ACOUSTICS AND AIR

ALTERATIONS & ADDITIONS TO MERIDEN SCHOOL PROJECT APPLICATION

CONSTRUCTION & OPERATIONAL NOISE REPORT

REPORT NO. 18238
VERSION D

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PREPARED FOR

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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.

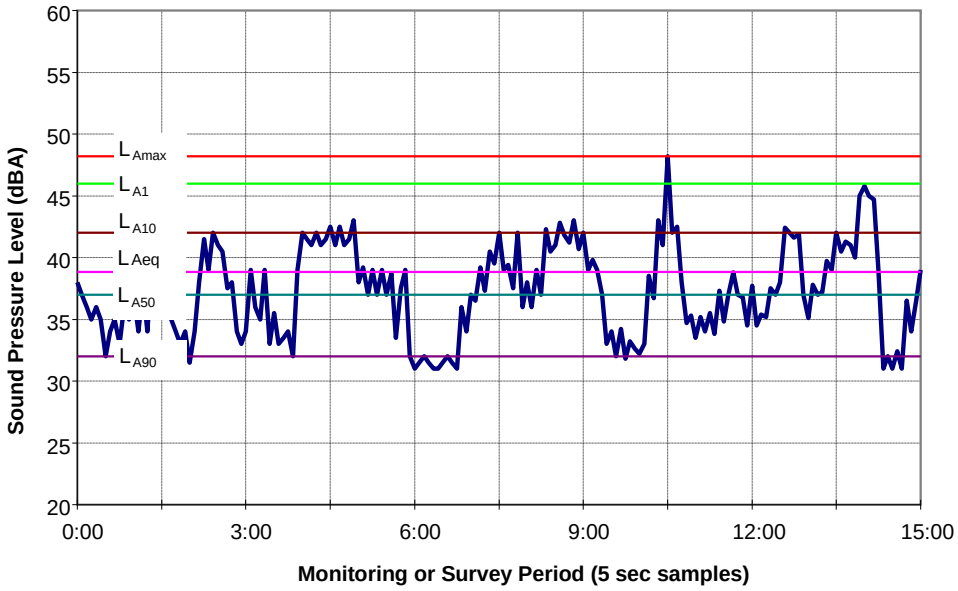
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{eq} – 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 report supports a State Significant Development Application (SSDA) submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This application is SSD by way of clause 8 and schedule 1 under State Environmental Planning Policy (State and Regional Development) 2011 on the basis that the development is for the purpose of an existing school and has a Capital Investment Value of more than $20 million.

This Noise Impact Assessment (NIA) has been prepared to accompany a State Significant Development Application for the proposed masterplan and boarding house development which is on the grounds of Meriden Girls School located at 10-12 Redmyre Road, Strathfield. This report has been prepared having regard to the Secretary's Environmental Assessment Requirements issued for the project by DPE, ref no SEAR 9692 issued on 22 November 2018.

The report has been updated from the original submission to address issues raised in the "Response to Submissions" which consists of the acoustics impact to 2 Vernon Street including additional ambient noise logging, measurement of students in play areas and computer noise modelling.

The State Significant Development is for:

- Meriden Centre of Music and Drama (CMD);
- Stage 2 Lingwood Campus; and
- Vernon Street Playground Area.

This assessment responds to the issue raised in item 12 of the SEARs as follows:

> ***12. Noise and Vibration***
>
> - *Identify and provide a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation, construction. Outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*
> - *Identify and assess operational noise, including consideration of any public-address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.*

The following relevant Policies and Guidelines have been considered during the course of our assessment:

- NSW *Noise Policy for Industry* (EPA 2017).
- *Interim Construction Noise Guideline* (DECC 2009).
- *Assessing Vibration: A Technical Guideline* (DECCW 2006).
- *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning 2008).

2 PROJECT DESCRIPTION

The primary objective of the proposal is to improve the current school facilities of Meriden School for Girls to cater for the increased demand for high quality music teaching and learning spaces from existing students, more contemporary teaching spaces (replacing the existing demountable), additional administration facilities and increasing the playground area in the Junior School Campus.

The proposed State Significant Development (SSD) comprises works on all three school campuses and comprise:

- Senior School: Demolition of existing music building and construction of a new 3-storey Centre for Music and Drama (CMD);
- Lingwood Prep School: Demolition of existing single storey building and construction of a new 2-storey teaching and administration building; and
- Junior School: Demolition of existing dwelling at 4 Vernon and creation of new landscaped playground area.

Figure 2-1 shows site aerial with proposed development locations. Figure 2-2 to Figure 2-4 shows the CMD, Stage 2 Lingwood Campus and Vernon Street works areas.

Figure 2-1 Site Aerial

Figure 2-2 Proposed Centre for Music and Drama (CMD) Development

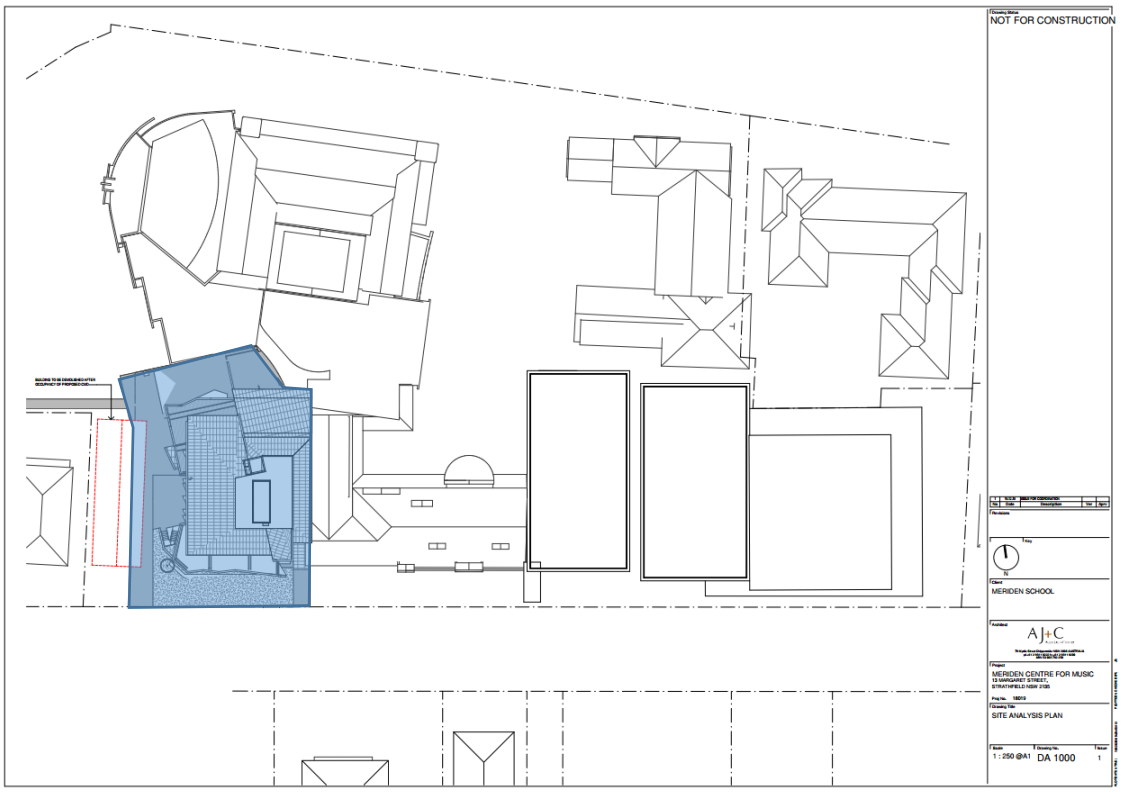


Figure 2-3 Proposed Lingwood Prep School Development

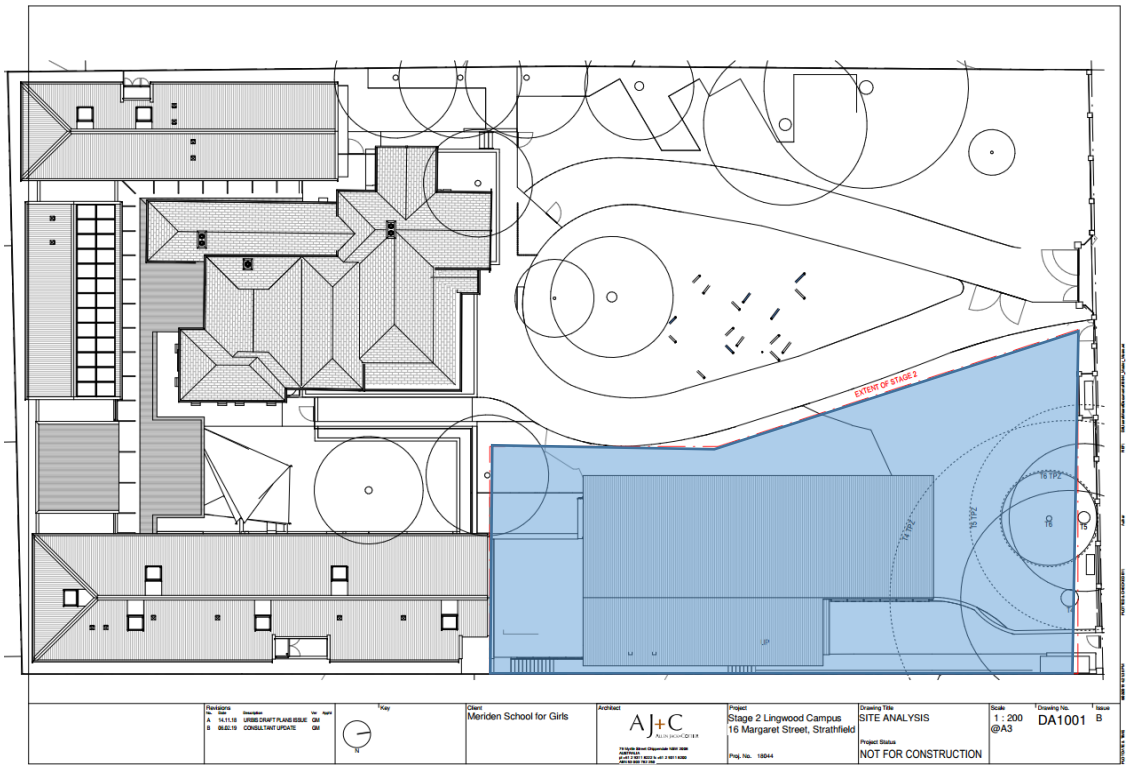


Figure 2-4 Proposed New Landscaped Playground at 4 Vernon Street

Residential receivers surrounding the sites that may be affected by construction and operational noise are located as follows:

- **CMD Development** – Residences are to the west on Margaret Street, the nearest being a single residence at 15 Margaret Street and flats at 12-14 Margaret Street at a distance of 20 metres across the street to the south.
- **Lingwood Prep School Development** – Residences to the east on Margaret Street the nearest being flats at 12-14 Margaret Street bounding the site.
- **4 Vernon Street Playground** – An individual residence immediately to the north at 2 Vernon Street.

3 AMBIENT NOISE MONITORING

3.1 Ambient Noise Levels at the Site

In order to quantify the existing noise environment, long-term ambient noise levels were monitored at the following locations:

- Location 1 – The southern boundary of the school and 15 Margaret Street between 3 and 12 December 2018.
- Location 2 – The eastern boundary of the Lingwood site between 29 August and 5 September 2017.
- Location 3 – Rear of 4 Vernon Street between 11 September and 22 September 2019.

The noise monitoring equipment used for the Wilkinson Murray noise measurements consisted of ARL Type EL-215 environmental noise loggers 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_{Aeq} 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.

Noise logging at Location 2 was conducted for the Stage 1 Lingwood application by Acoustic Logic Consultancy (ALC) and have been used for this assessment as currently Stage 1 construction works would contaminate any current noise measurements. Therefore, the ALC noise measurements are considered appropriate for use.

The logger at Location 3 was deploy as a result of submissions in regard to 4 Vernon Street impacts.

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

Table 3-1 below 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 *Noise Policy for Industry (NPfI)*.

Table 3-1 Summary of measured ambient noise levels

Location	RBL (dBA)			
	Daytime 7am-6pm	Evening 6-10pm	Night Time 10pm-7am	Saturday 8am-1pm
1. 15 Margaret Street boundary	46	43	37	46
2. Lingwood site	43	40	36*	42*
3 2 Vernon Street	38	35	31	36

* Estimated from graphic results

Background noise levels were free of the influence of extraneous noise sources, such as plant or construction activities. Noise data measured during inclement weather was excluded in accordance with EPA procedures.

Detailed results of noise monitoring are presented in Appendix A.

4 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

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 + 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.

In addition, the following construction noise management levels $L_{Aeq,(15min)}$ are recommended for other receivers and areas relevant to this project:

- Active recreation areas (such as parks): external $L_{Aeq,(15min)}$ 65dBA
- Industrial premises: external $L_{Aeq\ ,(15min)}$ 75dBA
- Offices, retail outlets: external $L_{Aeq,(15min)}$ 70dBA
- Classrooms at schools and other educational institutions: internal $L_{Aeq,(15min)}$ 45dBA

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.

Table 4-2 Site-specific construction noise management levels

Area	Construction Noise Management Level, L_{Aeq} – dBA				Highly Noise Affected Noise Level, L_{Aeq} – dBA
	Day	Evening	Night	Saturday*	
1. 15 Margaret Street boundary	56	48	52	56	75
2. Lingwood site	53	45	41	52	75
3. 2 Vernon Street	48	40	36	41	75

* 8.00am to 1.00pm.

Hours of Operation

The proposed working hours for this project are as follows:

- Monday to Friday 7.00am to 7.00pm
- Saturday 8.00am to 1.00pm
- Sunday and Public Holidays No work

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

4.2 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.

4.2.1 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 BS 7385 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

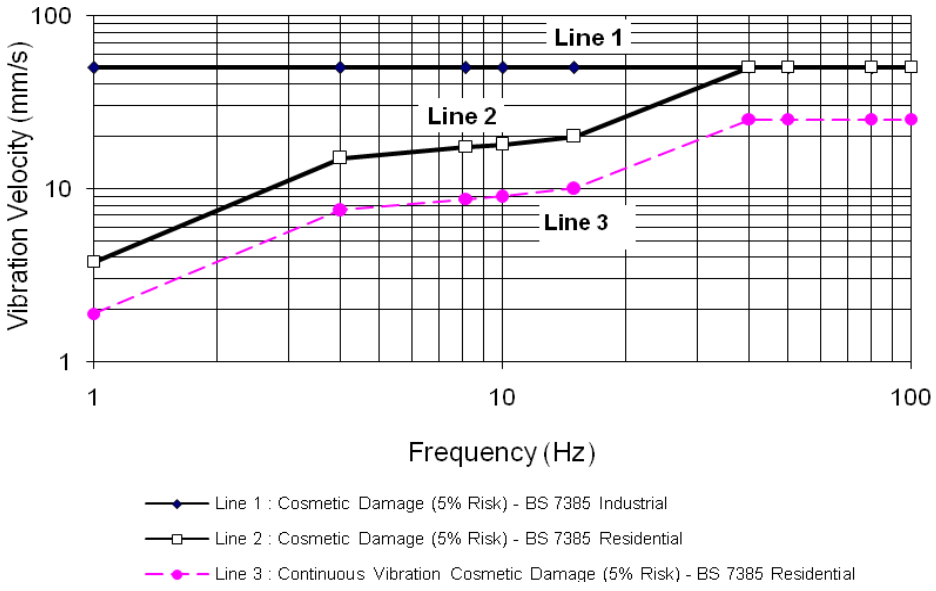
Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4 Hz and above	N/A
Un-reinforced or light framed structures Residential or light commercial type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

Note that rock breaking / hammering, and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.

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.

Figure 4-1 Graph of transient vibration guide values for cosmetic damage



In addition to the British Standard, for the case of nearby heritage buildings, guidance for structural damage is derived from the German Standard DIN 4150 -3 *Structural Vibration Part 3 – Effects of Vibration on Structures*. Table 4-6 details these recommendations for heritage buildings.

Table 4-6 DIN 4150 Recommended PPV Vibration Level for Heritage Buildings

Guideline Values for Velocity – mm/s		
1-10 Hz	10 to 15 Hz	40 to 50 Hz
3	3 to 8	8-10

4.3 Construction Equipment & Noise Source Noise Levels

Sound Power Levels (SWLs) for typical construction plant are identified in Table 4-7. 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 4-7 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 – 120mm diameter / 50 bar	112	87
Concrete Saw	116	91
Mobile Crane	98	73
Dump Truck	108	83
Compressor	100	75
Bobcat	103	78
Hand Tools	90	65
Excavator	108	83
Crawler Cranes	98	73
Tower Crane	104	79
Front End Loader	112	87
Excavator	107	82
Hammer Hydraulic	122	97
Bored Pile Rig	112	87

4.4 Construction Noise Predictions

Assessment of likely construction noise at surrounding receivers has been undertaken for the proposed construction works. Assessment has been based on the construction of a new buildings and play areas.

Factors that are addressed in the noise predictions are:

- equipment sound level emissions and location;
- screening effects from buildings;
- receiver locations;
- ground topography;
- noise attenuation due to geometric spreading;
- ground absorption; and
- atmospheric absorption.

Modelling has been conducted for three construction scenarios for the CMD, Lingwood and playground sites. Details of the works scenarios considered are summarised in Table 4-8.

Table 4-8 Construction Scenarios for Construction Works for CMD and Lingwood Sites

Scenario	Description	Works
A	Demolition	Demolition works to buildings. Excavator with rock-breaker attachment along with front end loader. Also, dump trucks assumed to be two movements in 15 minutes.
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 15 minutes. Also, concrete trucks and normal delivery trucks assumed to be two movements in 15 minutes.
C	Facade / Fitout	In the event that the construction of the facade occurs in isolation. Forklift, truck, tower crane and power tools assumed. Two truck movements in 15 minutes assumed.

In the case of the Vernon Street Playground site, the scenarios detailed in Table 4-9 have been used in the assessment.

Table 4-9 Construction Scenarios for Construction Works for Vernon Street Playground Site

Scenario	Description	Works
A	Demolition	Demolition works to buildings. Excavator with rock-breaker attachment along with front end loader. Also, dump trucks assumed to be two movements in 15 minutes.
B	Earthworks and Landscaping	Excavation and levelling of the site with backhoe. Also, concrete trucks and normal delivery trucks assumed to be two movements in 15 minutes.

Noise modelling has been conducted for each of the above scenarios detailed in Table 4-8 (CMD and Lingwood) and Table 4-9 (Vernon St), with plant located across each construction 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 4-10 to Table 4-12 detail results of construction noise modelling for each scenario.

Table 4-10 Predicted Construction Noise Levels CMD site at Residences – $L_{Aeq(15min)}$ – dBA

Residential Receiver	Predicted Noise Level			NML*
	Demolition	Building Construction	Fitout	
12-14 Margaret Street	60	68	56	53/52
15 Margaret Street	51	57	49	56/56

* Weekday and Saturday noise management levels.

Table 4-11 Predicted Construction Noise Levels Lingwood Site at Residences – $L_{Aeq(15min)}$ – dBA

Residential Receiver	Predicted Noise Level			NML*
	Demolition	Building Construction	Fitout	
12-14 Margaret Street	68	67	57	53/52
15 Margaret Street	59	60	47	56/56

* Weekday and Saturday noise management levels.

Table 4-12 Predicted Construction Noise Levels Vernon Street Site at Residences – $L_{Aeq(15min)}$ – dBA

Residential Receiver	Predicted Noise Level			NML*
	Demolition	Building Construction	Fitout	
2 Vernon Street	65	58	47	48/41

* Weekday and Saturday noise management levels.

4.5 Discussion of Results

CMD Site

Noise levels from construction at the CMD site will be greatest at residences across the road at 12-14 Margaret Street where exceedances of up to 16dBA can be expected during construction and demolition activities, noting that the maximum construction limit of 75dBA is not exceeded.

In the case of residences to the west at 15 Margaret Street, noise levels are expected to be lower due to shielding by the existing intervening school building.

Lingwood Site

Noise levels from construction at the Lingwood site will be greatest at residences immediately adjacent to the site at 12-14 Margaret Street where exceedances of up to 16dBA can be expected during construction and demolition activities, noting that the maximum construction limit of 75dBA is not exceeded.

In the case of residences to the North West at 15 Margaret Street, noise levels are expected to be lower due to increased distance to these residences with relatively small exceedances of up to 4 dBA predicted.

Vernon Street

Noise levels from construction at the Vernon site will be greatest at residences immediately adjacent to the site at 2 Vernon street where exceedances of up to 24 dBA can be expected during construction and demolition activities, noting that the maximum construction limit of 75dBA is not exceeded.

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.

4.6 Construction Vibration Assessment

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

With reference to *Construction Noise and Vibration Strategy* (V4.0) - May 2018 (TfNSW 2018), Table 4-13 sets out the typical ground vibration levels at various distances for safe working distances.

Table 4-13 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

It is not envisaged that any vibration intensive equipment will be associated with the construction of any of the proposed facilities and as such vibration should not be an issue.

4.7 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:

- Installation a 2.4 metre plywood hoarding around the construction site particularly between the playground area and 2 Vernon Street;
- Selection of quietest feasible construction equipment; and
- Localised treatment such as barriers, shrouds, and the like around fixed plant, such as pumps, generators, and concrete pumps.

In addition, the following measures should be included in a Noise & 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 adoption of the above measures is aimed at working towards achieving the noise management levels established at surrounding receivers.

4.8 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.

4.9 Noise & Vibration Management Plan

A Construction Noise & Vibration 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.

4.10 Management of Construction Noise & Vibration to the School

Noise and vibration levels from construction are likely to be similar to the levels predicted for receivers immediately surrounding the site. Accordingly, measures that will be adopted to manage the school should be detailed in a Construction Management Plan.

Measures that can be adopted to manage noise and vibration impacts at the school will be managed between the school and the successful contractor and could include:

- Closing of classroom windows;
- Relocating classes during busy construction periods; and
- Scheduling works during school holidays.

5 OPERATIONAL NOISE & VIBRATION

Operational noise from the proposed CMD and Stage 2 Lingwood Campus will be from activities associated with the new building, as well as mechanical plant located predominantly on roofs.

5.1 Operational Noise Criteria

The NSW *NPfI* provides a framework and process for deriving noise criteria for consents and licences that enable the EPA and others to regulate premises that are scheduled under the Protection of the Environment Operations Act 1997. Whilst specifically aimed at assessment and control of noise from industrial premises regulated by the EPA, the policy is also appropriate for use by the DP&E when assessing major development proposals.

Having been designed for large industrial and agricultural sources, the monitoring and assessment procedures may not be applicable to the smaller developments and noise sources regulated by local government. It is recognised however, that Councils may find the policy to be of assistance in noise assessment and land-use planning.

The *NPfI* documents a procedure for assessment and management of industrial noise which involves the following steps:

- Determining the project noise trigger levels for a development. The project noise trigger level is a benchmark level above which noise management measures are required to be considered. They are derived by considering short-term intrusiveness due to changes in the existing noise environment (applicable to residential receivers only) and maintaining noise level amenity for particular land uses for residents and other sensitive receivers;
- Predicting or measuring noise produced by the development (having regard to any associated annoying characteristics and prevailing meteorological effects);
- Comparing the predicted or measured noise level with the project noise trigger level and assessing impacts and the need for noise mitigation and management measures;
- Considering any residual noise impacts following the application of feasible and reasonable noise mitigation measures;
- Setting statutory compliance levels that reflect the best achievable and agreed noise limits for development; and
- Monitoring and reporting environmental noise levels from the development.

The project noise trigger level represents the level that, if exceeded, may indicate a potential noise impact upon a community. It is a benchmark or objective and is not intended for use as a mandatory requirement.

5.2 Intrusiveness Noise Level

For assessing intrusiveness, the background noise level (L_{A90}) is measured and the Rating Background Level (RBL) determined. The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous noise level (L_{Aeq}) of the source (measured over a 15-minute period) does not exceed the background noise level (RBL) by more than 5dBA.

5.3 Amenity Noise Level

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 transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms, amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

The recommended amenity noise level represents the objective for total industrial noise at a receiver location. The project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To prevent increases in industrial noise due to the cumulative effect of several developments, the project amenity noise level for each new source of industrial noise is set at 5dBA below the recommended amenity nose level.

The following exceptions apply to determining the project amenity noise level:

- For high-traffic areas, the amenity criterion for industrial noise becomes the $L_{Aeq,period(traffic)}$ minus 15dBA.
- In proposed developments in major industrial clusters.
- If the resulting project amenity noise level is 10dB or lower than the existing industrial noise level, the project amenity noise level can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a consideration because no other industries are present in, or likely to be introduced into the area, the relevant amenity noise level is assigned as the project amenity noise level for the development.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

An extract from the NSW *NPfI* that relates to the amenity noise levels for surrounding receivers is given in Table 5-1.

Table 5-1 Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level L_{Aeq} (dBA)
Residence	Suburban	Day	55
		Evening	45
		Night	40

Note 1: Daytime 7.00am–6.00pm; Evening 6.00pm–10.00pm; Night 10.00pm-7.00am.

5.4 Maximum Noise Level Events

Noise sources of short duration and high level that may cause disturbance to sleep if occurring during the night time need to be considered.

The approach recommended by the *NPfI* is to apply the following initial screening noise levels:

- $L_{Aeq,15min}$ 40dBA or the prevailing RBL + 5dB, whichever is the greater; and/or
- L_{AFmax} 52dBA or the prevailing RBL + 15dB, whichever is the greater.

The sleep disturbance screening noise levels apply outside bedroom windows during the night time period.

Where the screening noise levels cannot be met, a detailed maximum noise level event assessment should be undertaken. It may also be appropriate to consider other guidelines including the NSW *Road Noise Policy (RNP)* which contains additional guidance relating to potential sleep disturbance impacts.

A review of research on sleep disturbance in the *RNP* indicates that in some circumstances, higher noise levels may occur without significant sleep disturbance. Based on currently available research results, the *RNP* concludes that:

- "Maximum internal noise levels below 50dBA to 55dBA are unlikely to cause awakening reactions."
- "One or two noise events per night, with maximum internal noise levels of 65dBA to 70dBA, are not likely to affect health and wellbeing significantly."

5.5 Project Noise Trigger Levels

The amenity and intrusiveness noise levels and resulting project trigger levels (shown in **bold**) applicable to sources of continuous operational noise associated with the project (i.e. mechanical plant and equipment) are shown in Table 5-2.

Table 5-2 Project Noise Trigger Levels

Receiver	Period	Intrusiveness Noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity Noise Level[2] $L_{Aeq,15min}$ (dBA)
15 Margaret Street	Day	**51**	58
	Evening	**48**	48
	Night	**42**	43
12-14 Margaret Street	Day	**48**	58
	Evening	**45**	48
	Night	**41**	43
2 Vernon Street	Day	**43**	58
	Evening	**40**	48
	Night	**36**	43

Note 1: Project amenity noise level (ANL) is suburban ANL minus 5dBA plus 3dBA to convert from a period level to a 15-minute level.

For maximum noise level events (night time period only), the following screening noise levels apply.

Table 5-3 Sleep Disturbance Trigger Levels (10 pm to 7am)

Receiver	$L_{Aeq,15min}$	L_{AFmax}
15 Margaret Street	47	57
12-14 Margaret Street	46	56

5.6 Mechanical Services (CMD & Lingwood Stage 2)

The major mechanical noise sources associated with the development will be exhaust fans and plant that will be located on the roof of the new buildings. These will consist of roof mounted condensers and/or exhaust fans.

Noise from most major plant, such fan coil units and pumps will be contained by the building structure. Therefore, it is the roof condensers and exhaust fans that may require noise mitigation to achieve the established site-specific noise criteria at surrounding receivers.

To mitigate noise from mechanical plant, it is likely the some or all of the following noise control measures may need to be adopted at the design stage to meet noise objectives:

- Attenuators on fans;
- Acoustic louvres;
- Noise barriers; and
- Variable speed controls on condenser fans.

Preliminary specifications for mechanical services equipment are presented below:

CMD

- 4 x Daikin REYQ12TY1, 59 dBA at 1 metre;
- 1 x Daikin REYQ14TY1, 60 dBA at 1 metre;
- 2 x Daikin REYQ16TY1, 61 dBA at 1 metre;
- 2 x Daikin REYQ18TY1, 62 dBA at 1 metre;
- 3x Toilet Exhaust, Fantech CE354V, 52 dBA at 3 metre; and
- 2x Kitchen Exhaust, Fantech CHE314, 48 dBA at 3 metre.

Lingwood Building

- 2 x Daikin REYQ20TY1, 65 dBA at 1 metre;
- 2 x Toilet Exhaust, Fantech CE354V, 52 dBA at 3 metre.

Appendix B presents the proposed locations of the mechanical plant.

Based on the equipment noise levels as documented above, the following indicative resultant noise levels at nearby residences have been predicted, including allowances for distance and any shielding by intervening building walls. Resultant noise levels at nearby residences are predicted to be:

- 15 Margaret Street 36 dBA; and
- 12-14 Margaret Street (Upper Level) 37 dBA.

The predicted noise levels indicate compliance will be achieved with the site specific noise criteria presented in Table 5-2. For 15 Margaret Street no additional acoustic treatment is likely to be required, however for 12-14 Margaret Street a solid barrier on three sides of the roof top plant room would be required. Determination of the specific treatment design details will be required when plant selection has been finalised.

Specific treatment design should be incorporated and confirmed prior to the issue of construction certificate, to ensure operational noise resulting from the mechanical plant is deemed acceptable.

5.7 CMD Building Noise Emissions

The proposed operations of the CMD building will consist of the following:

Monday to Friday

- 7.00am – 8.20am
    - Band and orchestra practice
- 8.20am – 3.10pm
    - School hours

- 3.10pm – 5.30pm
    - Band and orchestra practice
- 6.00pm – 9.00pm
    - Performances from time to time (HSC and trial performances and practices, etc). The main performance space will continue to be the Wallis Auditorium on the SS campus and the Blackman Auditorium on the JS Campus.
    - Events in the top floor common staff room in evenings. Up to approximately 80 people with grand piano rolled to north side of room for performances. Could also be a string quartet or similar. On rare exceptions to 10.00pm.

Saturdays

- 8.00am – 5.30pm
    - Music Academy practice room use, classrooms sometimes used for things such as rehearsals for musicals.
- 6.00pm – 9.00pm
    - Performances from time to time (HSC and trial performances and practices, etc). The main performance space will continue to be the Wallis Auditorium on the SS campus and the Blackman Auditorium on the JS Campus.
    - Events in the top floor common room in evenings. Up to approximately 80 people with grand piano rolled to north side of room for performances. Could also be a string quartet or similar. On rare exceptions to 10.00pm.

Sundays

- Usage avoided, although rare occasions that musical rehearsals are permitted.

Potentially significant noise emanating from the CMD building is likely to be associated with music practice in the large ground level classrooms and the level 2 common staff area that may be used for functions and small performances. Noise levels at the nearest residence at 15 Margaret Street have been predicted for windows / glazed facades opened and closed based on the flowing typical L_{Aeq} internal noise levels of likely activities in these areas:

- 80 persons in the upper staff area 82dBA
- Small band in the upper staff area 90dBA
- Band rehearshal / performanace in large classroom 95dBA

Table 5-4 presents likely noise levels at the nearest residence, being the 15 Margaret Street residence, being the most potentially affected residence. The assumptions adopted are that the glazing is least 6.38mm laminated glass.

Table 5-4 Predicted Operational CMD Noise at 15 Margaret Street – $L_{Aeq(15min)}$ dBA

Activity	Façade Condition			Noise Criteria
	Northern & Western Windows Open	Western Closed	All Windows & Doors Closed	

80 Persons	41	16	>10	51 Day
Small Band	45	34	45	48 Evening
Band Rehearshal	56	45	32	42 Night

Based on the above noise predictions, the following conclusions and recommendations are made:

Functions in the Common Staff Area

Functions in the common Staff area with and without a small band are predicted to comply with noise criteria during proposed hours of operation.

Band Rehearsals

Western windows to the large classrooms when band rehearsal / performance may occur should be closed during these activities. In addition, during weekend and evening it may necessary to close the Western doors of classroom 1 when band activities occur.

Stage 2 Lingwood Campus Development

Operations of the Stage 2 of this development is to consist typical classroom and administration activities. Therefore, there are no "acoustically significant" activities proposed in this part of the project apart from mechanical services noise. Control of noise emissions from mechanical plant are addressed and discussed in Section 5.6 with respect to site specific noise criteria.

5.8 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 where new bells and speakers are proposed 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. The coverage of the system should be subject of the detail design of the 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 bell system should be set so that it only occurs on school days.

5.9 Vernon Street Playground

In the case of the Vernon Street Playground Area noise levels emanating from this area will be associated with PE classes and children playing which will be typical of existing school operations that already occur in the play area to the north of Vernon Street. Play activities in the new playground will be during normal school hours.

Noise measurements on site at the existing playground area have determined the following sound power levels for students in play areas.

- 20 Children in PE class Lw 79 dBA (i.e. 66 dBA per child)
- 300 Children at Play Lw 97 dBA (i.e. 69 dBA per child).

Noise modelling has been conducted based on the following advised scenarios:

- 36 Students using the area for PE.
- 60 Students using the area for play.

Initial modelling indicated that a barrier in the order of 2.1 metres is required between the playground and the northern driveway in combination with a 1.8 m fence on the northern boundary with the residence at 2 Vernon Street.

Based on the above scenarios the following $L_{Aeq\ (15\ minute)}$ noise levels at 2 Vernon Street are predicted indicating compliance with established noise criteria.

- 36 Children in PE class 23 dBA.
- 60 Children at Play 42 dBA.

The following Figure 5-1 shows the noise contours for the 60 Children playing scenario.

Figure 5-1 Predicted Operational Noise at 2 Vernon Street – $L_{Aeq(15min)}$ dBA

As a result of noise modelling, it has been determined that a 2.1 m high noise barrier is required on the northern boundary as shown in Figure 5-1. The barrier should be 2.1 metres from the playground level and should be continuous construction of any of the following constructions:

- Hebel or masonry Panels;
- Continuous metal fencing at least 0.8mm thick;
- Fibre Cement at least 12mm thick; or
- Plywood at least 18mm thick.

Upper levels of the barrier could consist of transparent material such as glass or Perspex if required.

In addition, the existing 1.8 metre timber fence between the properties should be made good so that there are no gaps in the timber construction.

6 SUMMARY OF RECOMMENDATIONS

Based on Wilkinson Murray's acoustic assessment of the project, the following findings have been determined.

6.1 Construction Noise

Noise objectives for construction have been established based on EPA guidelines. The noise management levels should be adopted as objectives to work toward in minimising any noise impact at surrounding residences.

Table 6-1 presents applicable noise management levels at residential receivers in the vicinity of the site.

Table 6-1 Site-specific construction noise management levels – dBA

Area	Construction Noise Management Level, L_{Aeq} – dBA				Highly Noise Affected Noise Level, L_{Aeq} dBA
	Day	Evening	Night	Saturday*	
1. 15 Margaret Street boundary	56	48	52	56	75
2. Lingwood site	53	45	41	52	75
3. Vernon Street site*	48	40	36	41	75

* 8.00am to 1.00pm.

It has been determined that noise from construction activities for the construction during the day period will potentially exceed established construction noise management levels, noting that the maximum level of 75 dBA will not be exceeded. Therefore, the planning and management of construction activities must consider the sensitivities of surrounding residents so as to minimise the impact of construction activities at these receivers.

The control of construction noise and vibration should be addressed in a Noise & Vibration Management Plan developed when the successful contractor has been appointed for the project.

The following project-specific mitigation measures are recommended:

- Selection of quietest feasible construction equipment;
- A 2.4m plywood hoarding around the construction sites including 2 Vernon Street;
- Use of rock saws or smaller rock breakers where feasible; and
- Localised treatment, such as barriers, shrouds, and the like around fixed plant, such as pumps, generators, and concrete pumps.

6.2 Operational Noise

Site-specific noise criteria for the development have been established based on the lower of intrusive and amenity noise criteria.

The applicable operational noise levels at residential receivers in the vicinity of the site are presented in Table 6-2.

Table 6-2 Project Noise Trigger Levels – dBA

Residence	Period	Intrusiveness Noise Level[1] $L_{Aeq,15min}$ (dBA)	Project Amenity Noise Level[2] $L_{Aeq,15min}$ (dBA)
15 Margaret Street	Day	51	58
	Evening	48	48
	Night	42	43
12-14 Margaret Street	Day	48	58
	Evening	45	48
	Night	41	43

Mechanical plant, such as rooftop exhausts and condenser units has been assessed.

The predicted noise levels indicate compliance will be achieved with the site specific noise criteria presented in Table 5-2. For 15 Margaret Street no additional acoustic treatment is likely to be required, however for 12-14 Margaret Street a solid barrier on three sides of the roof top plant room would be required. Determination of the specific treatment design details will be required when plant selection has been finalised.

Specific treatment design should be incorporated and confirmed prior to the issue of construction certificate, to ensure operational noise resulting from the mechanical plant is deemed acceptable.

In the case of the proposed CMD, noise will be attenuated by the building itself which will act as a noise barrier to nearby residences. The exception to this occurs when out of hours practice / performance occurs in the large ground level classrooms. In these occurrences, windows and doors should be closed to protect the amenity of surrounding residences.

Noise generated within the Stage 2 Lingwood is not considered to be acoustically significant and will be adequately contained by the building facade.

Noise from and new bells and announcements will be managed by design and volume adjustment techniques.

The playground boundary and driveway between 2 Vernon Street and the new Playground area should have a continuous 2.1 metre barrier installed between the play area and the driveway. In addition, the existing fence should be made good with no gaps in the construction.

7 CONCLUSION

A construction and operational noise and vibration assessment of the Alterations and Additions to Meriden School has been conducted. Site-specific noise criteria that are applicable to this project have been presented.

A noise assessment has been conducted for the proposed construction activities associated with the Meriden Centre of Music and Drama, Stage 2 Lingwood Campus and Vernon Street Playground Area development to determine the potential for noise and vibration impact at surrounding receivers. Exceedances of noise management levels are expected at surrounding receivers to the when demolition and structure stages of the project occur. Accordingly, management of noise from construction activities should be included in the Site Construction Environmental Management Plan.

Vibration associated with on-site construction activities is unlikely to impact on surrounding receivers.

Site-specific operational noise criteria have been determined for the project based on ambient noise monitoring. A review of likely major mechanical plant indicates that noise levels can comply with established noise criteria during proposed operation with the inclusion of acoustic treatment. A detailed review of all mechanical plant with respect to site specific noise criteria is required at detailed design stage.

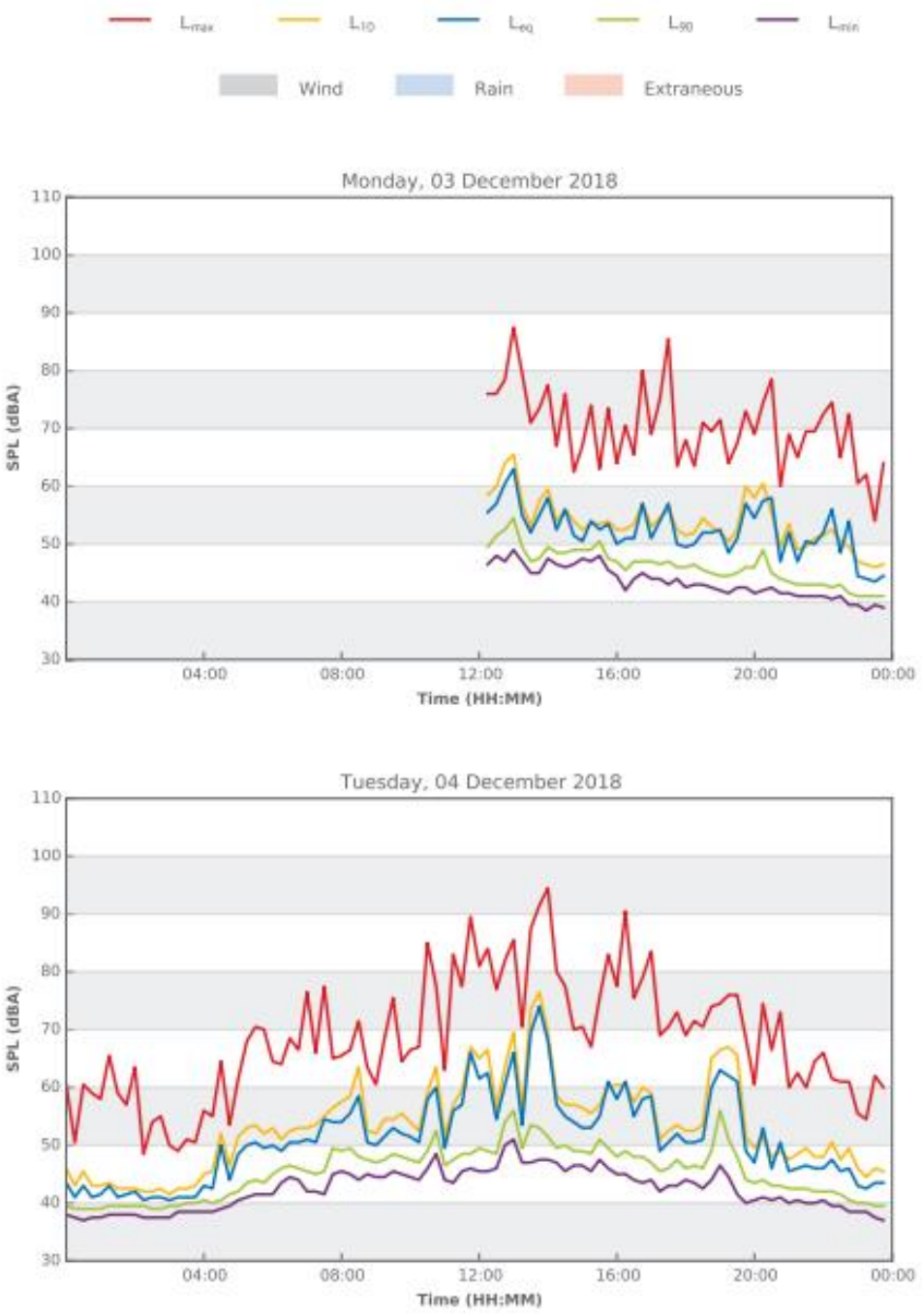
Noise from operation of the CMD building will be acceptable provided windows are closed when rehearsals/performances occur out of normal school hours. In the case of Stage 2 Lingwood, no acoustically significant noise sources are associated with the operation of this building.

In the case of the residence at 2 Vernon Street treatment to the northern boundary in the form of a noise barrier and the maintenance of the existing fence and the property is required to ensure noise from the new playground is addressed.

APPENDIX A

NOISE MEASUREMENT RESULTS

15 Margaret Street Boundary



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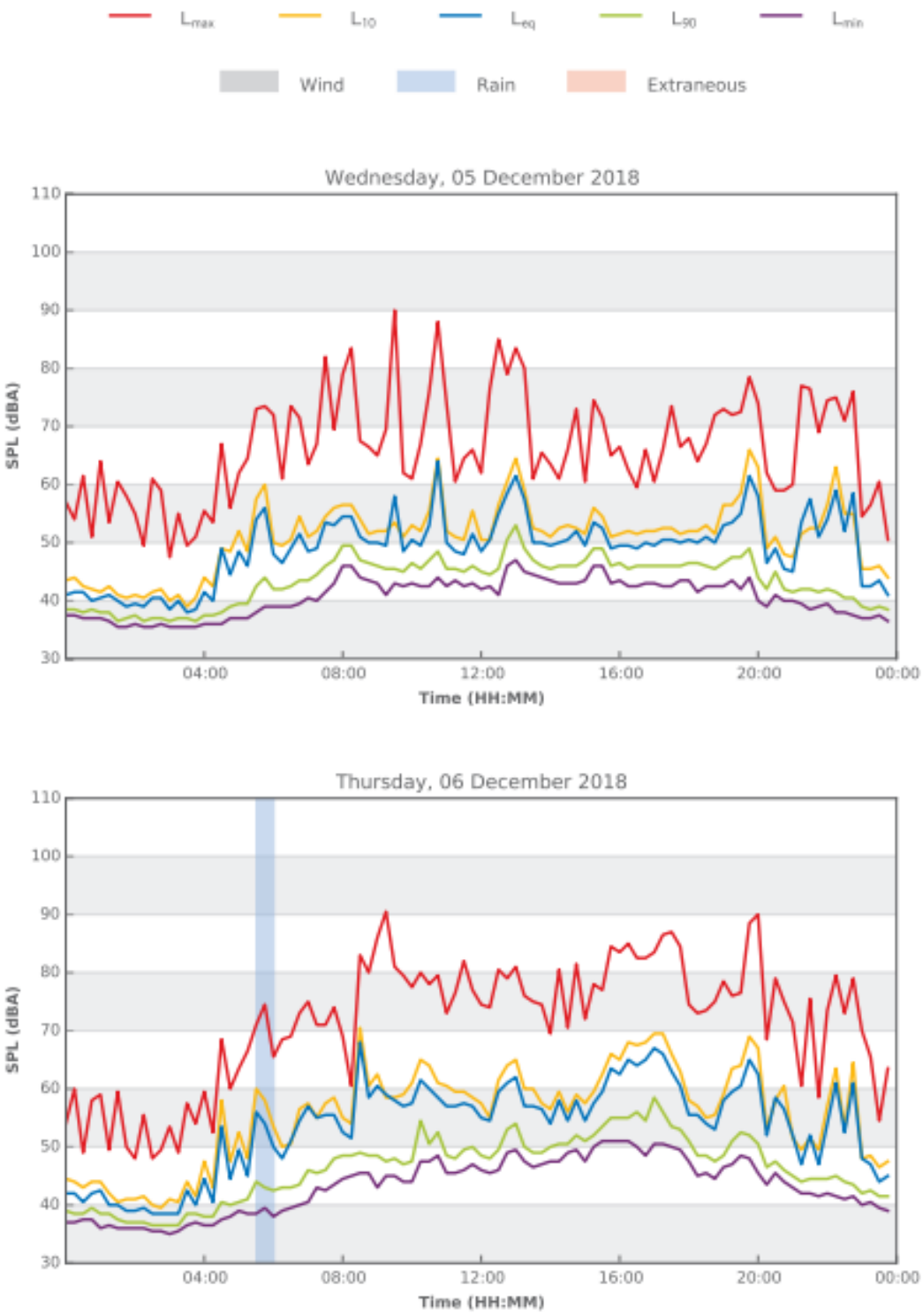

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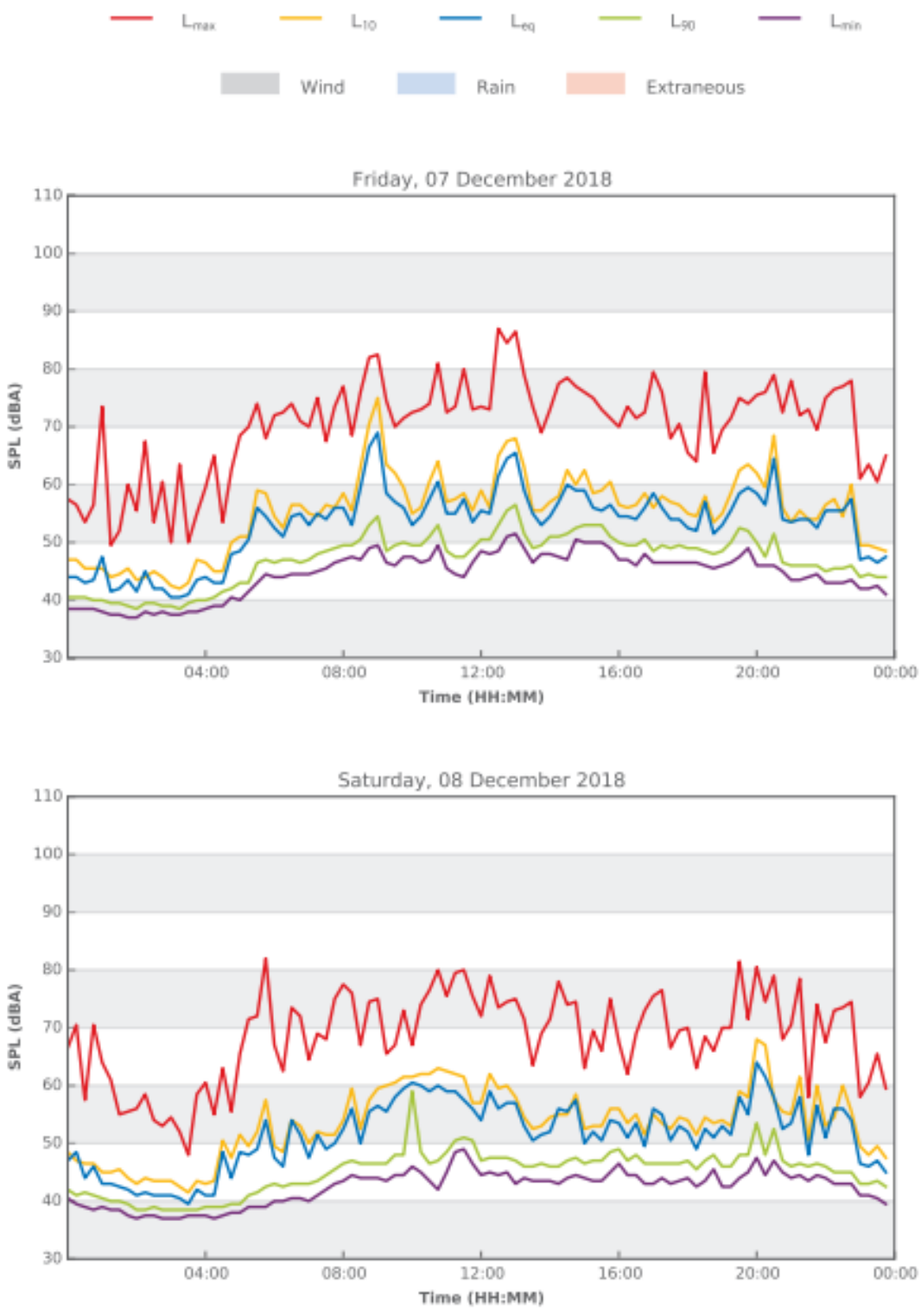

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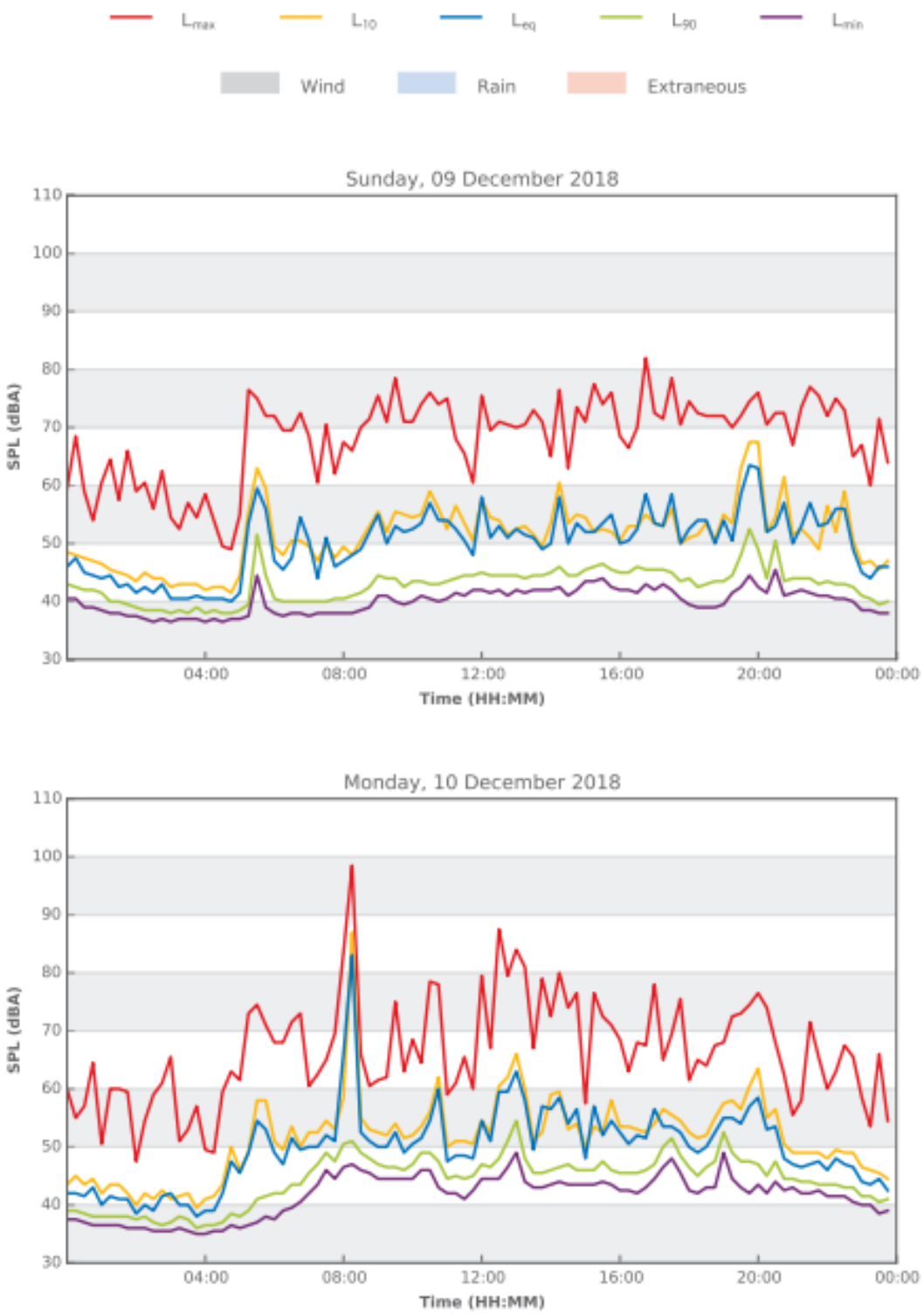

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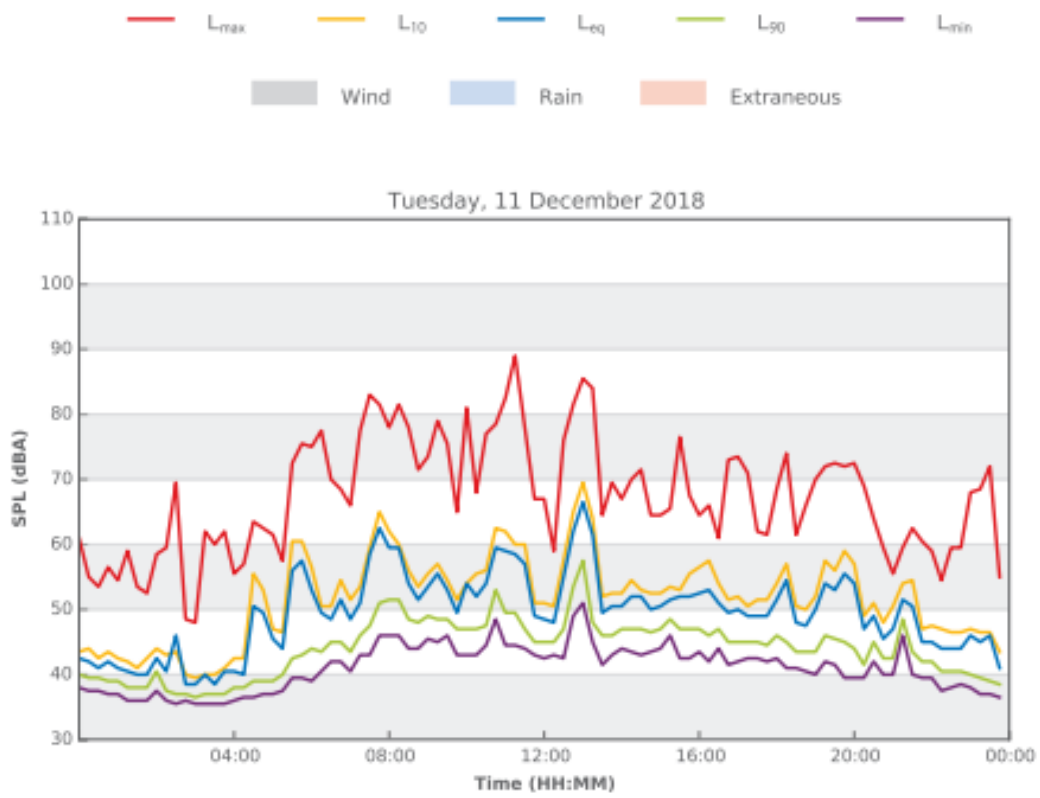
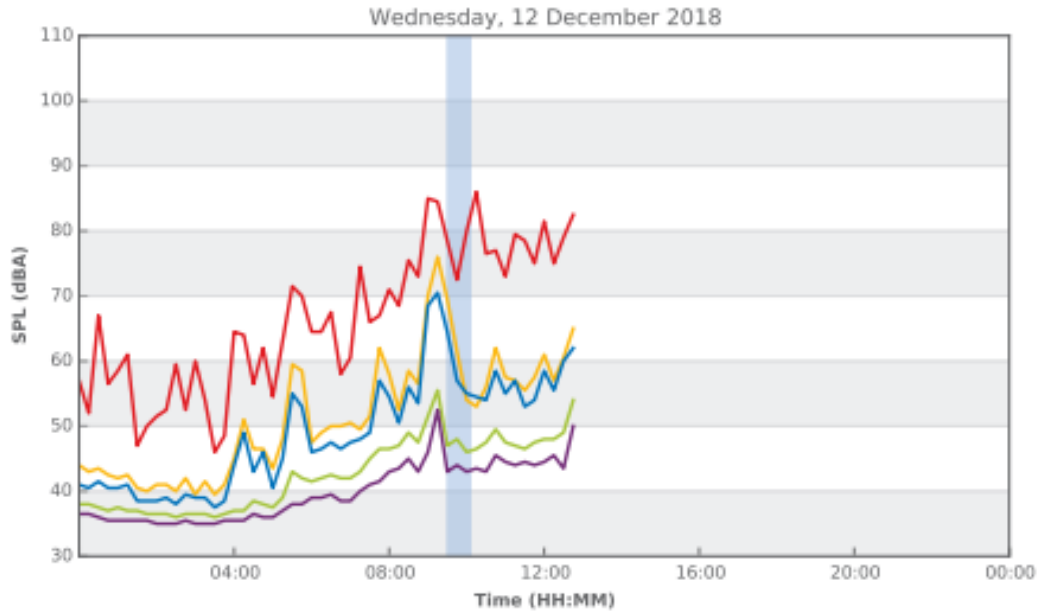
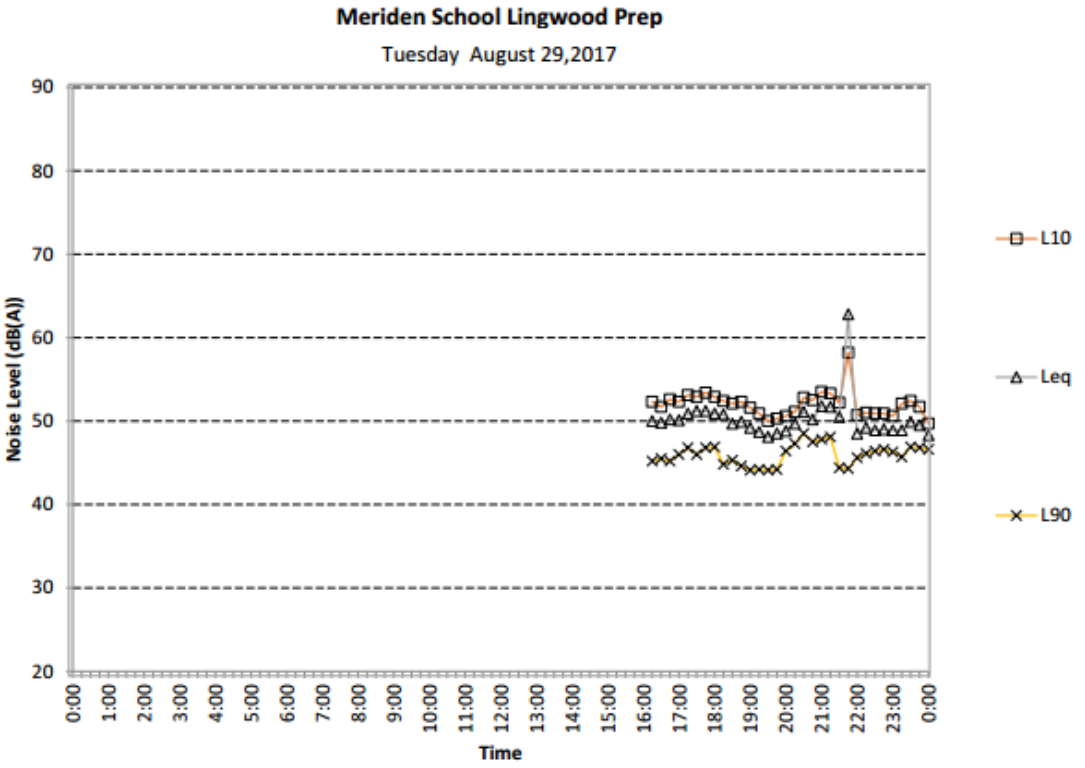
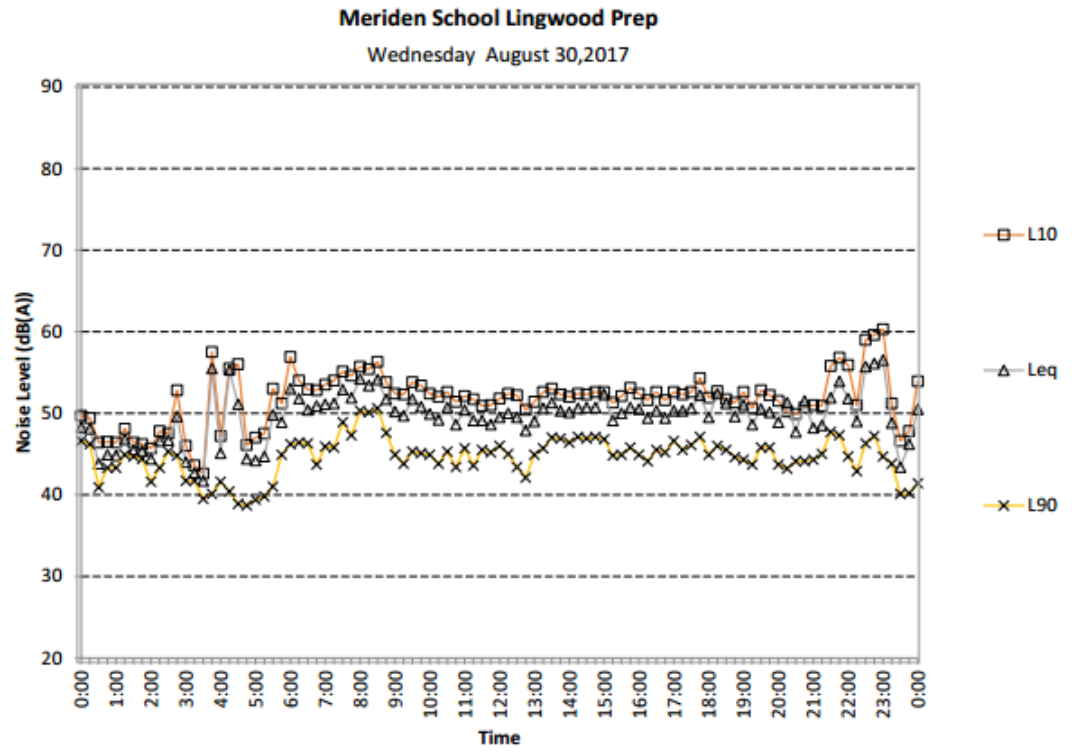




Lingwood Site Boundary





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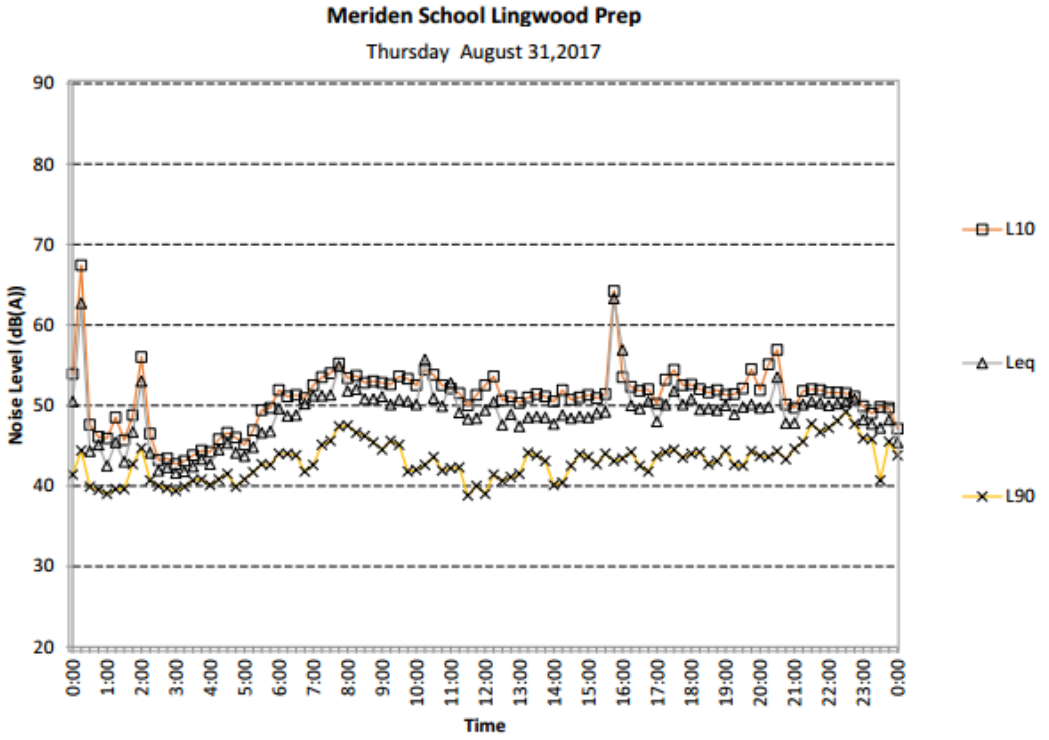

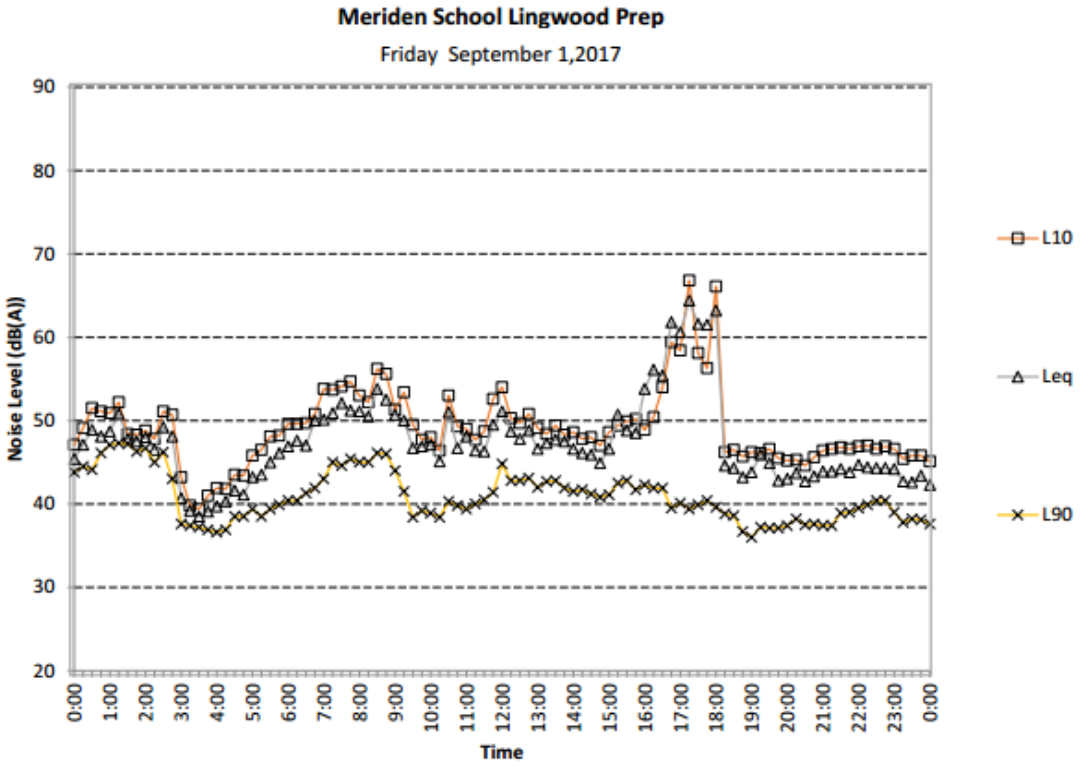

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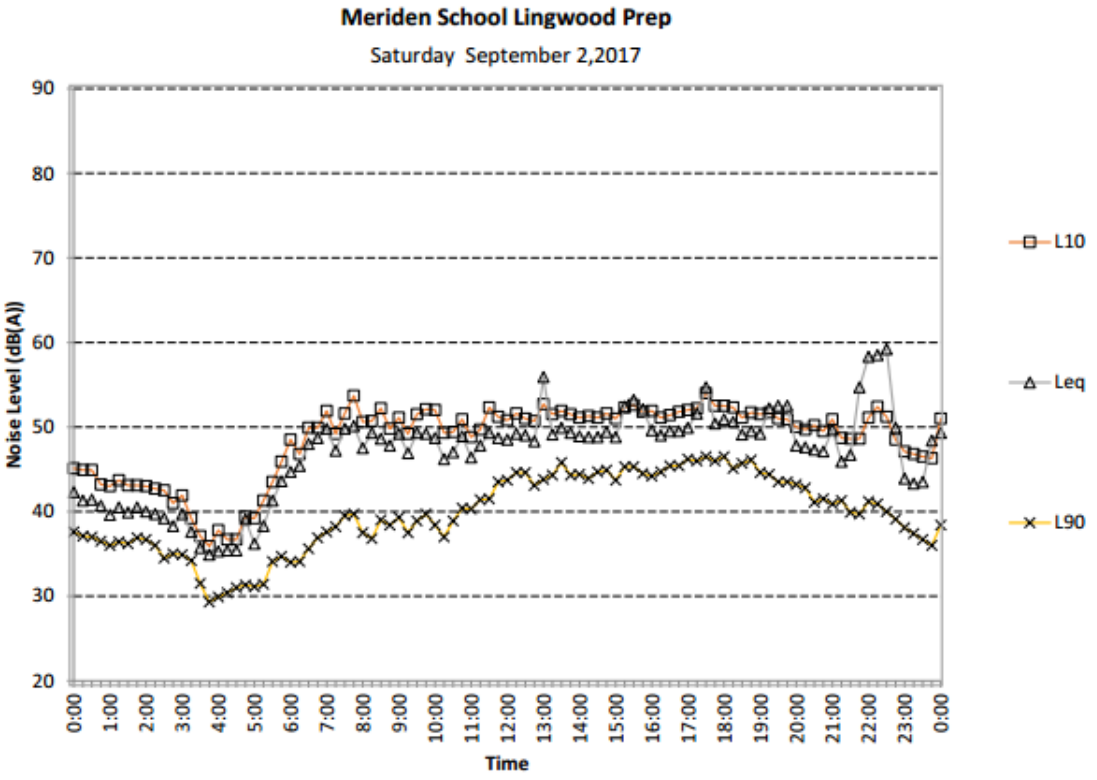

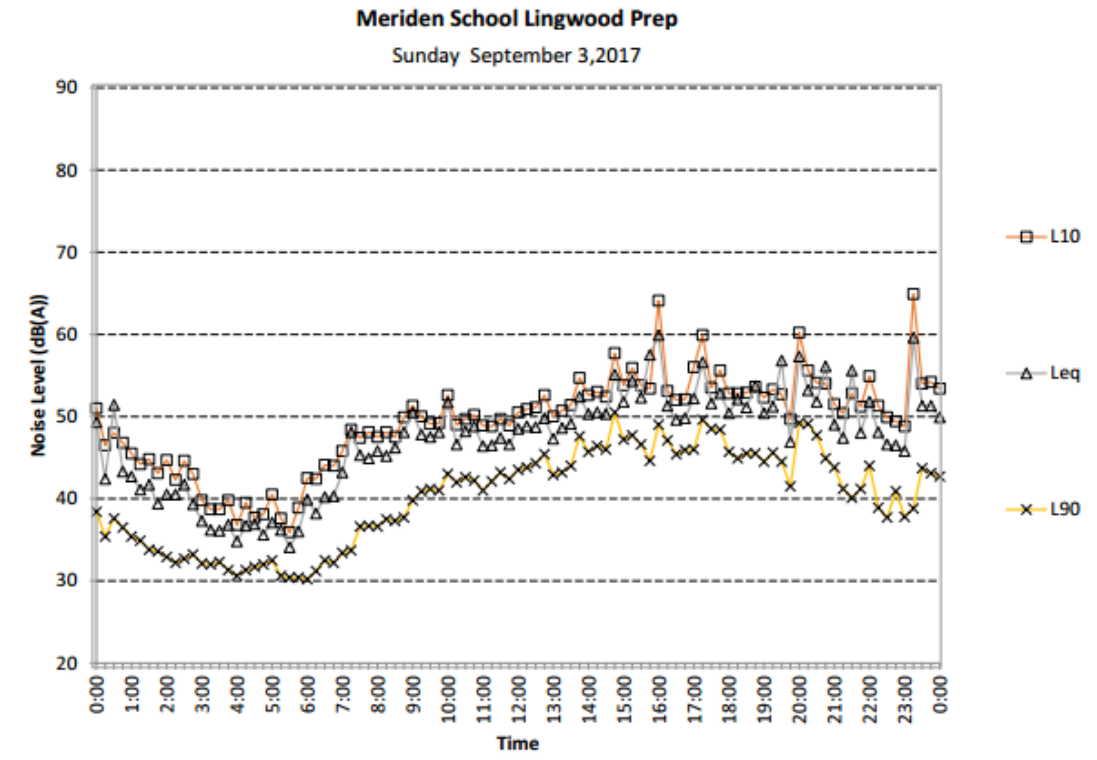

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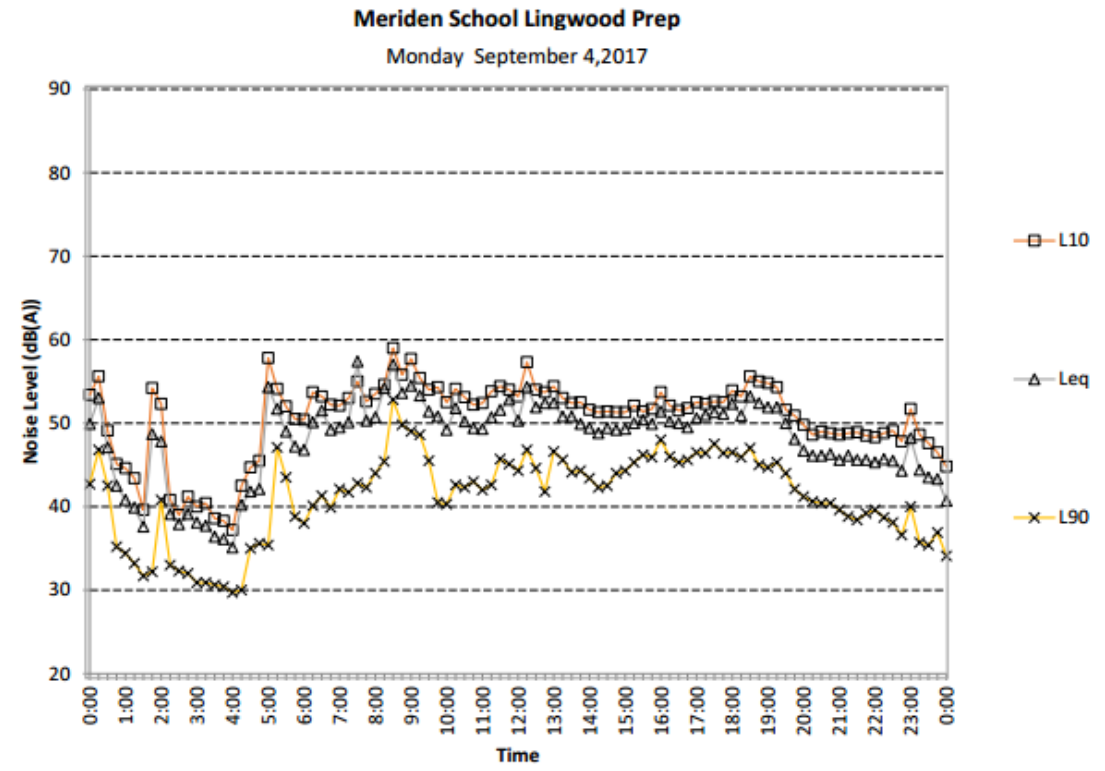
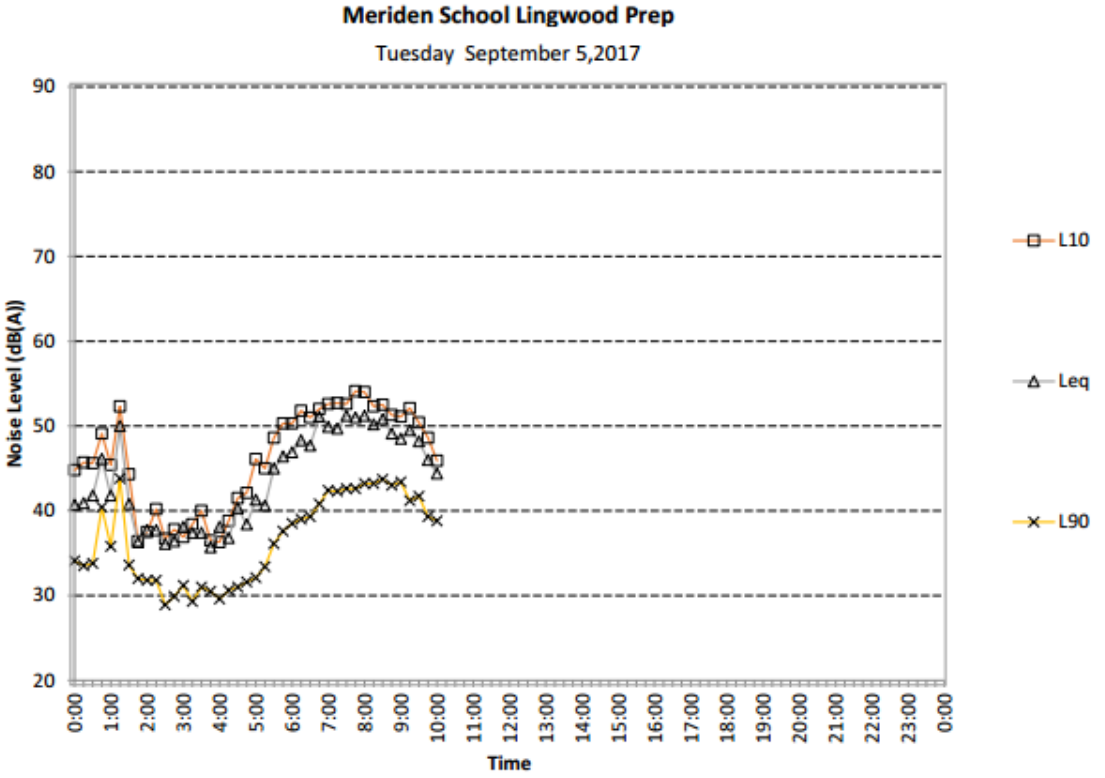
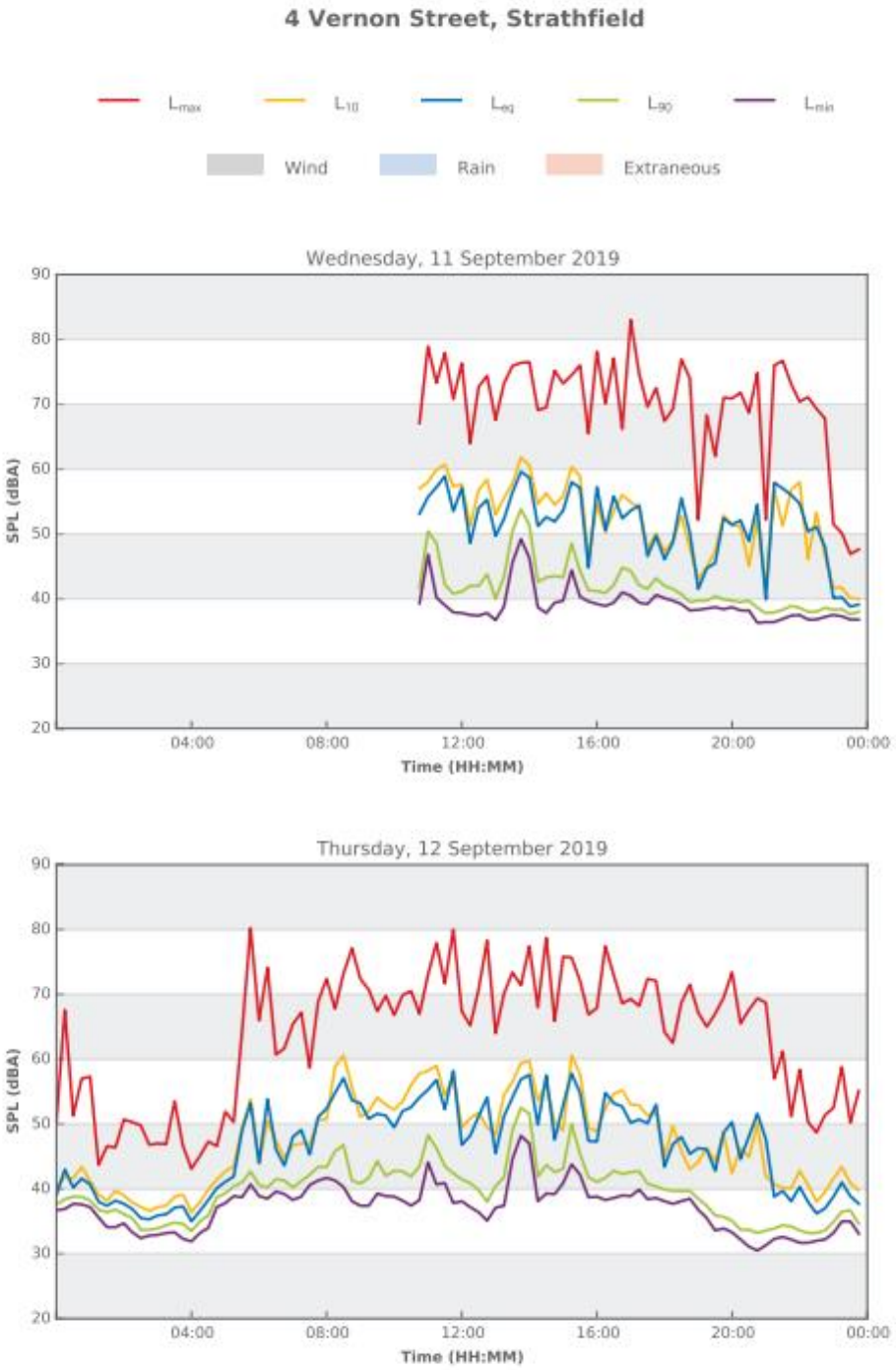
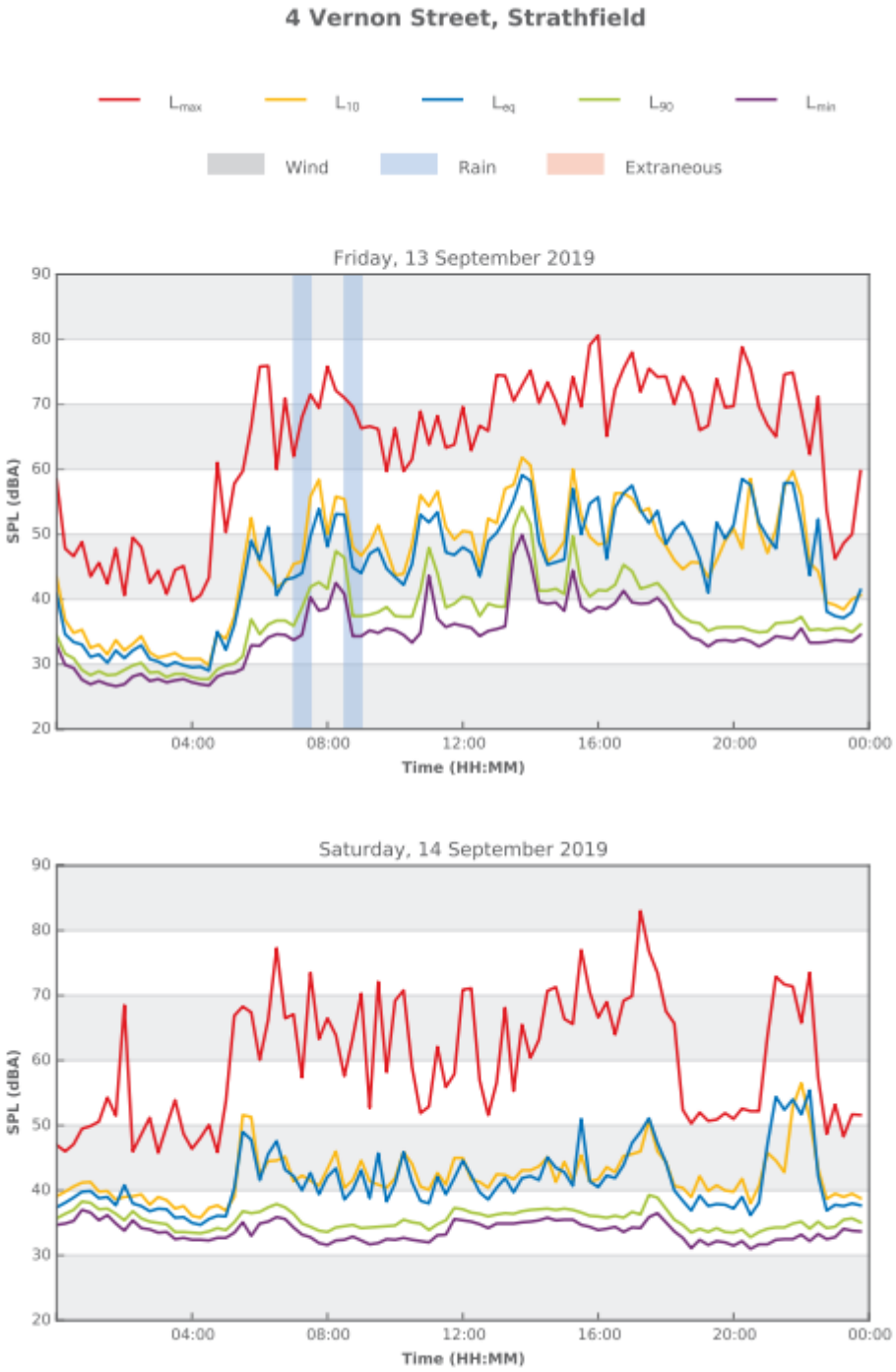





4 Vernon Street, Strathfield
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Wednesday, 11 September 2019
SPL (dBA)
Time (HH:MM)
Thursday, 12 September 2019
SPL (dBA)
Time (HH:MM)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L_{max}
L_{10}
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Wind
Rain
Extraneous
Friday, 13 September 2019
SPL (dBA)
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)
Saturday, 14 September 2019
SPL (dBA)
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80
70
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04:00
08:00
12:00
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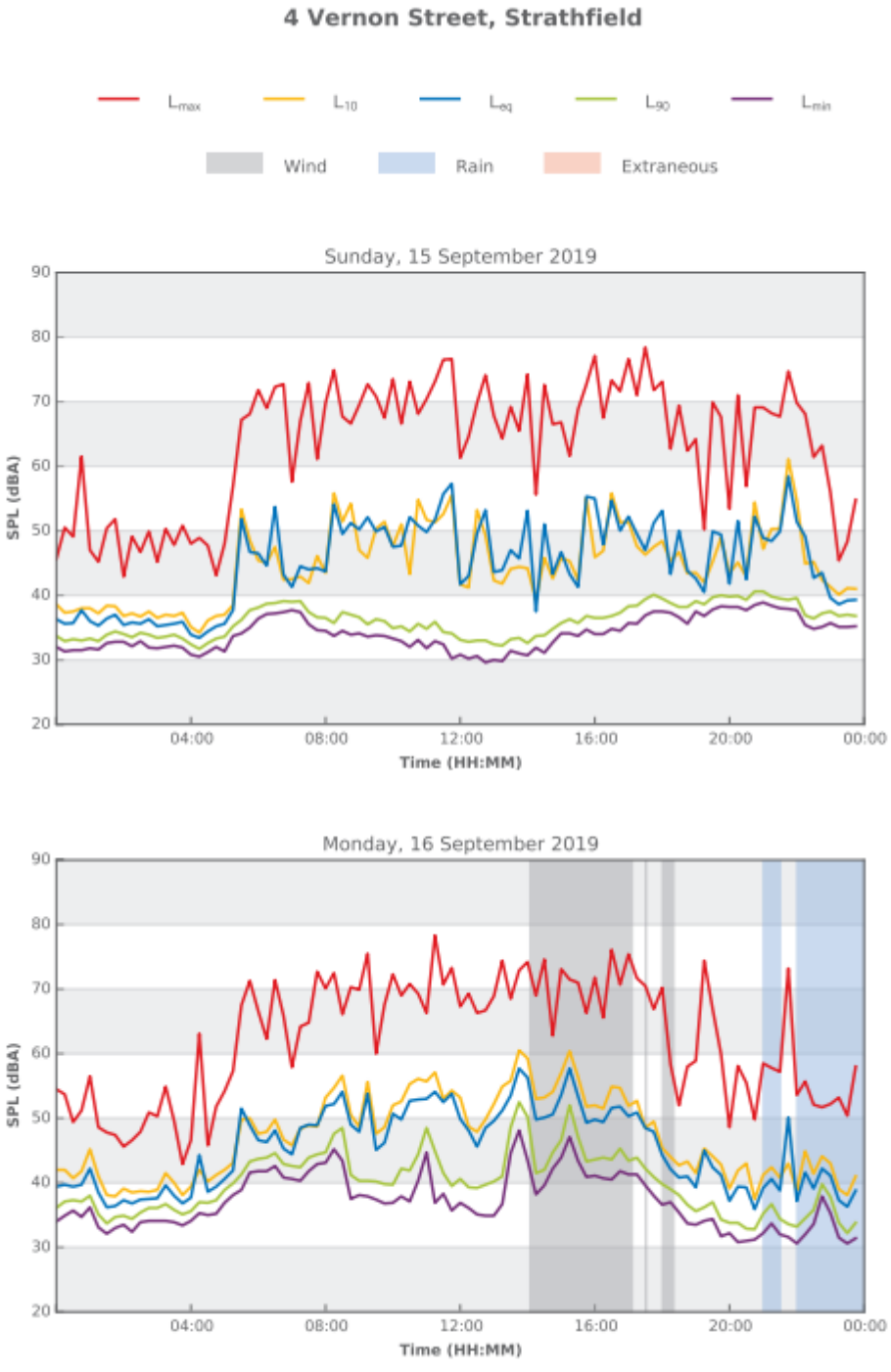
Time (HH:MM)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L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Sunday, 15 September 2019
SPL (dBA)
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)
Monday, 16 September 2019
SPL (dBA)
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04:00
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16:00
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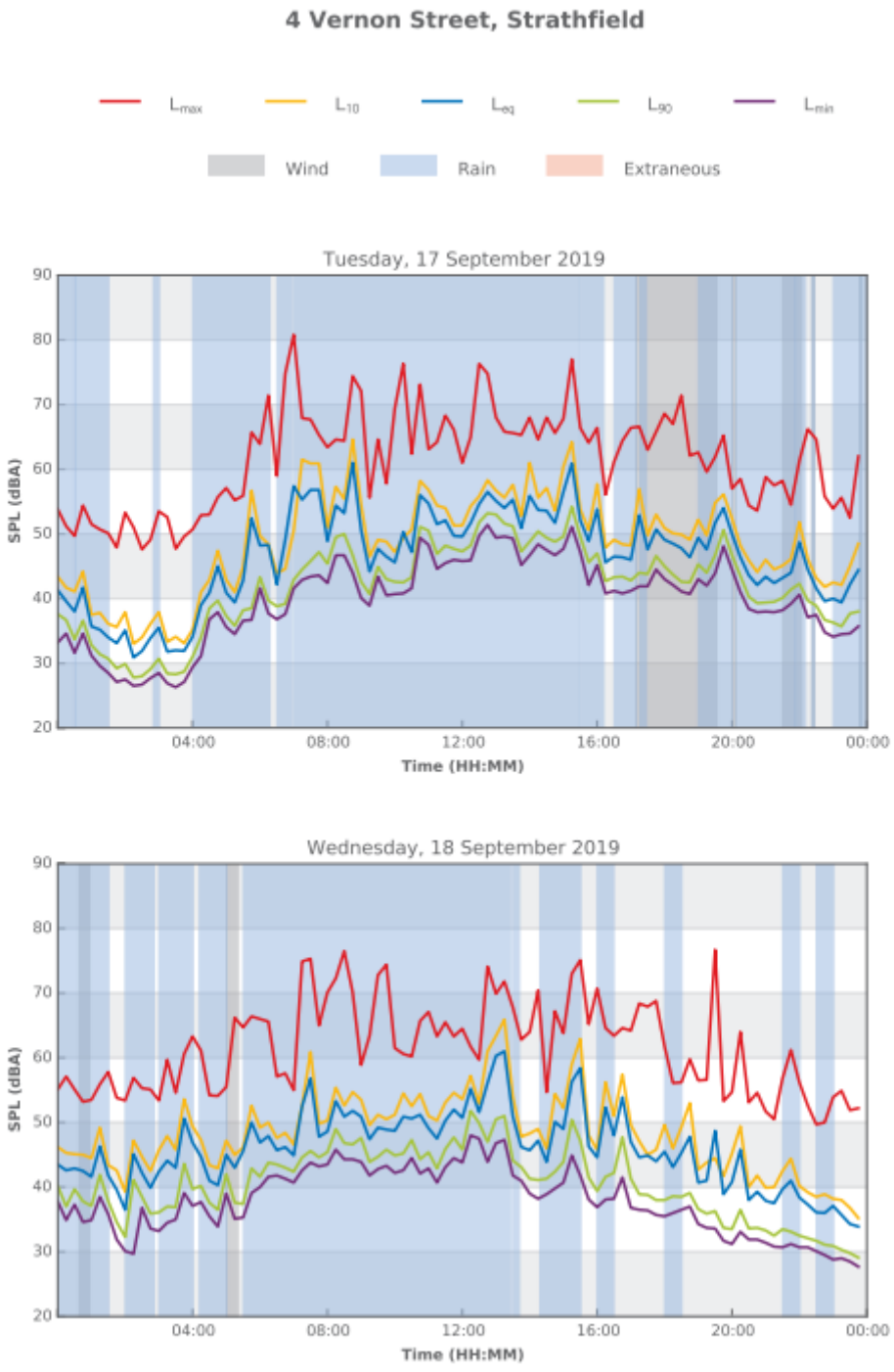
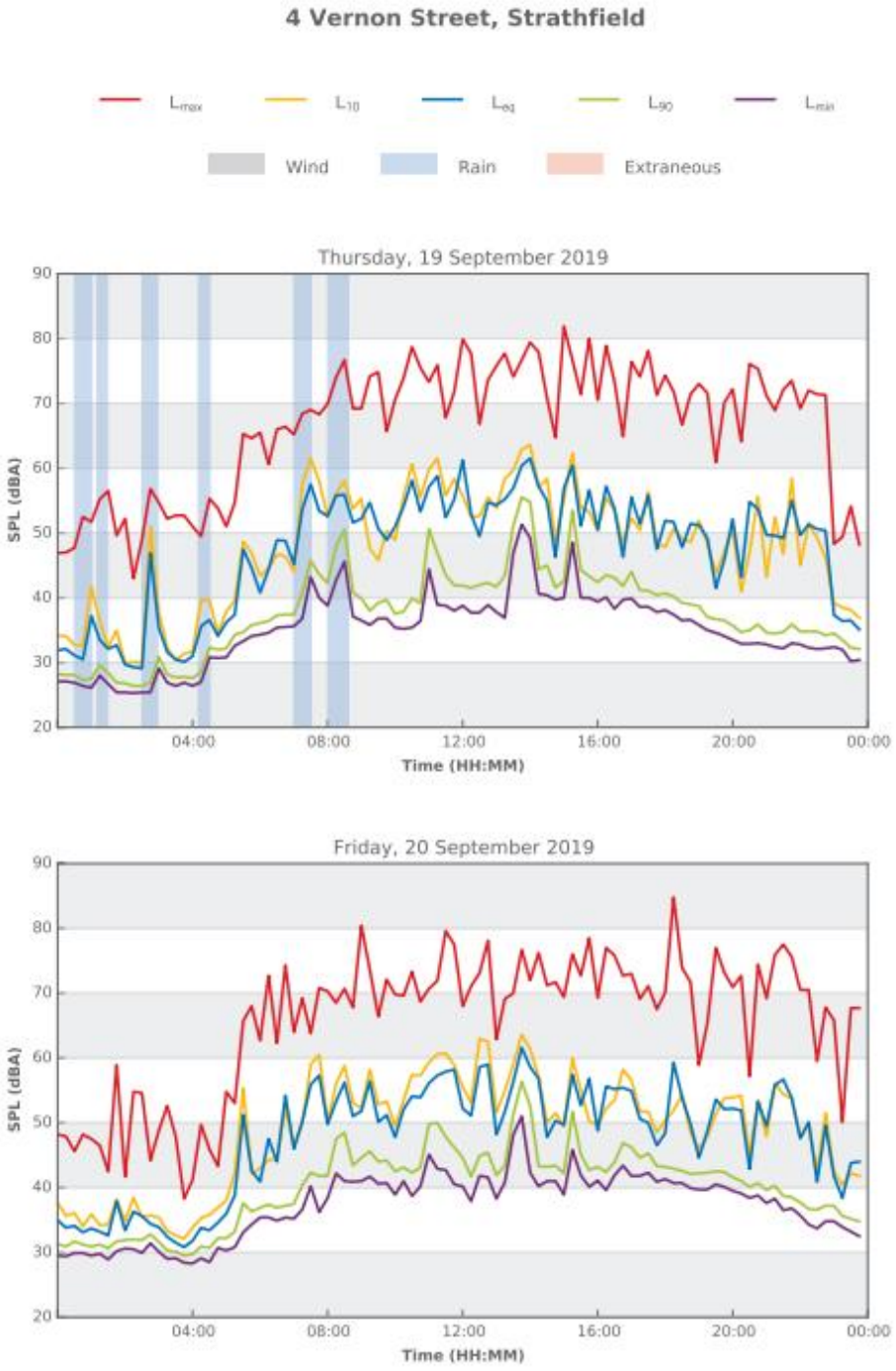
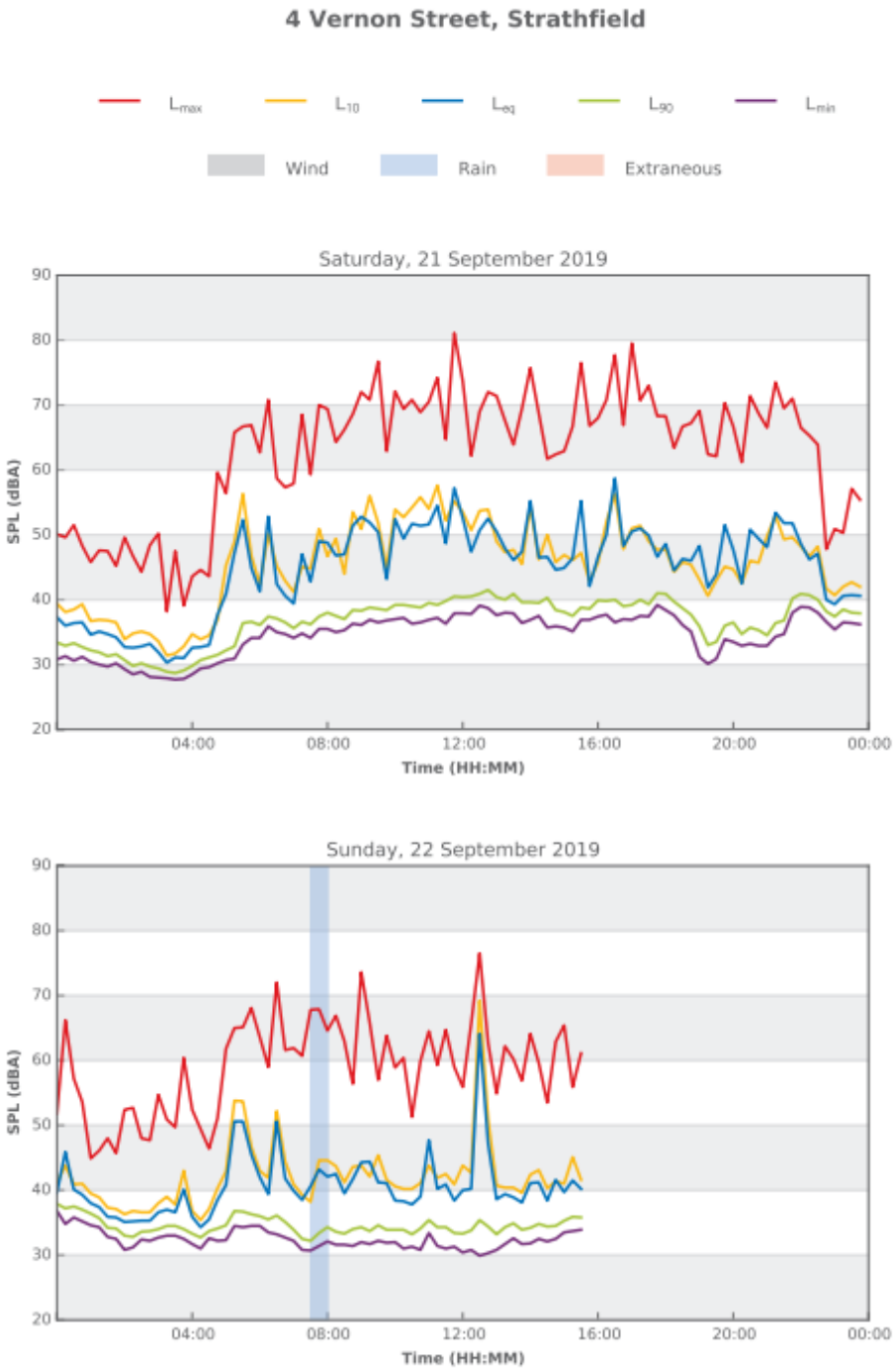
Time (HH:MM)

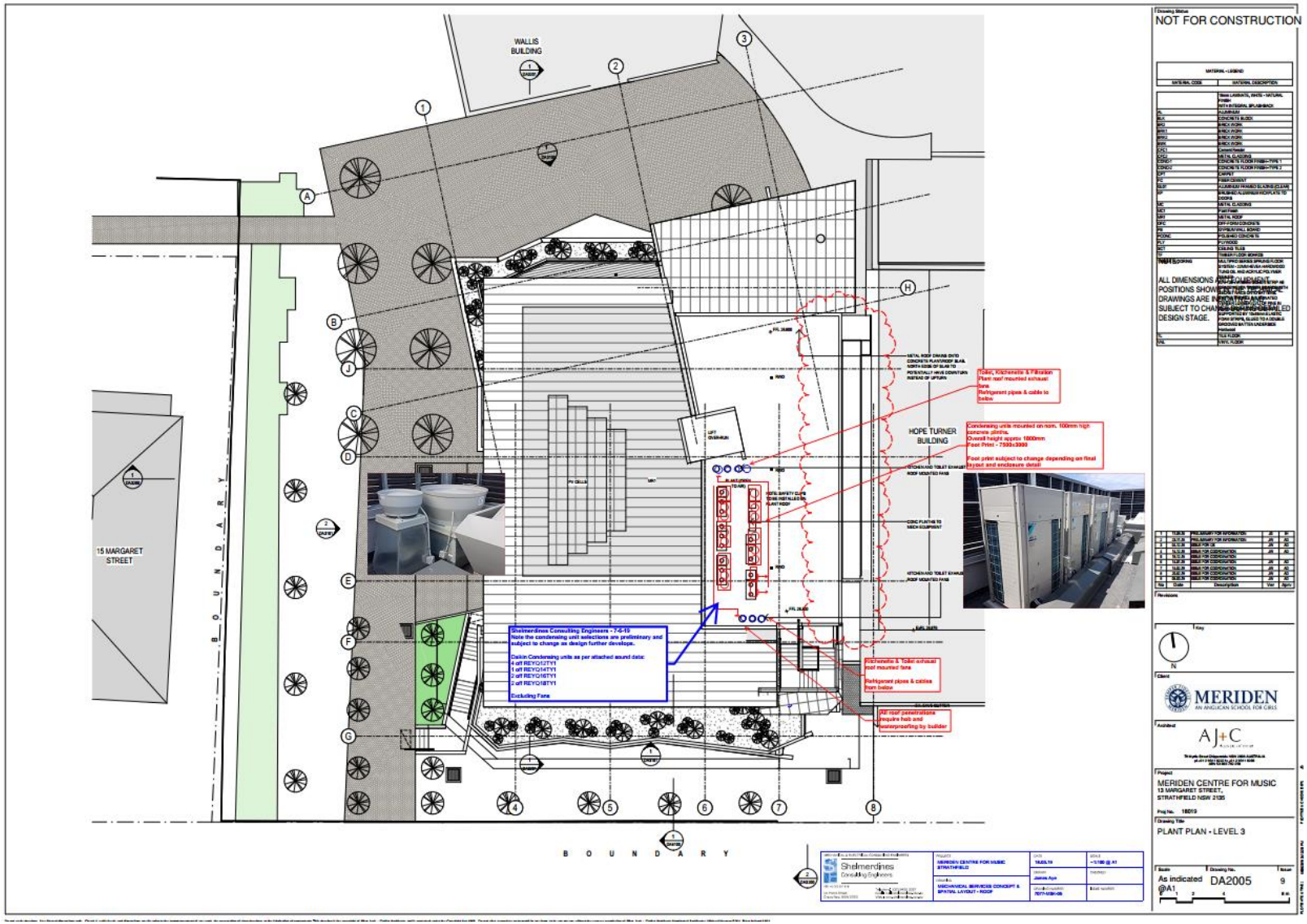

4 Vernon Street, Strathfield
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Tuesday, 17 September 2019
SPL (dBA)
Time (HH:MM)
Wednesday, 18 September 2019
SPL (dBA)
Time (HH:MM)

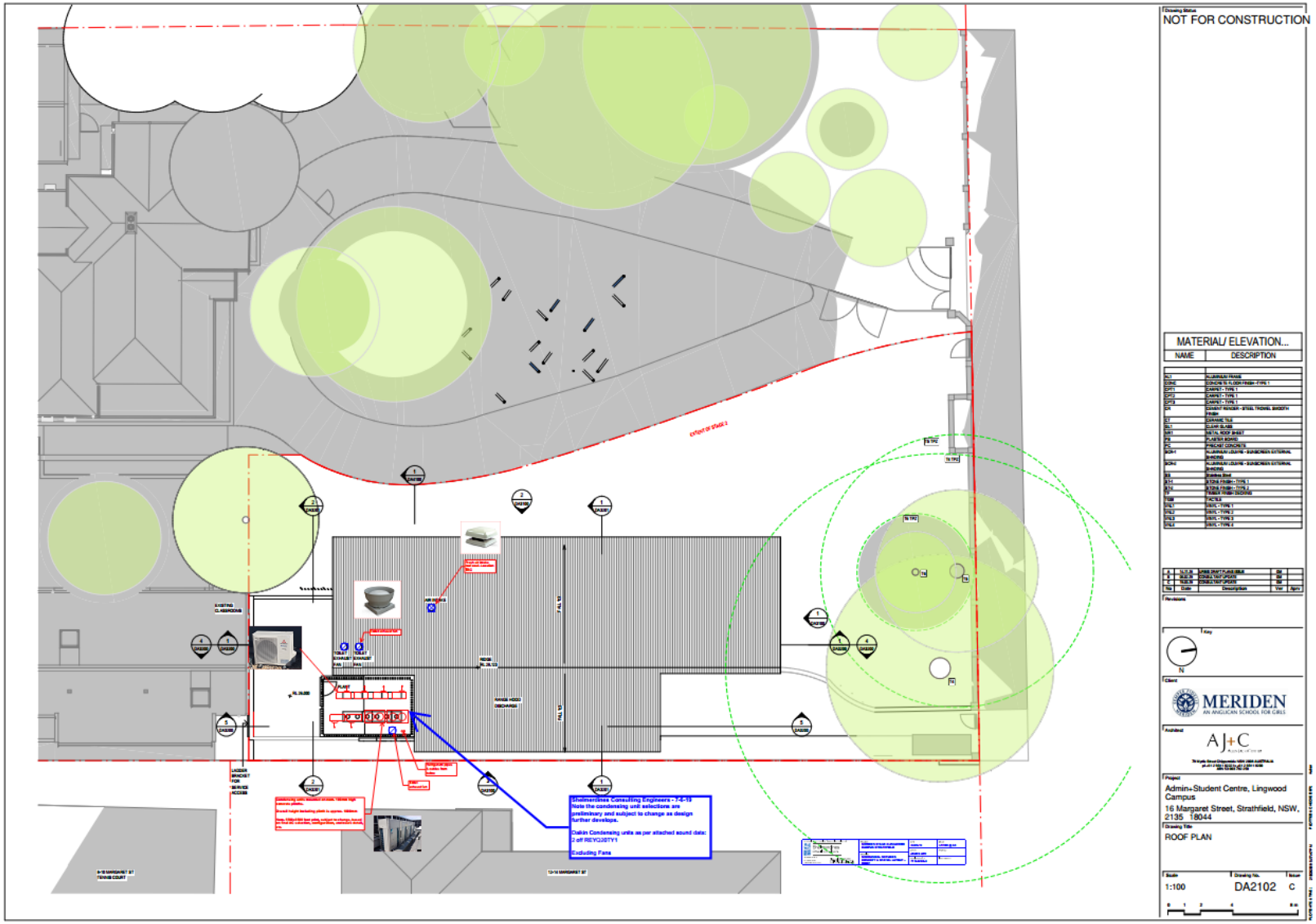

4 Vernon Street, Strathfield
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Thursday, 19 September 2019
SPL (dBA)
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)
Friday, 20 September 2019
SPL (dBA)
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)


4 Vernon Street, Strathfield
L_{max}
L_{10}
L_{eq}
L_{90}
L_{min}
Wind
Rain
Extraneous
Saturday, 21 September 2019
SPL (dBA)
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)
Sunday, 22 September 2019
SPL (dBA)
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)

APPENDIX B

MECHANICAL DRAWINGS


WALLIS BUILDING
HOPE TURNER BUILDING
15 MARGARET STREET
B O U N D A R Y
B O U N D A R Y
Toilet, Kitchenette & Filtration Plant roof mounted exhaust fans
Refrigerant pipes & cable to below
Condensing units mounted on nom. 100mm high compres. plinths.
Overall height approx 1600mm
Foot Print - 7500x3000
Foot print subject to change depending on final layout and enclosure detail
Shelmerdines Consulting Engineers - 7-6-19
Note the condensing unit selections are preliminary and subject to change as design further develops.
Daikin Condensing units as per attached sound data:
4 off REYQ12TY1
1 off REYQ14TY1
2 off REYQ16TY1
2 off REYQ18TY1
Excluding Fans
Kitchenette & Toilet exhaust roof mounted fans
Refrigerant pipes & cables from below
All roof penetrations require hob and waterproofing by builder
NOT FOR CONSTRUCTION
ALL DIMENSIONS & EQUIPMENT POSITIONS SHOWN ARE INDICATIVE ONLY. DRAWINGS ARE IN PROGRESS AND ARE SUBJECT TO CHANGE AS THE PROJECT DEVELOPS TO FINAL DESIGN STAGE.
MERIDEN
AN ANGLICAN SCHOOL FOR GIRLS
AJ+C
MERIDEN CENTRE FOR MUSIC
13 MARGARET STREET,
STRATHFIELD NSW 2135
PLANT PLAN - LEVEL 3
As indicated
DA2005
9
@A1
Shelmerdines Consulting Engineers
MECHANICAL SERVICES CONCEPT & SPATIAL LAYOUT - ROOF


NOT FOR CONSTRUCTION
MATERIAL/ ELEVATION...
NAME
DESCRIPTION
MERIDEN
AN ANGLICAN SCHOOL FOR GIRLS
AJ+C
Admin+Student Centre, Lingwood Campus
16 Margaret Street, Strathfield, NSW, 2135 18044
ROOF PLAN
1:100
DA2102
C