Construction	112	66	60	10	4
3	2, 3	Facade/Fitout	105	59	53	3	0
	R2 Buckland Street - West						
Scenario	**Phase**	**Activities**	**Total L_w dBA**	**Maximum Noise Level**		**Exceedance NML**	
				Closest	**Typical**	**Closest**	**Typical**
1	2, 3	Demolition and Excavation	114	**78**	66	22	10
2	2, 3	Building Construction	112	**76**	64	20	8
3	2, 3	Facade/Fitout	105	69	57	13	1
	R3 Belmont Street						
Scenario	**Phase**	**Activities**	**Total L_w dBA**	**Maximum Noise Level**		**Exceedance NML**	
				Closest	**Typical**	**Closest**	**Typical**
1	1, 2	Demolition and Excavation	114	**79**	72	23	16
2	1, 2	Building Construction	112	**78**	70	22	14
3	1, 2	Facade/Fitout	105	71	63	15	7

4.6 Discussion of Results

The greatest potential impact from construction occurs when mobile construction plant operates in closest proximity to residential receivers adjacent to the western boundary. Throughout the demolition and excavation period, careful management will be required to minimise impact at residences.

A review of the predicted noise level range indicates exceedances of up to 23dBA may occur during bulk excavation works. This exceedance is not unusual for construction works in a relatively quiet residential area and can be mitigated by the construction noise management procedures detailed in the following sections.

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.

4.7 Construction Vibration Assessment

Operation of piling rigs and the like may 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 4-10 Recommended Safe Working Distances for Vibration-Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Pile Boring	≤ 800mm	2m (nominal)	N/A
Jackhammer	Hand held	1m (nominal)	Avoid contact with structure

The highest vibration levels will occur when construction equipment is located on the western side of the site near Buckland Street and Belmont Street apartments.

On review of the site layout and surrounding receivers, the minimum distance between the vibration generating activities and surrounding residences will be in the order of 10 metres. Safe working distances will be achieved.

It is recommended that trial testing of vibration levels when piling occurs be conducted where identified equipment having the potential to exceed the human comfort criteria is proposed.

4.8 Construction Noise & Vibration Mitigation Measures

When operating in closest proximity to the neighbouring residential properties along the western side of the site, noise levels from construction works are likely to exceed the applicable noise management levels. Noise control measures are recommended to ensure that noise is minimised where feasible and reasonable.

The following project-specific mitigation measures should be adopted:

- Installation of localised noise barriers between piling rigs and western residences;
- Selection of quietest feasible construction equipment;
- Use of rock saws and ripping in preference to rock breakers if rock removal is required (unlikely);
- Localised treatment, such as barriers, shrouds and the like around fixed plant, such as pumps, generators and concrete pumps;
- Provision of respite periods, particularly on Saturdays; and
- Trial testing of vibration levels 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 service. To this end, testing should be established with the Contractor.
- *Operator Instruction* – Operators should be trained 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 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 should be optimised to minimise noise emission levels.

Adoption of these measures is aimed at working towards achieving the noise management levels established at surrounding receivers.

4.9 Community Liaison & General Approaches to Mitigation

An effective community relations programme should be put in place to keep the surrounding community informed of work progress, and to forewarn potentially affected receivers (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 the work site 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.

4.10 Noise & Vibration Management Plan

A Construction Noise and Vibration Management Plan should be prepared and implemented by the Contractor. The plan should reference the findings of this assessment. Areas to 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 ASSESSMENT

5.1 Assessment Criteria

5.1.1 Environmental Noise Intrusion

The Educational Facilities Standards and Guidelines (*EFSG*) set out the minimum standards and design criteria for all new Department of Education (DoE) projects. Design Guide 11 documents the recommendations in relation to acoustical design and Table 11.06.1 lists the recommended internal noise levels for various areas of occupancy within schools based upon the "satisfactory" design levels from AS 2107:2016. A level of 35dBA is recommended for primary and secondary school teaching spaces. Whilst 35dBA reflects the "optimum" design level, AS 2107:2016 recommends up to 45dBA as being acceptable.

Based upon the recommendations of the *RNP*, the *Interim Guideline*, AS2107:2016 and the *EFSG*, the design levels shown in Table 5-1 have been adopted as the limiting criteria for internal noise intrusion to potentially sensitive spaces within future school buildings.

Table 5-1 Recommended Internal Noise Levels

Room	**Noise Level** $L_{Aeq,1hr}$ **- dBA**
Classrooms	40
Hall	40
Library	40
Music Practice	40
Drama Studios	40
AV Rooms	40
Art/Craft	40
Laboratories	40 - 45
Fitness rooms	< 50
Manual Arts Workshops	< 45
Admin	40
Staff	40 - 45

5.1.2 Operational Noise Emissions

Operational noise from the proposed facilities may be generated by the following activities:

- Mechanical services plant;
- Teaching and practical activities, particularly (timber and metal) technology workshops and performing arts-based;
- School announcements and bells;
- Sporting events and concerts in the Hall;
- Sporting activities in outdoor play areas.

Noise impact from the general operation of the proposed school redevelopment is to be assessed with respect to site-specific noise criteria based on ambient noise monitoring conducted at the site in accordance with the NSW *Industrial Noise Policy* (INP).

The INP is not intended to be applicable to schools, and there are no criteria specifically relating to noise emissions from primary and secondary schools. Some noise emissions will be consistent with those from industrial or commercial premises. These include external mechanical plant and activity-related noise generated during the use of such spaces as the hall, music facilities and performance spaces and industrial technology workshops. It is therefore reasonable and appropriate to consider these sources of noise in the context of the INP.

The INP criteria for industrial noise sources have two components:

- Controlling the *intrusive* noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level *amenity* for particular land uses for residents and sensitive receivers in other land uses.

Intrusiveness Criterion

For assessing intrusiveness, the background noise level must be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source (measured over a period of 15 minutes) should not be more than 5 dBA above the measured Rating Background Level.

Amenity Criterion

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. If present, the existing noise level from industry is generally measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas the amenity criterion for industrial noise becomes the $L_{Aeq,period(traffic)}$ minus 10 dB.

An extract from the NSW INP that relates to the amenity criteria recommended for surrounding residential receivers (Urban Amenity Area) is given in Table 5-2.

Table 5-2 Amenity Criteria - Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dBA	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

The project-specific goals for continuous operational noise emissions associated with the school facilities are shown in bold in Table 5-3. Note that intrusiveness criteria are evaluated over a 15-minute period, while amenity criteria are evaluated over an entire day, evening or night period. As industrial noise sources do not determine (or influence) the existing ambient noise levels in the immediate area, and future development is predominantly residential, it is appropriate to use the 'recommended acceptable noise levels' specified in the INP for an urban area as the basis for the amenity criteria for the redevelopment project.

Table 5-3 Assessment Criteria for Continuous Operational Noise Emissions

Location	Area Classification	Period	ANL [1] $L_{Aeq(period)}$ dBA	RBL [2] $L_{A90(15min)}$ dBA	$L_{Aeq\ (period)}$ Noise Level dBA	Criteria for New Sources[3]	
						Intrusive[4] $L_{Aeq(15min)}$	Amenity $L_{Aeq\ (period)}$
Residence	Urban	Day	60	49/46[5]	59	**51**	60
		Evening	50	43	52	**48**	50
		Night	45	37/39[6]	47	**42/44[6]**	45

Note 1: Recommended - ANL Acceptable Noise Level.
Note 2: RBL Rating Background Level.
Note 3: Assuming existing noise levels unlikely to decrease in the future.
Note 4: Intrusive criterion only applicable to residential receivers
Note 5: Daytime background L_{A90} level of 49dBA influenced by contributions from construction works on the subject and neighbouring sites. Attended measurements established the L_{A90} background sound level in the absence of construction noise in Belmont Street west of Fountain Street as 46dBA. This level was supported by the results of the second ambient noise survey. Accordingly, this level has been conservatively adopted as the basis for determining the assessment criteria for daytime operational noise emissions.
Note 6: Belmont Street receivers/Buckland Street receivers.

5.1.3 Road Traffic Noise

The *NSW Road Noise Policy* (2011) was released by the EPA to replace the *Environmental criteria for road traffic noise* (1999) from 1 July 2011. The key provisions of the policy are an emphasis on the use of land use planning, better road design and vehicle noise emission control to avoid or minimise road traffic noise impacts. Wattle Street is a sub-arterial road carrying in excess of 20,000 vehicles per day. Wentworth Park Road is also classified as a sub-arterial road. The assessment criteria for residences potentially affected by additional traffic generated by land use developments on arterial and sub-arterial roads are summarised in Table 5-4.

Table 5-4 Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Development	Assessment Criteria – dBA	
		Day (7am-10pm)	**Night (10pm-7am)**
Freeway/arterial/sub-arterial roads	Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,15hr}$, 60 (external)	$L_{Aeq,9hr}$ 55 (external)
	Relative Increase Criteria	Existing traffic $L_{Aeq,15hr}$ + 12 dB (external)	Existing traffic $L_{Aeq,9hr}$ + 12 dB (external)
Local roads	Existing residences affected by **additional traffic** on existing local roads generated by land use developments	$L_{Aeq,(1hour)}$ 55 (external)	$L_{Aeq,(1hour)}$ 50 (external)

Where predicted noise levels exceed the project-specific noise criteria, an assessment of all feasible and reasonable mitigation options should be considered. The *RNP* states that *an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person*.

5.2 Operational Noise Assessment

5.2.1 Noise Intrusion

The site is not exposed to excessive levels of road traffic, aircraft or other sources of environmental noise.

Acceptable noise levels will generally be achieved throughout the educational facility. Where required, special purpose spaces will be designed to incorporate acoustic treatment as required to minimise noise ingress and egress to achieve acceptable levels.

5.2.2 Mechanical Services Noise

The noise emission of any mechanical plant associated with the proposed new buildings should be controlled so that the operation of such plant does not adversely impact upon surrounding residential properties. Air-conditioning will not be provided throughout the general school. Some localised areas may be air-conditioned but these will involve the use of split systems with small condenser units. Where individual split systems are provided, typically low-noise levels of around 55 – 58dBA at 1m can be expected from outdoor units. Operational noise emissions from these units would achieve design limits at adjacent residential receivers. Hydronic in-slab heating with condensing boilers is proposed and electric heat pump for water heating. This plant will be located within a services zone on Level 2 with noise emissions controlled by acoustic louvres.

Exhaust fans and dust extraction systems will likely be required for the wood/metal technology and food technology rooms.

Mechanical plant selection and location will be finalised during the detailed design phase. At this stage, potentially noise generating equipment will be examined to ensure compliance with the recommended criteria for mechanical noise emissions both to the site boundaries and at sensitive receiver locations within school buildings.

5.2.3 Classroom/Activities Noise

In terms of noise emissions, the primary school contains no teaching spaces of acoustical significance. All classrooms will be of a general learning nature and, as such, would not be considered to generate high levels of noise on a regular and on-going basis.

Generally, it is anticipated that the noise levels throughout the secondary school general learning spaces, seminar rooms, laboratories and passive social space will be relatively low. The technology-related workshops, performing arts, music rooms, sports hall are more likely to result in audible noise emissions. Calculations have been carried out to determine indicative levels of noise received at neighbouring residential properties due to activities typically conducted within these spaces.

Since the project is still in the development stage and detailed architectural design of the future buildings has not yet been finalised, we have endeavoured to ensure that calculations conducted are conservative.

5.2.4 Sports Hall

The sports hall building is located towards the northern end of the site. The building construction has not been defined however a lightweight cladding or glazed panel exterior, with glazed tilt-up doors on the northern elevation and a metal deck roof has been assumed.

Since the building will function as both a gymnasium and auditorium, noise will be generated by sporting activities, performances and presentations.

In sports mode, the highest noise-generating usage would likely be associated with competitive basketball games. An L_{Aeq} over 15 minutes of around 84dBA (reverberant sound pressure level) is typical during normal school basketball games, which includes the use of whistles.

Assuming a reverberant sound pressure level of 84dBA within the sports hall, the predicted $L_{Aeq,15min}$ at the potentially most exposed residential receivers in Buckland Street (to the north) is 25dBA assuming door openings on the northern facade are closed. With doors on the northern elevation open, the predicted $L_{Aeq,15min}$ at the potentially most exposed residential receivers in Buckland Street is 48dBA. Noise level emissions to the western boundary and (future) neighbouring residential apartments are expected to be around 35dBA predicted during typical sports usage with northern doors closed and 42dBA with the northern doors open.

The most stringent project-specific noise limit for residential receivers is $L_{Aeq,15min}$ 48dBA assuming an evening (out of school hours 6.00pm – 10.00pm) event. Sporting events, and other ancillary sports-related usage of the sports hall, including community use, will achieve the recommended criteria for environmental noise emissions during all operational periods and during out of hours use.

When operating in performance mode, the worst case acoustical scenario would involve a presentation involving live music. Assuming a reverberant sound pressure level of 90 dBA within the space (L_w 112dBA), the predicted $L_{Aeq,15min}$ at the potentially most exposed residential receivers in Buckland Street (to the north) is 33dBA assuming door openings on the northern facade are closed. With door openings on the northern elevation open, the predicted $L_{Aeq,15min}$ at the potentially most exposed residential recievers in Buckland Street is 54dBA. Noise level emissions to the western boundary and (future) neighbouring residential apartments are expected to be around 43dBA with door openings on the northern facade closed and 50dBA with doors open.

The most stringent project-specific noise limit for residential receivers is $L_{Aeq,15min}$ 48dBA assuming an evening (out of school hours 6.00pm – 10.00pm) event. Use of the sports hall in performance mode (absolute worst case scenario) will achieve the recommended criteria for environmental noise emissions during daytime and evening operational periods with the door openings on the northern elevation closed.

5.2.5 Design & Technology

Noise levels generated within the timber and metal technology workshop spaces will vary depending upon the type of equipment operated. Power tool usage would generate the highest noise level emissions within these spaces. Based on previously measured workshop noise levels, sound power levels can be expected to range between 78dBA for a bench drill, to 97dBA for a tech screw gun. Pneumatic hand tools generally have sound power levels of around 94dBA with pneumatic wrenches and ratchet guns around 98dBA to 99dBA.

The building construction has not been detailed however lightweight cladding exterior with operable glazing (on the eastern elevation in the case of the workshop) has been assumed. Based upon several power tools operating and a reverberant sound pressure level of 85dBA within the space, the noise emissions to the nearest residential receivers to the north could be in the order of 27dBA with doors/windows on the eastern elevation open. With doors/windows on the eastern elevation closed, the received level is likely to be less than 20dBA.

Operational noise emissions will achieve the environmental goal for the project at the nearest potentially sensitive receivers to the north (Buckland Street) with doors and windows open within the workshop spaces.

5.2.6 Band Room

Noise level emissions from the proposed band room to the nearest residential premises adjacent to the western boundary have been calculated based upon a reverberant sound pressure level of 85dBA with a typical school band playing within the space. This level is based upon archival data measured within similar spaces with a school jazz band playing.

The building construction has not been detailed however a composite lightweight cladding exterior with operable glazing has been assumed as a worst case. Calculations of the noise breakout from the band room during the assumed typical worst case operational scenario, result in a received noise level at the adjacent residences to the west of 30dBA with windows closed and 45dBA with windows open. These levels comply with the criteria applicable to operational noise during normal school and out of hours use.

5.2.7 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 whilst being directed away from residences. System coverage should be reviewed during the detail design stage.
- 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.

5.2.8 Outdoor Noise

Alexandria Park is currently used for outdoor activities by the existing school and general community. In addition, noise from outdoor activities taking place at the existing primary and secondary schools form a part of the prevailing ambient noise environment of the immediate area.

Sporting activities on the outdoor courts will generate noise from players, spectators, whistles and announcements.

No appreciable change or significant acoustical impact is therefore expected to result due to the school redevelopment.

Noise from sports-related PA should be limited by locating any speakers on the northern side of the courts directed downwards towards the courts and school.

Table 5-5 provides the typical sound power levels associated with sports activities.

Table 5-5 Typical Sound Power Levels of Sporting Activities/Events

Activity	Typical SWL ($L_{Aeq,15min}$)
≈ 15 students playing outside during lunch time	91dBA
≈ 15 students playing on a court with a small crowd	95dBA

Noise levels during a game with a small crowd can be expected to be in the order of 55dBA at residences on the northern side of Buckland Street and 59dBA at the residential apartment building to the west of the site. These levels exceed the daytime noise objective of 51dBA, and in the case of outside hours use, the evening objective of 48dBA. Noise emissions associated with sporting activities (school and community use) are expected to be generally within the range of background L_{A90} + 10dBA.

In order to minimise reduce the potential impact at residences the following recommendations made:

- Restrict the use of the sports courts prior to 7.00am.
- Minimise PA use and ensure speakers are appropriately located and limited to achieve acceptable levels.
- The L_{Amax} noise level from the PA system operation shall not exceed 56 dBA at the nearest residential boundary.
- The PA system should use small low-powered horn-type speakers oriented in such a manner to fire away from residential premises.
- Speakers should be mounted at a downward angle of 45^{o} and as close to ground level as possible.
- Only nominated persons, trained in the appropriate use of the system, should be permitted to operate the PA system.
- A sound limiter is to be installed to ensure that the maximum limiting criterion at residential boundaries is not exceeded.

It is recommended that management of noise be included in any site management plan.

5.3 Road Traffic Noise

The majority of students are understood to arrive on foot or by public transport. The existing school campus provides limited off-street parking for staff. A small number of on-site car spaces (indicatively 28 spaces plus accessible/delivery) are proposed on the redeveloped school site and little change is expected in traffic movements associated with the redeveloped school campus. There is unlikely to be significant change in the existing levels of road traffic currently experienced at receivers along either Buckland Street, Belmont Street or Park Road.

6 CONCLUSION

An assessment of the noise impact associated with the redevelopment of the Alexandria Park Community School on the Park Road campus site has been conducted. This development is required to meet the future educational needs of the surrounding community. A temporary school has been established on the Park Road site and staff and students from the Mitchell Road campus have been relocated. This assessment has been carried out in accordance with NSW regulatory requirements and this report is forms part of the EIS submission to the NSW Department of Planning and Environment.

The scope of the assessment involved a survey of the existing noise environment; derivation and establishment of assessment criteria for noise emissions; a noise impact assessment relative to appropriate criteria; and recommendations for measures to minimise the potential for disturbance to surrounding residents and commercial properties. The findings are as follows:

Construction Noise and Vibration

No detailed construction plan or schedule is available at this stage of the project, therefore prediction of construction noise levels should be regarded as indicative. Three work phase scenarios have been considered during each of the project phases, with an overall sound power level adopted for each based upon the likely plant operating throughout. Predictions have been carried out assuming the concurrent operation of all plant at worst case (closest) and typical locations.

The NMLs at nearby residential receivers can be expected to be exceeded, at times significantly, during periods of intensive high noise level works associated with demolition, excavation and building construction involving bored piling, concrete pours and the like. During general construction works, for example facade and fitout, the NMLs would only be significantly exceeded when plant operates in closest proximity to receivers near the (western) site boundary.

Throughout the noisier work periods adoption of reasonable and feasible noise management and mitigation will be required to minimise impact at residences.

A Construction Noise Management Plan, to be implemented by the Contractor, should be prepared. This plan should clearly identify the strategies to be put in place to minimise potentially adverse noise impacts upon the surrounding community (including the school).

Vibration is unlikely to be a significant concern however, should activities be required that may generate vibration, further, more detailed assessment shall be conducted.

Noise Intrusion

The site is not exposed to excessive levels of road traffic, aircraft or other noise sources. The recommended design objectives for environmental noise intrusion will be achieved within all spaces.

Operational Noise

The predominant sources of potential operational noise were identified as the sports hall building, technology workshops, band room and future mechanical plant. The noise level emissions from assumed worst-case operational scenarios of the future potentially noise-generating activity/teaching spaces have been predicted to the nearest surrounding residential receivers.

The results of calculations of continuous operational noise sources were compared with design goals for environmental noise, determined in accordance with State Government guidelines. All relevant criteria can generally be achieved by the development. Detailed mechanical plant selection will take place during the detailed design phase. Acceptable noise levels due to plant operation are likely to be achieved given the location of plant within a services zone enclosed by acoustic louvres. Further assessment will be required when detailed mechanical services design and plant selection becomes available.

Noise from outdoor activities held on the site (school and community use) is not expected to undergo any significant change due to the redevelopment of the school. Emissions during use of the outdoor courts are expected to generally achieve L_{A90} background + 10dBA limit. Operation of the outdoor sports facilities should be managed to minimise noise emissions to nearby residences by measures such as restricting use prior to 7.00am and limiting the use of whistles and PA system (where feasible).

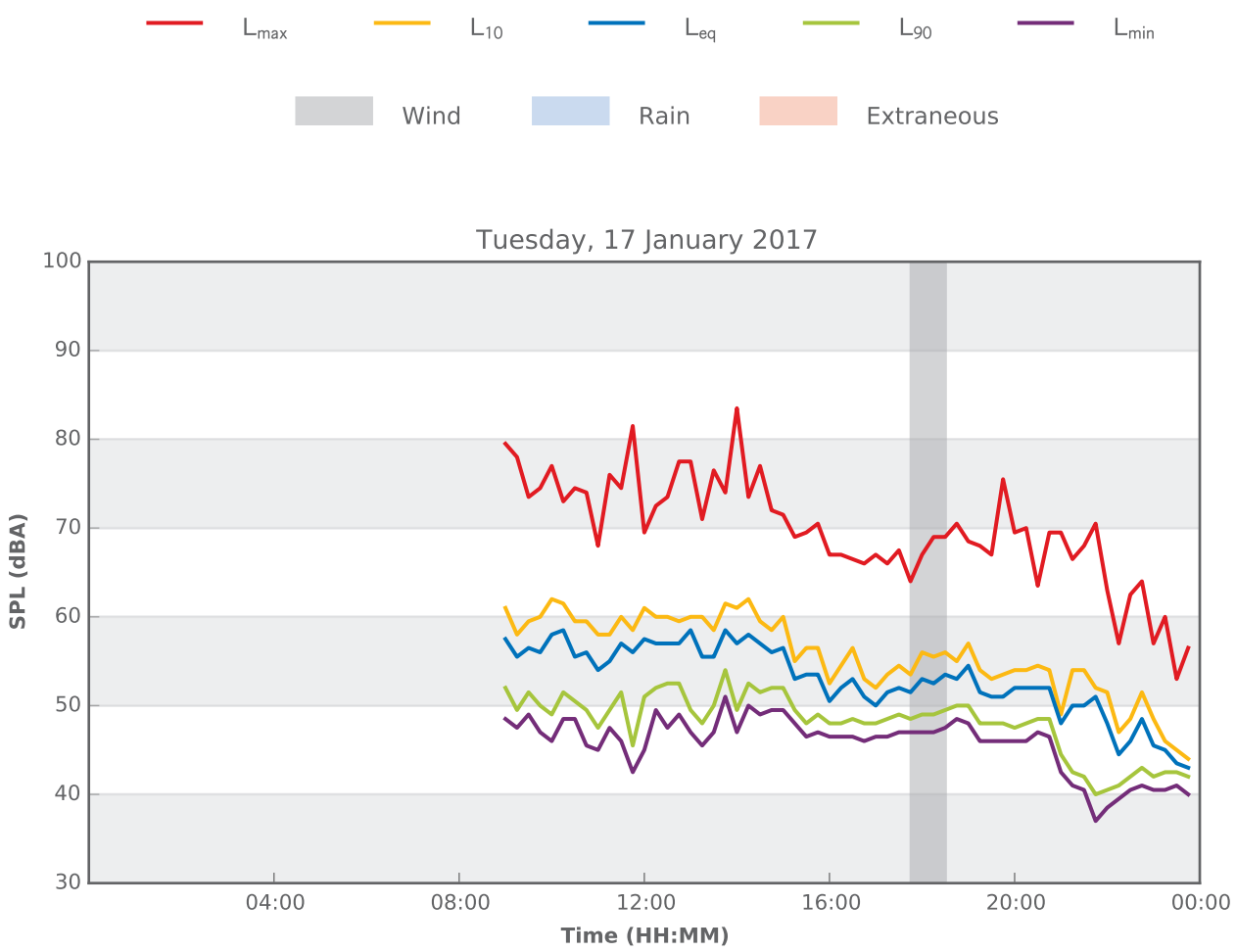
Road Traffic Noise

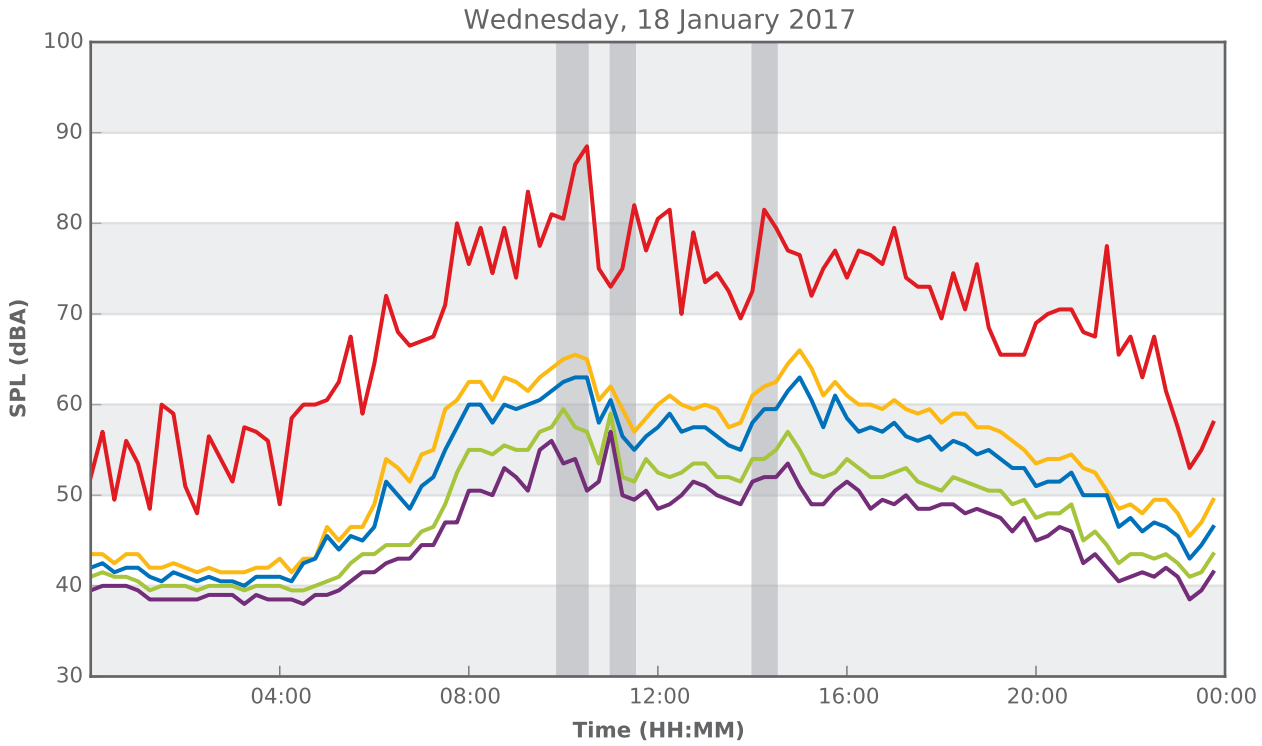
Road traffic generated by the development will comply with the NSW *Road Noise Policy* (RNP) guidelines and is not expected to have any significant effect on road traffic noise levels currently experienced at receiver locations along Buckland Street, Belmont Street or Park Road.

APPENDIX A

NOISE MEASUREMENT RESULTS

Buckland Street Alexandria, Council of the City of Sydney





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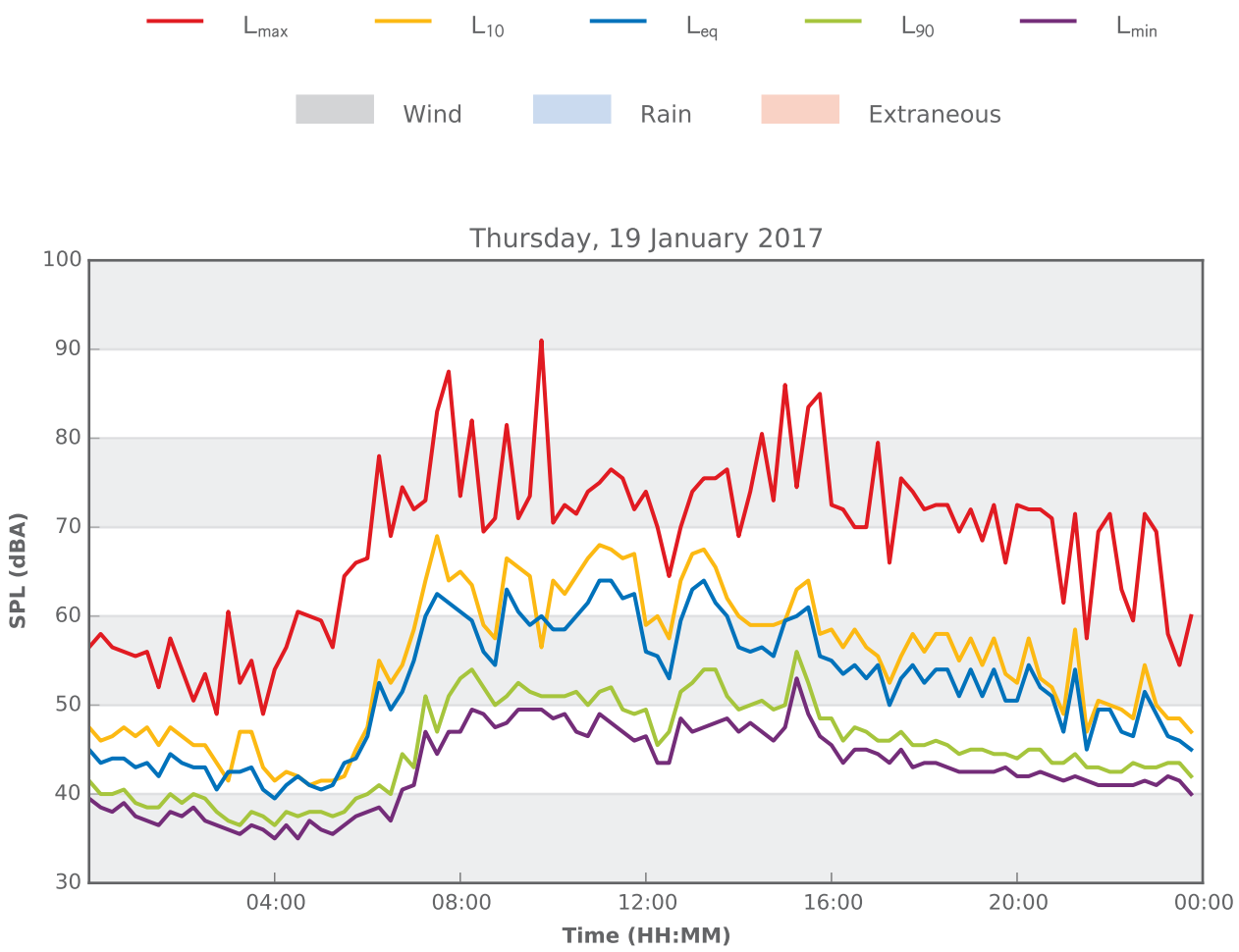

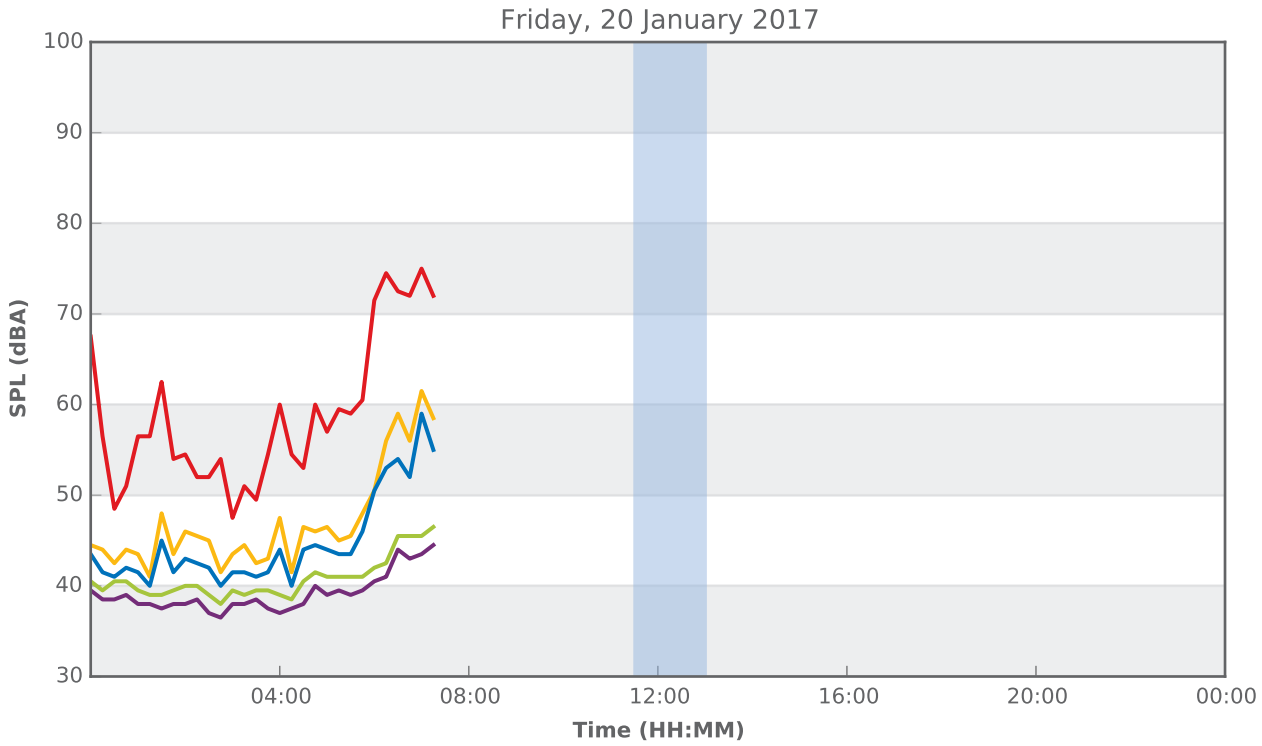

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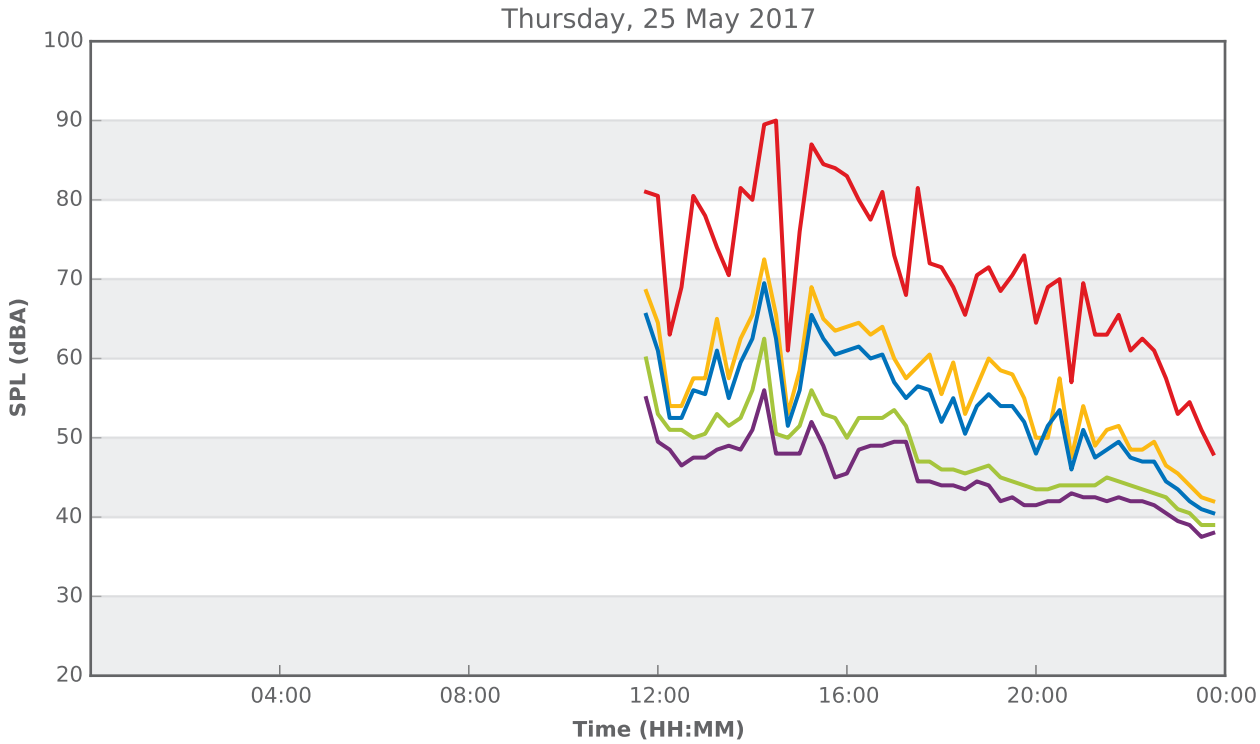

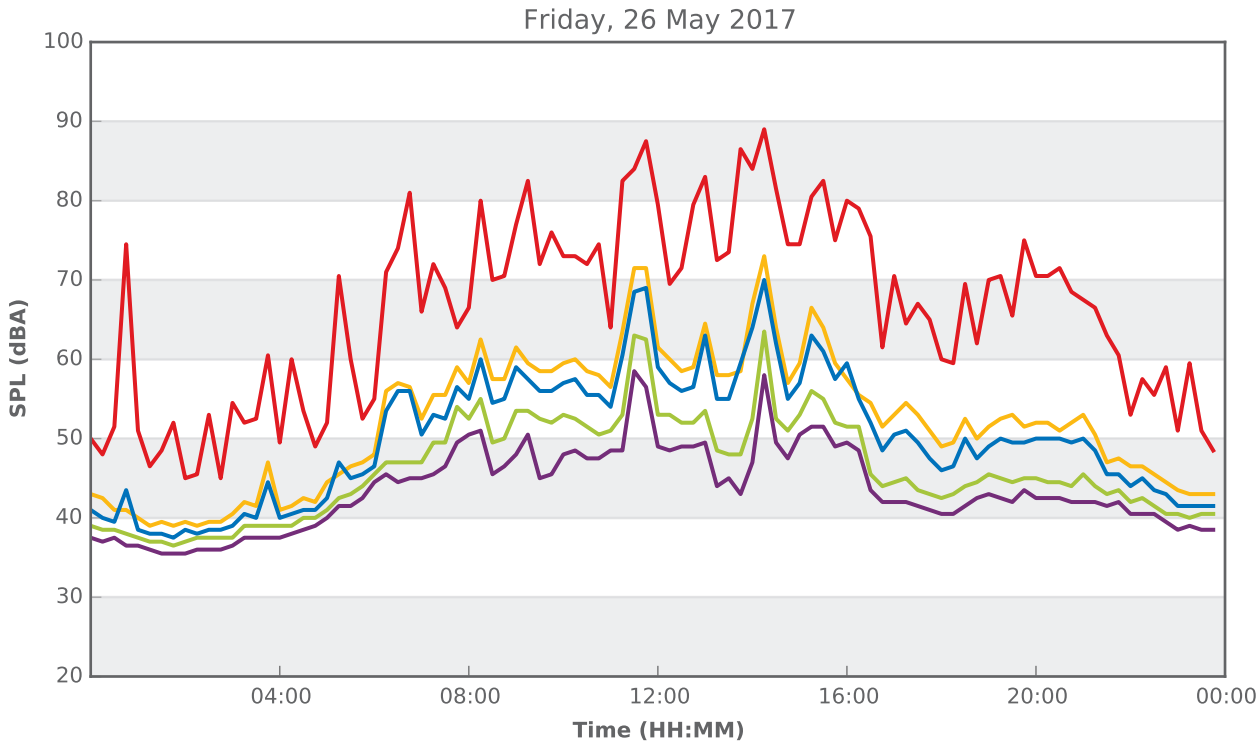

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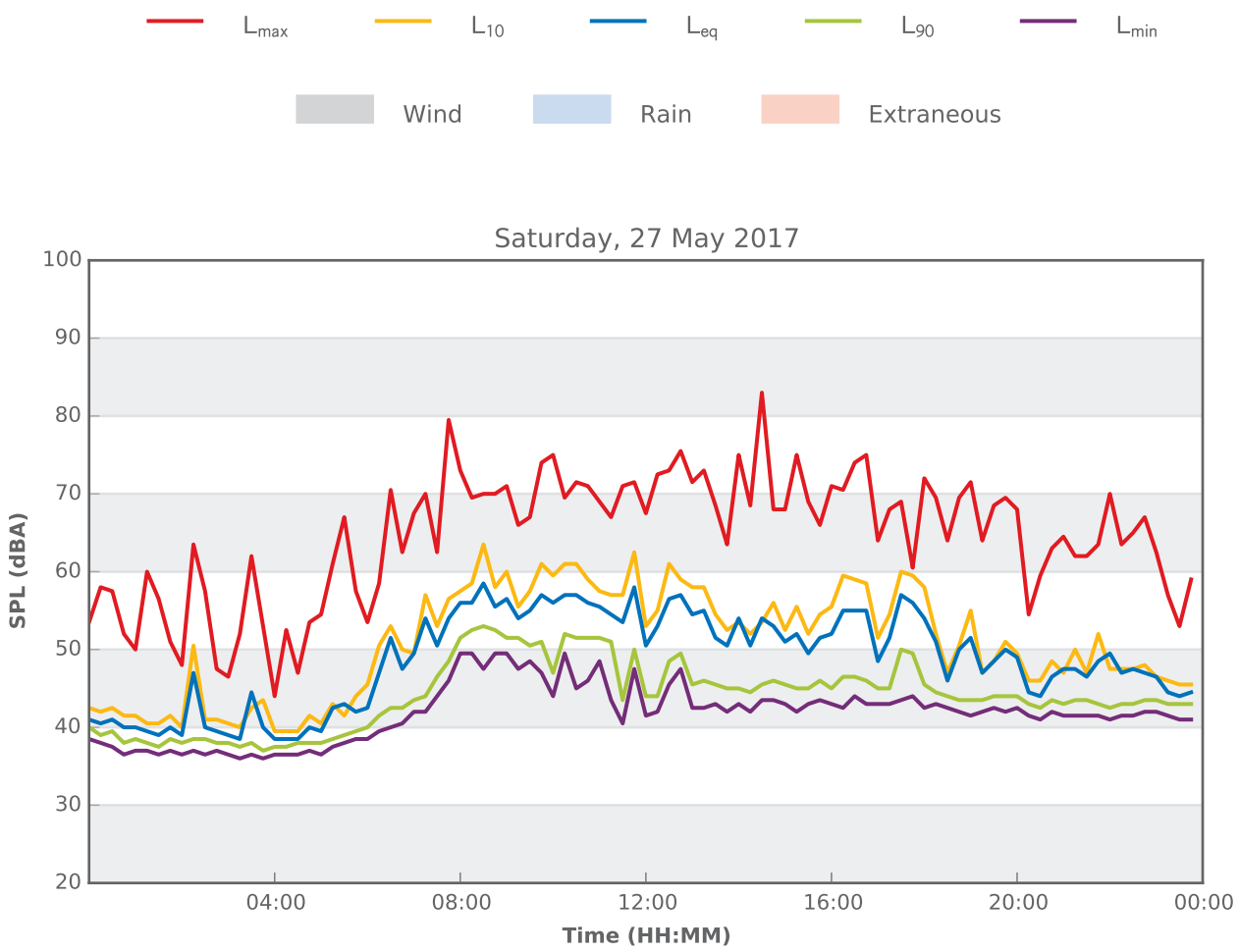

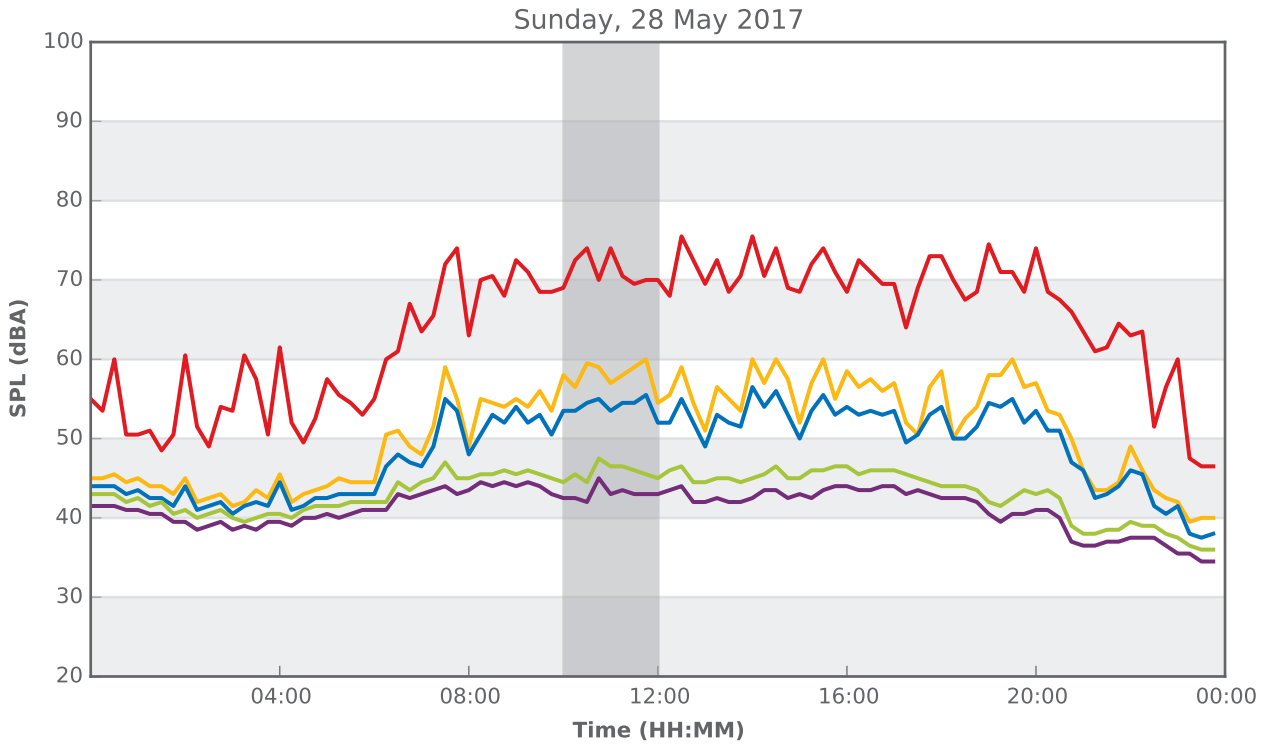

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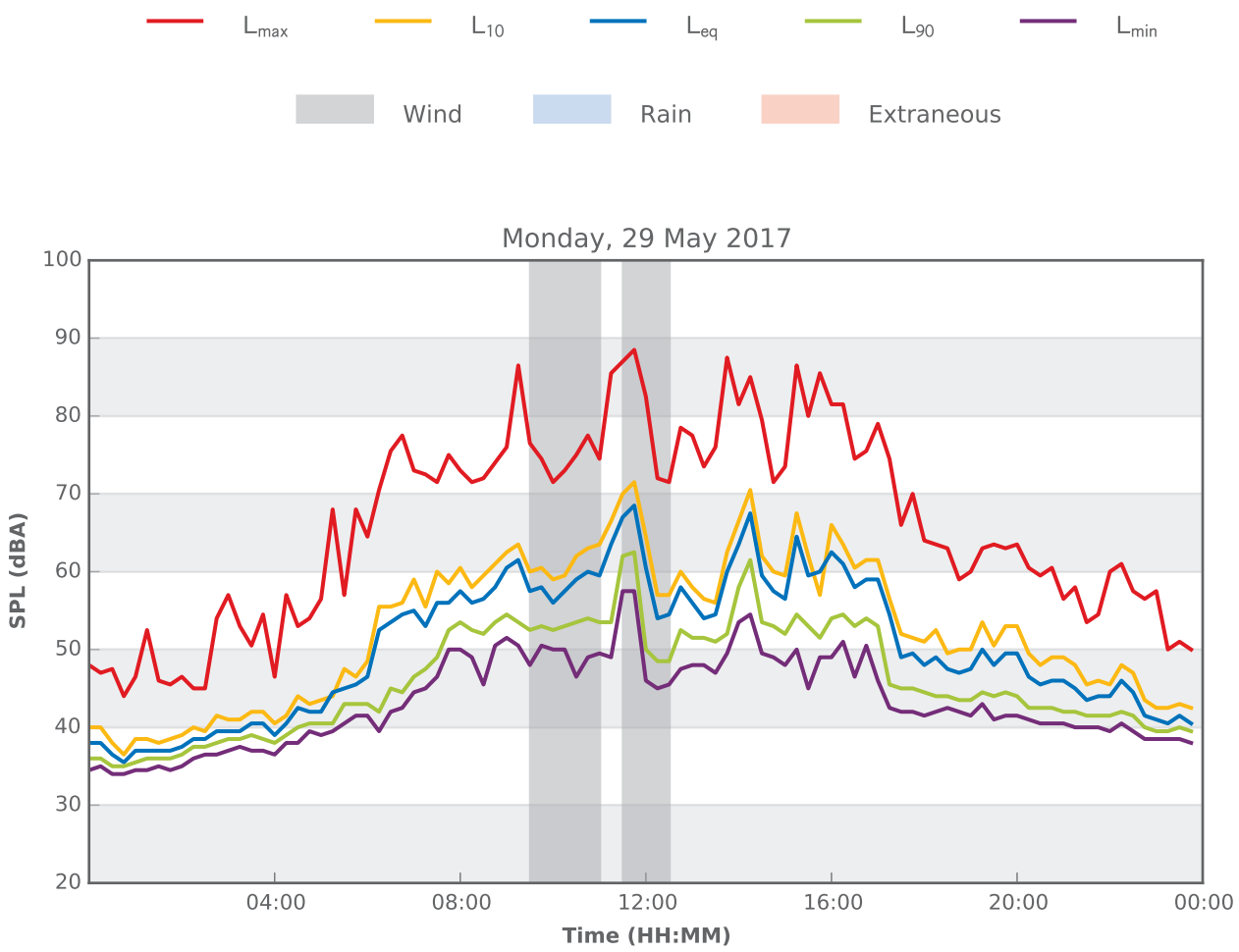

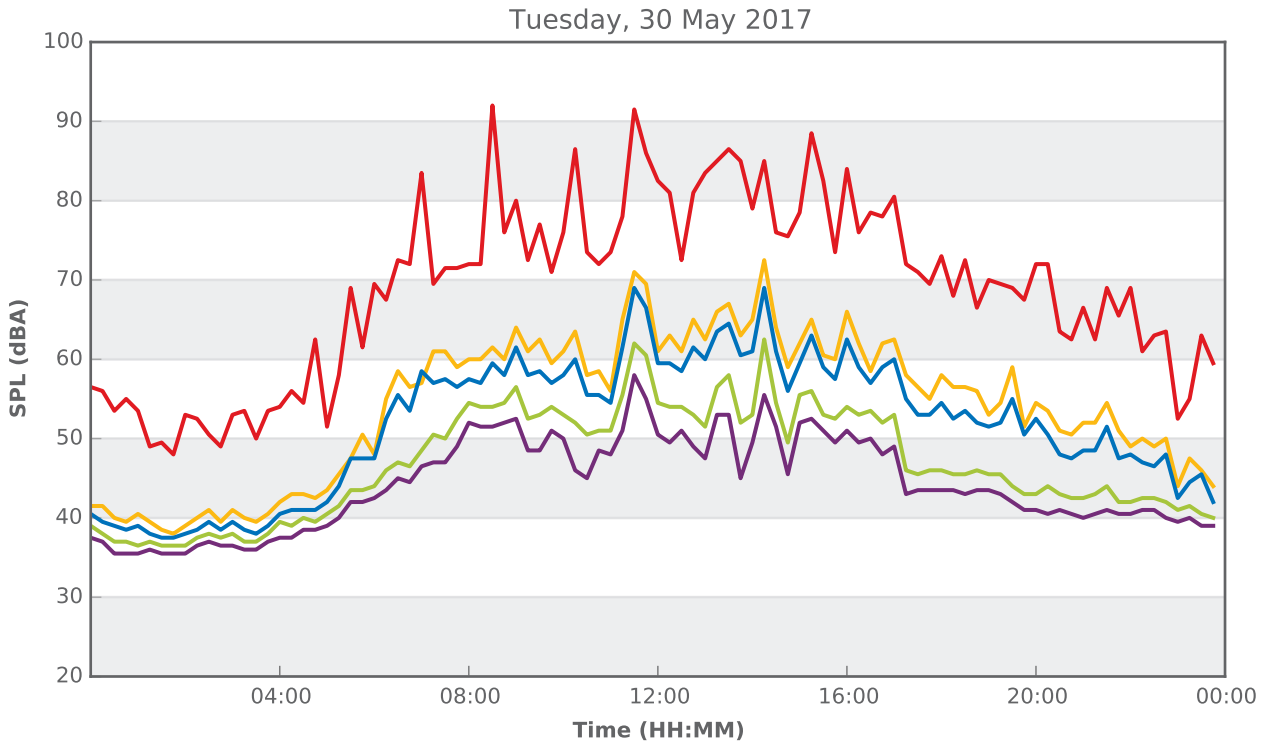

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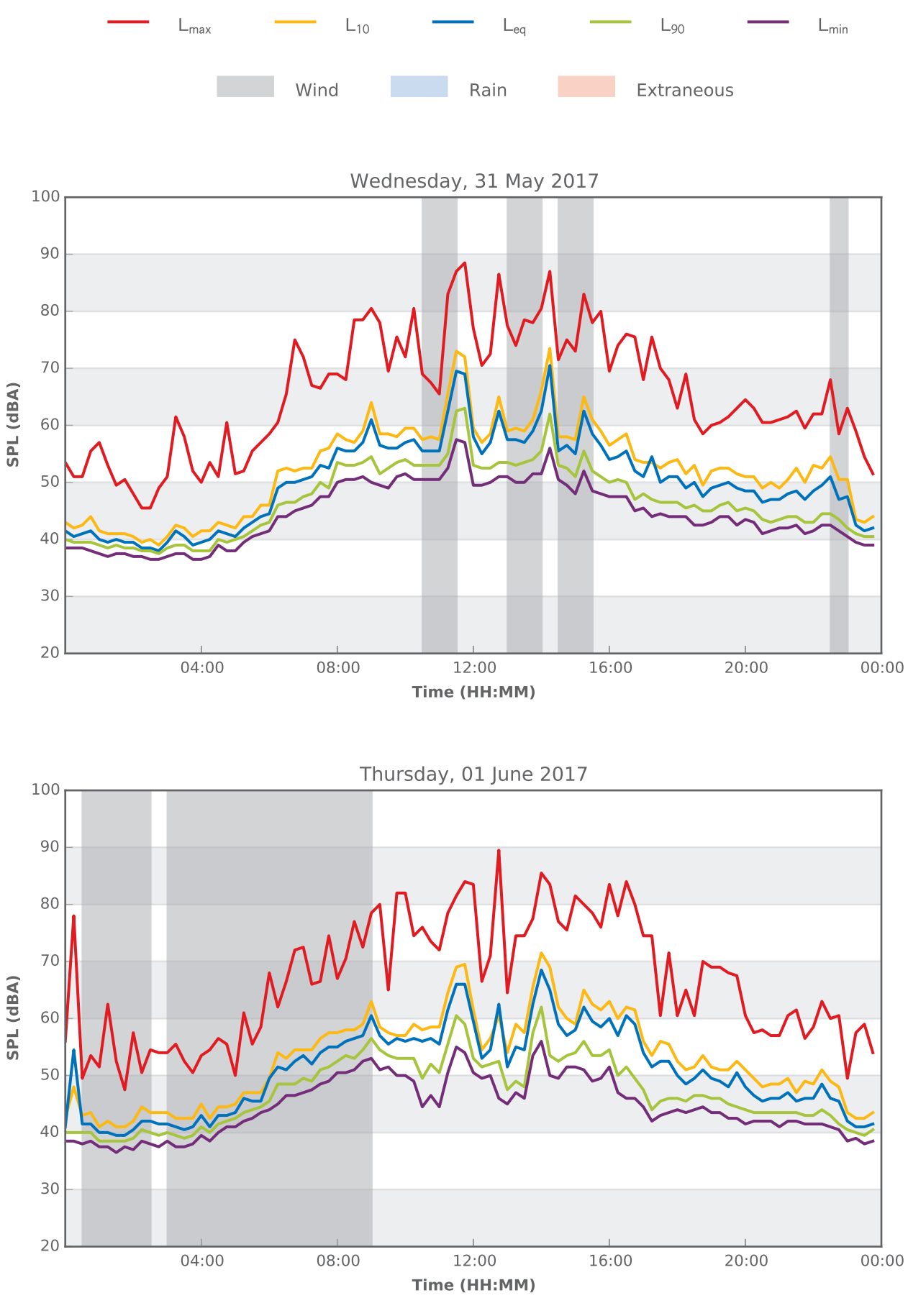

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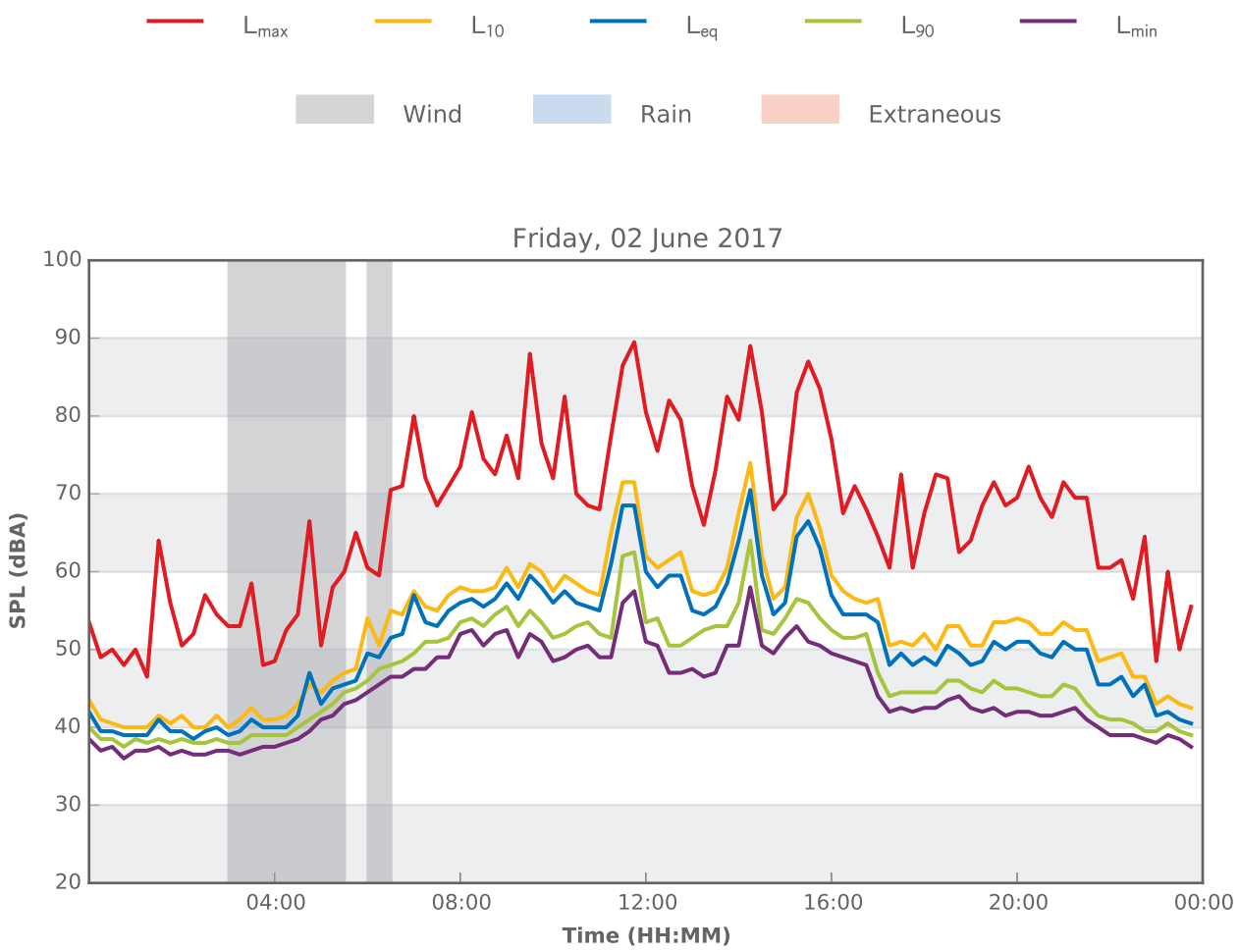
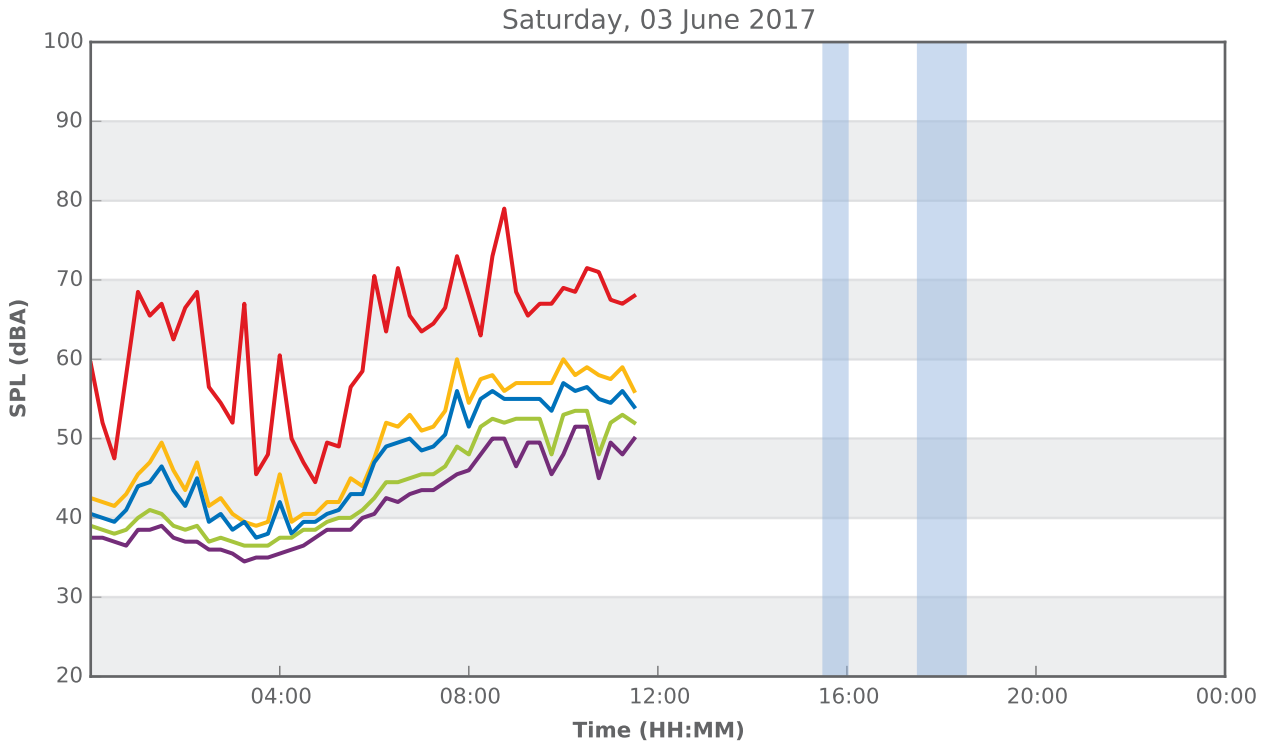
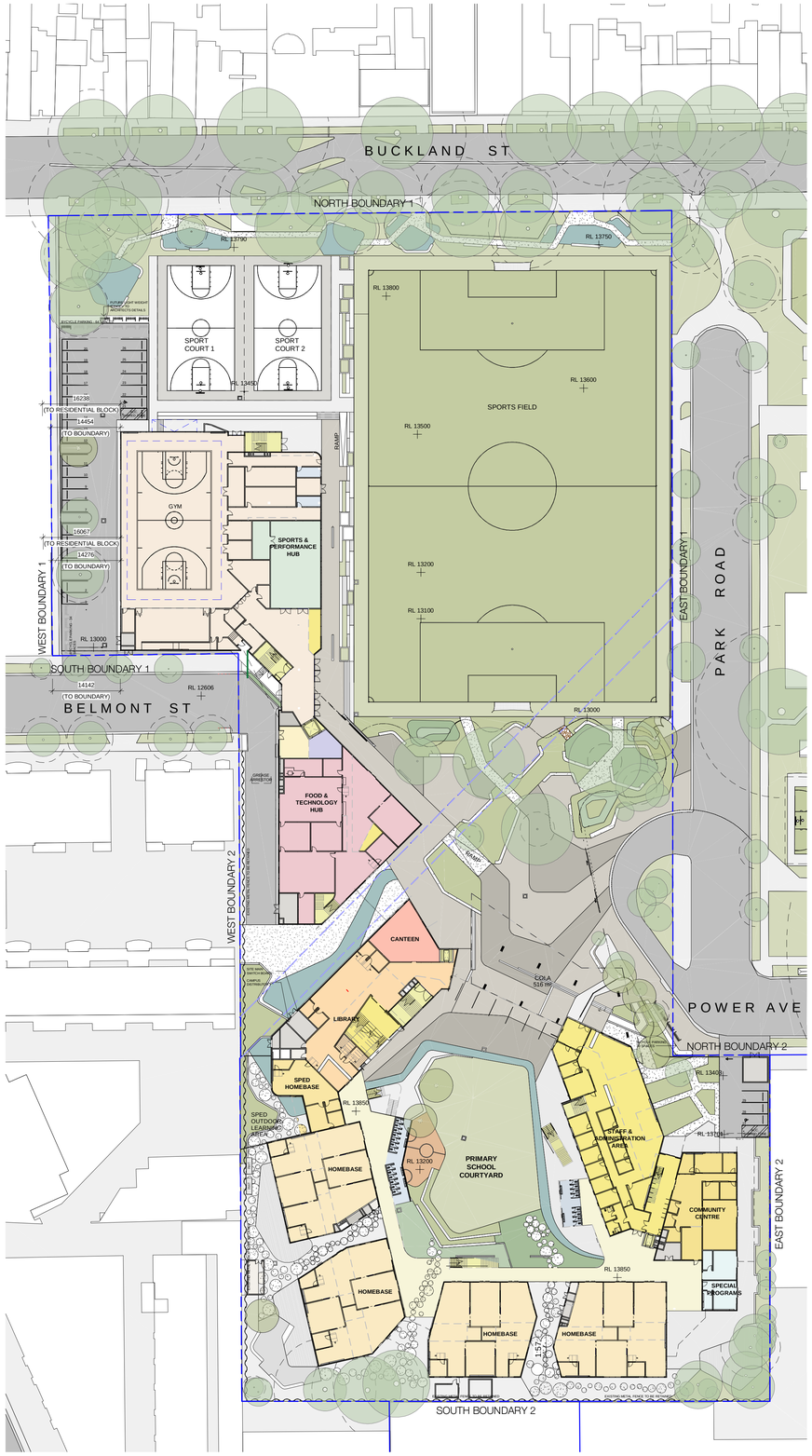


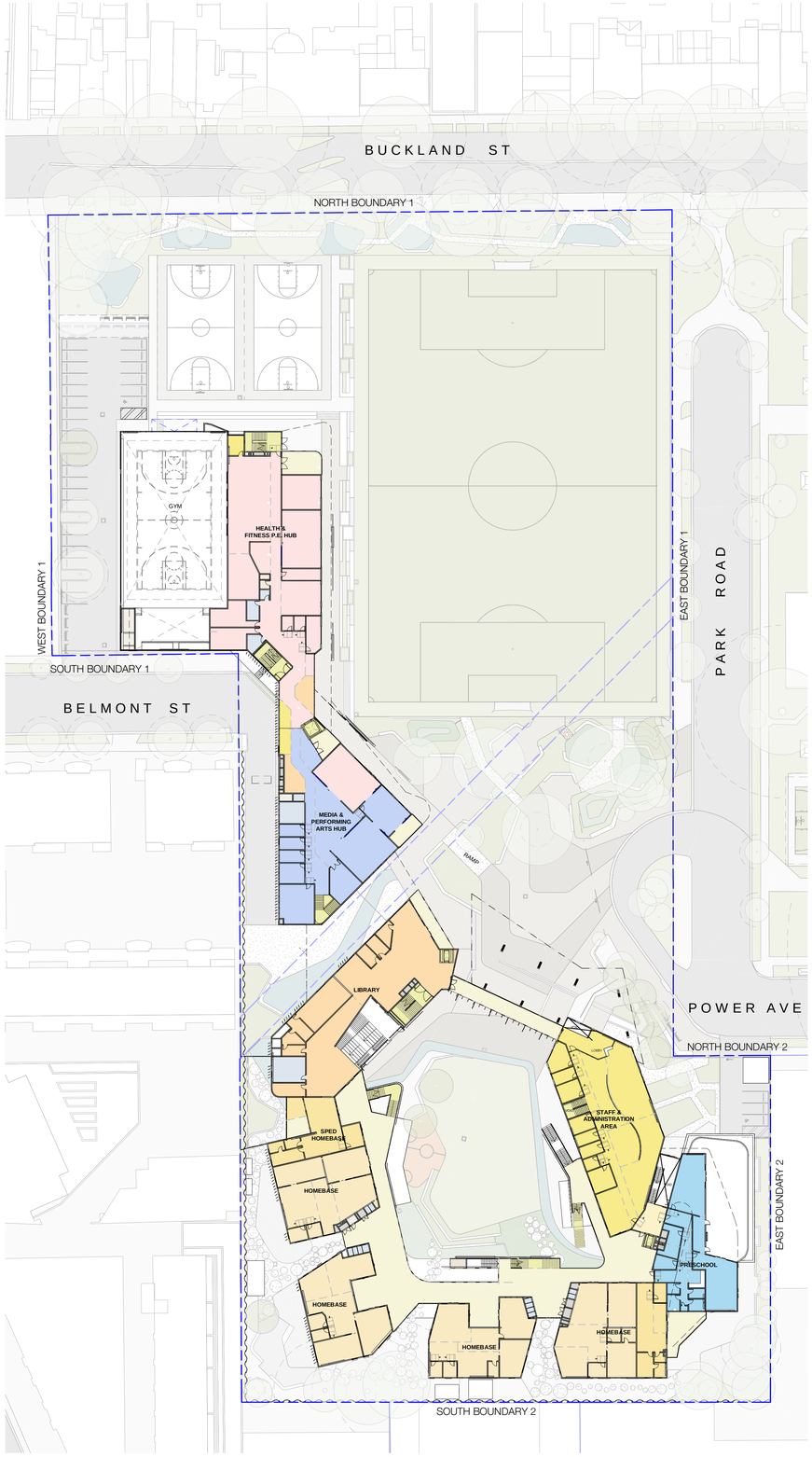


APPENDIX B

FLOOR PLANS



1 GROUND FLOOR - CAMPUS PLAN
1 : 500



2 FIRST FLOOR - CAMPUS PLAN
1 : 500

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Do not scale drawings. Verify all dimensions on site. Notify architect of all discrepancies

Rev	Date	Description	Checked	Auth.
P1	08.12.17	Issue For SSDA	AH	AK

NOT FOR CONSTRUCTION

Project
ALEXANDRIA PARK COMMUNITY SCHOOL

Drawing Title
CAMPUS PLANS - GROUND AND FIRST FLOORS

Proj. Dir	Proj. Arch	Drawn
AK	AH	BO/HC
Job No.	Sheet	Scale
161044	B1	1 : 500

Drawing No. AR.DA. 2001 Revision P1

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