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Acoustic Assessment Report

Penshurst Public School
Arcadia Street, Penshurst

REPORT No
6320-1.1R Rev E

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TABLE OF CONTENTS

TABLES

1.0 CONSULTING BRIEF

Day Design Pty Ltd was engaged by Perumal Pedavoli Pty Ltd to carry out an acoustic assessment for the redevelopment of Penshurst Public School located at Arcadia Street, Penshurst, NSW The scope of work is as follows:

- Review the architectural drawings.
- Inspect the development site in Penshurst.
- Measure the background noise levels at critical locations and times
- Establish acceptable noise level criteria
- Quantify noise emissions from the School
- Calculate the level of noise emission, taking into account building envelope transmission loss, screen walls, ground absorption and distance attenuation
- Prepare a site plan identifying the development and nearby noise sensitive locations
- Provide recommendations for noise control (if necessary)
- Prepare an Acoustic Assessment Report.

Section 11.1 has been included to show engineering noise controls available to reduce construction noise at the nearby noise sensitive receivers.

2.0 PROJECT DESCRIPTION

Penshurst Public School is proposed to be redeveloped on the existing site at 18 Arcadia Street, Penshurst, NSW. The new school will have capacity for approximately 1,000 students and 65 staff. The Secretary's Environmental Assessment Requirements (SEARs) requires a noise and vibration assessment of the proposed Public School, extracted below:

> *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.*
>
> *Relevant Policies and Guidelines*
>
> - *NSW Industrial Noise Policy (EPA)*
> - *Interim Construction Noise Guideline (DECC)*
> - *Assessing Vibration: A Technical Guideline 2006*
> - *Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008).*

Existing residences are located along the northern boundary, to the east across Arcadia Street and to the south across Forest Road. St Declan's Primary School is located to the west, along the western boundary of the site.

Long term ambient noise measurements have been taken on the School site as shown in Figure 1. Ambient noise levels are presented in Section 3 of this report. These locations have been chosen to represent the acoustic environment of the nearby residential neighbours.

Acceptable noise limits are derived from the EPA's Industrial Noise Policy for intrusive noise impacts from mechanical plant and indoor noise, at each residence, and The Association of Australasian Acoustical Consultants (AAAC) *Technical Guideline for Child Care Centre Noise Assessment* noise criteria for children in outdoor areas.

Noise levels from children in the outdoor areas, public address system and use of the hall have been calculated at the nearest residential premises and are presented in Section 5.0.

Road traffic noise from Forest Road has been measured on the existing site to determine the impact of road traffic noise on the proposed School building. Noise control recommendations to reduce the level of road traffic noise from Forest Road are recommended in Section 8 of this report.

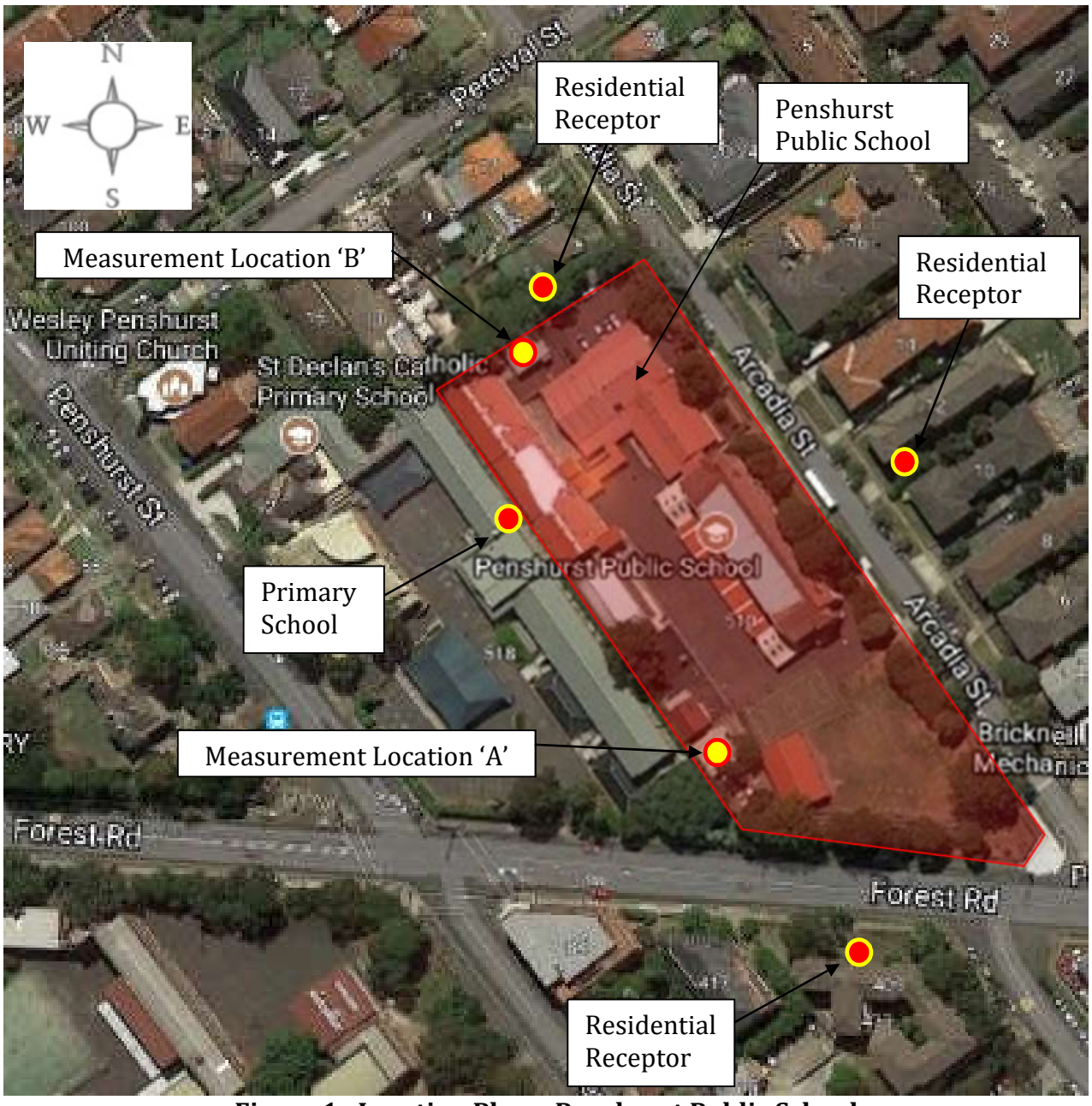


Figure 1 : Location Plan – Penshurst Public School

3.0 NOISE SURVEY INSTRUMENTATION

Noise level measurements and analysis were made with instrumentation as follows in Table 1:

Table 1 Noise Instrumentation

Description	Model No	Serial No
Infobyte Noise Logger(Type 2)	iM4	107
Condenser Microphone 0.5" diameter	MK 250	107
Infobyte Noise Logger(Type 2)	iM4	116
Condenser Microphone 0.5" diameter	MK 250	116

An environmental noise logger is used to continuously monitor ambient noise levels and provide information on the statistical distribution of noise during an extended period of time. The Infobyte Noise Monitor iM4 is a Type 2 precision environmental noise monitors meeting all the applicable requirements of AS1259 for an integrating-averaging sound level meter.

All instrument systems had been laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The measurement system was also field calibrated prior to and after noise surveys. Calibration drift was found to be less than 1 dB for unattended measurements. No adjustments for instrument drift during the measurement period were warranted.

4.0 NOISE EMISSION CRITERIA

4.1 Background Noise Level

In order to assess the severity of a possible environmental noise problem in a residential area it is necessary to measure the ambient background noise level at the times and locations of worst possible annoyance. The lower the background noise level, the more perceptible the intrusive noise becomes and the more potentially annoying.

The ambient L_{90} background noise level is a statistical measure of the sound pressure level that is exceeded for 90% of the measuring period (typically 15 minutes).

The Rating Background Level (RBL) is defined by the NSW EPA as the median value of the (lower) tenth percentile of L_{90} ambient background noise levels for the day, evening or night time periods, measured over a number of days during the proposed days and times of operation.

The places of worst possible annoyance are the residences located to the east across Arcadia Street and to the north on the northern boundary. These potentially affected locations can be seen in Figure 1. The times of greatest annoyance will be during the day time when children are outdoors.

Two environmental noise loggers were placed on the existing school site at Penshurst, one at the front towards Forest Road and another to the rear, to determine the Rating Background Level. This location is shown on Figure 1 as Measurement Location 'A' and Measurement Location 'B'.

Measurement Location 'A', while conducted on School premises, is a good representation of the background noise level for the adjoining residential dwelling at 13 Arcadia Street. We are of the opinion that the background noise levels measured at Location 'A' are representative of the most affected residential premises in the area.

Measurement Location 'B', while conducted on School premises, is a good representation of the background noise level for the residential dwellings exposed to road traffic noise from Forest Road. We are of the opinion that the background noise levels measured at Location 'B' are representative of the residential premises that are also affected by road traffic noise from Forest Road.

The measured noise levels are presented in the attached Appendix A1 and A2 and also in Table 2 below.

Table 2 Ambient Noise Levels – Penshurst

Location	Time Period	L_{90} Rating Background Level (dBA)	Existing L_{eq} Noise Level (dBA)
Location 'A' – Penshurst Public School (Front of site, towards Forest Road)	Day (7 am to 6 pm)	**55**	**65**
	Evening (6 pm to 10 pm)	**49**	**62**
	Night (10 pm to 7 am)	**36**	**58**
Location 'B' – Penshurst Public School (Rear of site, towards 13 Arcadia Street)	Day (7 am to 6 pm)	**44**	**55**
	Evening (6 pm to 10 pm)	**42**	**49**
	Night (10 pm to 7 am)	**34**	**49**

Extraneous noise from children playing in the outdoor areas of the School has been excluded from the measurements .Atmospheric conditions were ideal for noise monitoring. Noise measurements were therefore considered reliable and typical for the receptor area.

4.2 NSW Industrial Noise Policy

The Environment Protection Authority (EPA) published their NSW Industrial Noise Policy in January 2000. The Industrial Noise Policy is specifically aimed at assessing noise from industrial noise sources scheduled under the Protection of the Environment Operations Act 1997 (POEO, 1997).

Penshurst Public School is not a 'scheduled premises' under the Protection of the Environment Operations Act 1997 as it is not required to hold a licence under that Act for operations at the site.

The appropriate regulatory authority may, by notice in writing given to such a person, prohibit the person from causing, permitting or allowing:

(a) any specified activity to be carried on at the premises, or

(b) any specified article to be used or operated at the premises,

or both, in such a manner as to cause the emission from the premises, at all times or on specified days, or between specified times on all days or on specified days, of noise that, when measured at any specified point (whether within or outside the premises,) is in excess of a specified level.

The Industrial Noise Policy provides a useful framework to assess noise emission from non-scheduled premises, whether that premises produces intrusive or non-intrusive noise.

While the Industrial Noise Policy is not strictly applicable to this site, as the site is not scheduled, in the absence of other relevant standards the limits set out in the NSW Industrial Noise Policy will be used as a guide in determining whether the level of noise is considered intrusive or not.

4.3 Residential Receptor Intrusiveness Criteria

Section 2.1 of the NSW Industrial Noise Policy states that a noise source is generally considered to be intrusive if the noise from the source when measured over a 15 minute period exceeds the background noise by more than 5 dB.

The representative Rating Background Levels were as shown in Table 2 above. Therefore the acceptable L_{eq} noise intrusiveness criteria for broadband noise at the residences are as follows:

Front of Site (towards Forest Road):

- (55 + 5 =) **60 dBA** during the day (7 am – 6 pm);
- (49 + 5 =) **54 dBA** in the evening (6 pm – 10 pm);
- (36 + 5 =) **41 dBA** at night (10 pm – 7 am).

Rear of Site (towards 13 Arcadia Street):

- (44 + 5 =) **49 dBA** during the day (7 am – 6 pm);
- (42 + 5 =) **47 dBA** in the evening (6 pm – 10 pm);
- (34 + 5 =) **39 dBA** at night (10 pm – 7 am).

4.4 Amenity Criteria

Depending on the type of area in which the noise is being made, there is a certain reasonable expectancy for noise amenity. The NSW Industrial Noise Policy provides a schedule of recommended L_{eq} industrial noise levels that under normal circumstances should not be exceeded. If successive developments occur near a residential area, each one allowing a criterion of background noise level plus 5 dB, the ambient noise level will gradually creep higher.

The recommended L_{eq} noise levels in Table 3 below are taken from Section 2.2 of the INP.

Table 3 Amenity Criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{eq} Noise Level, dBA	
			Acceptable	Recommended Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
School Classroom – internal	All	Noisiest 1-hour period when in use	35	40
Active recreation area (eg school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70

Compliance with the amenity criteria will limit ambient noise creep. Wherever the existing L_{eq} noise level from industrial noise sources approaches or exceeds the amenity criteria at a critical receptor location, the intrusive L_{eq} noise from the noise source in question must be reduced to a level that may be as much as 10 dB below the existing L_{eq} industrial noise level.

The existing L_{eq} noise level at Penshurst is shown in Table 2. The front of the site is affected by road traffic noise from Forest Road. Therefore the acceptable L_{eq} amenity criteria for in this area is:

Front of Site (towards Forest Road):

- (65 – 10 =) 55 dBA during the day;
- (62 – 10 =) 52 dBA in the evening; and
- (58 – 10 =) 48 dBA dBA at night.

Rear of Site (towards 13 Arcadia Street):

- 55 – 60 dBA during the day;
- 45 – 50 dBA in the evening; and
- 40 – 45 dBA dBA at night.

4.5 AAAC Noise Criteria for Outdoor Play Areas

In May 2008, the Association of Australasian Acoustical Consultants (AAAC) first published the *Technical Guideline for Child Care Centre Noise Assessment*. The guideline was updated in 2010 to assist both AAAC members and local councils to assess the noise impact from proposed child care centres both accurately and fairly, (see www.aaac.org.au).

Although the proposed development is a new Public School and therefore may produce different levels of noise than a childcare centre, there are similarities in noise emission from uses of outdoor play areas for schools and childcare centres. As students do not play outdoors continuously for long periods of time, and as the duration of time for students playing outside is reduced, the overall noise annoyance reduces. Therefore, it is reasonable to allow a higher level of noise impact for a shorter duration.

The AAAC document states that a total time limit of 2 hours of outdoor play per day (e.g. 1 hour in the morning and 1 hour in the afternoon) should allow an additional 5 dB noise impact.

We recommend that the noise criteria detailed in *Technical Guideline for Child Care Centre Noise Assessment* be applied to outdoor areas of the School.

The relevant criteria is $L_{eq,\ 15min}$ noise level emitted from the outdoor play area shall not exceed the background noise level by more than 10 dB at the residential assessment location.

Up to 2 hours (total) per day – The $L_{eq,\ 15min}$ noise level emitted from the outdoor areas shall not exceed the background noise level by more than 10 dB at the assessment location.

More than 2 hours per day – The $L_{eq,15min}$ noise level emitted from the outdoor areas shall not exceed the background noise level by more than 5 dB at the assessment location.

4.6 Road Traffic Noise Criteria

The NSW Road Noise Policy, in Section 2.3.1, sets out road traffic noise assessment criteria for residential land uses in Table 3. The information in that table is extracted below in Table 4.

Table 4 Road Traffic Noise Assessment Criteria - Residential

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	1. Existing residences affected by noise from **new** freeway/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	2. Existing residences affected by noise from **redevelopment** of existing new Freeway/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
	3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments		
Local roads	4. Existing residences affected by noise from **new** local road corridors	$L_{Aeq, (15\ hour)}$ 55 (external)	$L_{Aeq, (9\ hour)}$ 50 (external)
	5. Existing residences affected by noise from **redevelopment** of existing local roads		
	6. Existing residences affected by **additional traffic** on existing local roads generated by land use developments		

Note: Land use developers must meet internal noise goals in the Infrastructure SEPP for sensitive developments near busy roads.

The NSW Road Noise Policy, in Section 2.3.2, sets out road traffic noise assessment criteria for land uses other than residential in Table 4. The information in that table is extracted below in Table 5.

Table 5 Road Traffic Noise Assessment Criteria – Non- Residential

Existing sensitive land use	Assessment Criteria – dB(A)		Additional considerations
	Day (7 am – 10 pm)	Night (10 pm – 7 am)	
1. School classrooms	$L_{Aeq, (1\ hour)}$ 40 (internal) when in use		In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard AS2107:2000

4.7 Project Specific Noise Emission Criteria

When all the above factors are considered, we find that the most stringent noise criterion at the nearby residential premises is:

Front of Site (near Forest Road):

- (55 + 10 =) **65 dBA** for outdoor play during the day;
- (65 – 10 =) **55 dBA** during the day for all other activities;
- (62 – 10 =) **52 dBA** in the evening; and
- (36 + 5 =) **41 dBA** dBA at night.

Rear of Site (near 13 Arcadia Street):

- (44 + 10 =) **54 dBA** for outdoor play during the day;
- (44 + 5 =) **49 dBA** during the day for all other activities;
- (42 + 5 =) **47 dBA** in the evening;
- (34 + 5 =) **39 dBA** at night.

Outside the adjacent St Declan's Primary School, the acceptable noise criteria is **55 dBA** when in use for outdoor play areas. The acceptable noise criteria of **35 – 40 dBA** applies to inside classrooms of St Declan's Primary School when in use.

These criteria apply at the most-affected point on or within the residential property boundary – or, if that is more than 30 metres from the residence, at the most-affected point within 30 metres of the residence. For upper floors, the noise is assessed outside the nearest window.

5.0 SCHOOL NOISE EMISSION

The main sources of noise from Penshurst Public School will be from children playing in the outdoor areas, amplified music and speech in the hall and mechanical plant. Calculations are based on the building layout provided by Perumal Pedavoli Architects dated 20 October 2017 shown in Appendix B.

5.1 Children in Outdoor Areas

Children will be outside for a range of times, including before school, recess, lunch, PE classes and after school, however the outdoor areas are only likely to be at capacity during recess and lunch.

In order to model the worst case scenario of noise emission from students outdoors at play on the roof of the building, we have assessed the total permissible number of 680 students engaged in active play on the rooftop. The remaining students will be at ground floor level, typically in the assembly areas.

The rooftop area also includes a Covered Outdoor Learning Area on the northern end of the site, with a roof over accommodating the photovoltaic cells. A sports court is provided on ground floor level.

Sound power levels of children at play were previously measured for other similar projects and are presented in Table 6. These levels represent the typical maximum noise levels of children at play and will be used in this noise assessment.

Table 6 Children at Play (outside) L_{eq} Sound Power Levels

Description	Sound Power Levels (dB) at Octave Band Centre Frequencies (Hz)								
	dBA	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
1 Child at play – Primary School	**79**	54	64	69	73	76	73	68	65
400 Primary Children at play	**105**	80	90	95	99	102	99	94	91
680 Primary Children at play	**107**	82	92	97	101	104	101	96	93

Knowing the sound power level of a noise source, the sound pressure level (as measured with a sound level meter) can be calculated at a remote location using suitable formulae to account for distance losses, sound barriers, etc.

The predicted level of noise from all students playing was used as a worst case scenario and is calculated to be as shown in Table 7 at the upper most floor of the worst affected residences.

Table 7 Predicted L_{eq} Outdoor Noise Levels

Receptor Location	Predicted Noise Level (dBA)	AAAC Noise Criteria (dBA)	Amenity Noise Criteria (dBA)
With 1.2 metre Balustrade on Rooftop			
R1 – 13 Arcadia Street (Ground Floor)	46	54	55 - 60
R2 – 12 Arcadia Street (Third Floor)	**60**	54	55 - 60
R3 – St Declan's Primary School (Second Floor)	**62**	55	**55**
R4 – 409 Forest Road (Third Floor)	55	65	55 - 60

The NSW EPA has provided a presentation addressing noise issues from School developments (refer to Appendix D, attached). It explains that noise from outdoor play is expected from the School given the land zoning .

St Declan's Catholic Primary School has a student population of approximately 435 as reported on their website (https://sites.google.com/a/syd.catholic.edu.au/stdpenshurst/). The noise emission would therefore likely be greater from Penshurst Public School with a proposed student population of 1,000. The combination of both schools will likely lead to an increase in overall noise level by 1-2 dB at the most sensitive receptors across Arcadia Street, which is considered a negligible increase.

The noise from outdoor play will likely exceed the acceptable noise criteria by up to 7 dB. However, the noise levels will still be within the residential amenity noise criteria. The amenity criteria for the adjacent school will be exceeded by 7 dB, however are likely to be generating their own noise during recess and lunch breaks when the above is proposed to take place.

Given the existing school noise emission, the limited duration of noise from outdoor play, the zoning of the site and expectations of noise from children on a school site we are of the opinion that the noise from outdoor play would be considered acceptable.

5.2 Public Address System and School Bell

The Penshurst Public School will be provided with a public address system and a bell to signal the start and end of classes. The location of the speakers has not yet been determined however assuming up to 6 speaker locations are provided, the maximum sound pressure level should be no greater than **80 dBA** at 3 metres from each speaker in order to meet the residential noise criteria.

5.3 School Hall

The Hall will be used by students and teachers during school hours for activities such as indoor sport and fitness, assemblies, drama and music rehearsal and production. The School may be used infrequently outside of these hours for school events.

A typical use of the Hall has been provided and is as follows:

- Disco; 1 to 2 a year from 3 pm to 7 pm
- Band 1 to 2 times a week 8 am-9 am in hall
- Year 6 farewell – 1 x per year
- presentation nights – 1 x per year
- OOSH; Monday – Friday; 30-50 kids – 3 pm to 6:30 pm

The hall is not proposed to be used after 10 pm. We recommend that this be maintained, with no use of the hall after 10 pm.

A schedule of the sound power levels for loudest activities that may occur within the Hall is presented in Table 8.

Table 8 Hall Activity L_{eq} Sound Power Levels

Description	Sound Power Levels (dB) at Octave Band Centre Frequencies (Hz)								
	dBA	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Amplified music – concert	**98**	103	106	102	95	92	86	81	78
Fitness class – 30 people with amplified music	**87**	93	87	82	81	84	79	75	72
Indoor ball sports	**97**	71	74	79	84	94	92	87	81

The indoor sports and fitness class may occur during the daytime and are therefore compared against the daytime criteria. The amplified music during a concert / disco / function may occur during the evening and is therefore compared against the evening criteria.

The predicted level of noise from activities within the hall is calculated with the doors open to the south as shown below in Table 9 below at the worst affected residences.

Table 9 Predicted L_{eq} Hall Noise Levels (Large Doors Open)

Receptor Location	Predicted Noise Level (dBA)	Noise Criteria (dBA)	Compliance (Yes/No)
During School Hours			
R1 – 13 Arcadia Street (Ground Floor)			
- Fitness class	36	49	Yes
- Indoor ball sports	46	49	Yes
R2 – 12 Arcadia Street (Third Floor)			
- Fitness class	30	49	Yes
- Indoor ball sports	41	49	Yes
R3 – St Declan's Primary School (Second Floor)			
- Fitness class	48	55	Yes
- Indoor ball sports	**59**	55	**No (+ 4 dB)**
R4 – 409 Forest Road (Third Floor)			
- Fitness class	24	55	Yes
- Indoor ball sports	35	55	Yes
After School Hours			
R1 – 13 Arcadia Street (Ground Floor)			
- Concert / Disco / Function	47	47	Yes
R2 – 12 Arcadia Street (Third Floor)			
- Concert / Disco / Function	42	47	Yes
R3 – St Declan's Primary School (Second Floor)			
- Concert / Disco / Function	**59**	55	**No (+ 4 dB)**
R4 – 409 Forest Road (Third Floor)			
- Concert / Disco / Function	35	52	Yes

The levels of noise in Table 9 are within the acceptable noise criteria in Section 4.0 and are therefore acceptable, with the exception of a slight exceedance of 4 dB at the adjacent Primary School. We recommend that all windows and doors be kept closed during noisy events to meet the acceptable noise criteria when the adjacent St Declan's Primary School is in use in the evening.

5.4 On Road Traffic Noise Emission

The traffic from the school site on local roads is assessed against the Road Noise Policy criteria of 55 dBA during the day.

We have been informed that of the 65 staff and 1012 students, 83% of staff will drive their car and 48% of students will be driven to school in the morning (dropping to 45% picked up in the afternoon). The peak traffic generated by the school site is 540 vehicle trips (83% of 65 staff and 48% of 1012 students) visiting the school site in the morning.

The L_{eq} sound power level and spectrum of car noise was previously measured by Day Design and is given in Table 10.

Table 10 L_{eq} Levels of Car and Bus Noise

Description	dBA	Sound Power Levels (dB) at Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
L_{eq} level of car travelling 50 km/h	**88**	95	89	86	84	84	80	76	82

The closest receptors to Arcadia Street are at a distance of approximately 12 metres from the nearest trafficable lane.

In order to predict the 15 hour L_{eq} at the residential receptors, we have assumed 540 car movements before and after school. This results in a total of 1080 car movements generated by the school site.

Based on 1080 car movements generated by the school site per day, the predicted level of traffic noise at the residences on Arcadia Street is 52 dBA. This level of noise is within the Road Noise Policy criteria of 55 dBA during the daytime in Section 3.7 and is therefore considered acceptable.

5.5 Waste Collection and Grounds Maintenance

As part of the school operation, waste collection and grounds maintenance, including the use of lawn mowers, leaf blowers and potentially power tools for minor repairs, are to be restricted to the daytime hours of between 7.30 am and 6 pm Monday to Friday.

5.6 Mechanical Plant

The location and type of mechanical plant has not yet been selected for the new School. Any new mechanical plant will typically only operate during day time hours, Monday to Friday.

The sound power level for typical equipment used at school sites is presented in Table 11.

Table 11 Mechanical Plant L_{eq} Sound Power Levels

Description	dBA	Sound Power Levels (dB) at Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
Kitchen Exhaust Fan	**90**	91	89	89	87	87	81	71	68
Supply Fan	**83**	74	76	77	80	80	73	69	61
Toilet Exhaust Fan	**59**	48	48	56	57	54	53	45	38
Air Conditioner - Typical (Similar to RXYQ10TY1A)	**68**	71	73	69	67	61	56	52	43

A proposal for the mechanical plant locations is shown in Appendix C. Approximately 33 condensers may be required if air conditioning is proposed. With all 33 condensers operating and no additional noise controls, it is likely that the noise emission will be able to meet the noise criteria. The plant areas can be either positioned or acoustically treated to further reduce the level of noise emission.

Table 12 Predicted L_{eq} Noise Levels from Condenser Units

Receptor Location	Predicted Noise Level (dBA)	Noise Criteria (dBA)	Compliance (Yes/No)
R1 – 13 Arcadia Street (Ground Floor)	44	47	Yes
R2 – 12 Arcadia Street (Third Floor)	47	47	Yes
R3 – St Declan's Primary School (Second Floor)	48	55	Yes
R4 – 409 Forest Road (Third Floor)	35	52	Yes

Once the mechanical plant selection has been finalised, a final assessment should be made of the mechanical plant noise emission, prior to the issue of a Construction Certificate.

6.0 ACCEPTABLE NOISE INTRUSION LEVELS

6.1 NSW Road Noise Policy 2011

The *NSW Road Noise Policy 2011* recommends the following noise levels for non-residential developments near busy roads:

Table 13 Road Traffic Noise Assessment Criteria for Non-Residential Land Uses

Description	Noise Level, dBA	Applicable Time Period
School Classrooms	L_{Aeq}, (1 hour) 40 (internal) when in use	Day (7 am to 10 pm)

6.2 Australian Standard AS2107:2016

Australian Standard AS2107:2016 "*Acoustics – Recommended design sound levels and reverberation times for building interiors*" provides a list of recommended design sound levels for different areas of occupancy in buildings. The recommended internal noise levels and reverberation times for various rooms in Educational buildings are shown below in Table 14.

Table 14 AS2107 Recommended Internal Noise Levels

Type of occupancy/activity	Design sound level L_{eq} dB(A)	Recommended Reverberation Time (T).s
EDUCATIONAL BUILDINGS		
Teaching spaces / single classrooms -		
Open plan teaching spaces	35 - 45	0.4 to 0.5
Primary Schools	35 - 45	0.4 to 0.5
Secondary Schools	35 - 45	0.5 to 0.6
Libraries –		
General areas	40 - 50	0.4 to 0.6
Reading areas	40 - 45	0.4 to 0.6
Office areas	40 - 45	0.6 to 0.8
Assembly Halls over 250 Seats	30 - 35	0.4 to 0.6

6.3 Educational Facilities Standards and Guidelines

The NSW Department of Education (DoE) requires certain acoustic standards for the construction of school facilities. These acoustic criteria cover areas such as isolation of sound from one area to another, control of reverberation time in noise sensitive spaces and reduction of external noise. The following section summarises the DoE requirement related to noise intrusion from traffic:

Table 15 DoE Recommended Internal Noise Levels

Room	Internal Noise Level (dB L_{Aeq})	Reverberation Time, .s $RT60_{(Av\ 500Hz\ and\ 1000Hz)}$
Assembly halls up to 250 seats	35	See Note 1
Libraries – General areas	40	< 0.6
Libraries – Reading areas	35	< 0.6
Libraries – Stack areas	45	< 0.6
Office areas	40	< 0.8
Open plan teaching areas	40	< 0.8
Teaching spaces – Primary schools	35	< 0.5
Toilets/change/shower	50	-

6.4 Project Specific Internal Noise Criteria

Taking into consideration the above documents and policies, we recommend that the acceptable noise criteria for this development be as follows:

With Windows Closed:

- $L_{eq,\ 1\ hr}$ 40 dBA inside open plan classrooms

With Windows Open:

- $L_{eq,\ 1\ hr}$ 50 dBA inside open plan classrooms.

7.0 ROAD TRAFFIC NOISE LEVELS

7.1 Measured Road Traffic Noise Levels

The buildings within the proposed redevelopment of Penshurst Public School will be affected by road traffic noise from Forest Road, which carries heavy traffic volumes.

A noise monitor was placed at the front of the School site towards Forest Road as well as at the rear of the site, designated Measurement Location 'A' and Measurement Location 'B', as shown in Figure 2.

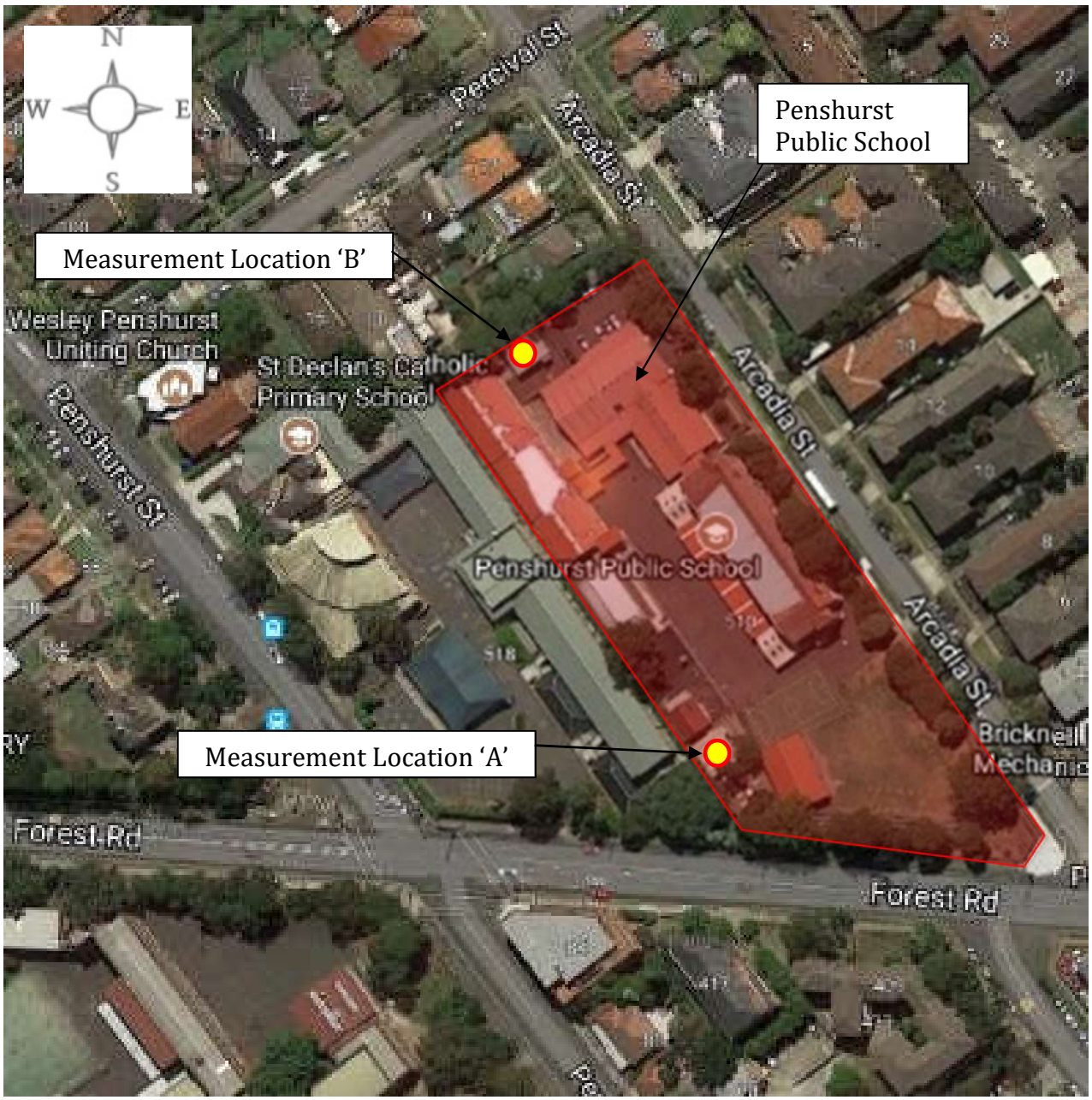


Figure 2 : Measurement Locations – Road Traffic Noise

Over a period of seven days, from Thursday 31 August 2017 to Thursday 7 September 2017, noise data was gathered to determine the road traffic noise level at the site. The following noise levels were measured during the day time periods:

Table 16 Long Term Road Traffic Sound Pressure Levels (Fast response)

Location	Daytime $L_{Aeq, 11\ hour}$ Noise Level (7 am to 6 pm)	Daytime $L_{Aeq, 1\ hour}$ Noise Level (9 am to 3 pm)
Location 'A' – Penshurst Public School (Front of site, on demountable near Forest Road)	65 dBA	64 dBA
Location 'B' – Penshurst Public School (Rear of site, near 13 Arcadia Street)	55 dBA	54 dBA

Atmospheric conditions were ideal for noise monitoring. Noise measurements were therefore considered reliable and typical for the receptor area.

We are of the opinion that the noise levels in Table 16 is typical for this area, and have adopted these values in the design of noise insulation for the proposed School buildings.

7.2 Required Road Traffic Noise Reduction

Based on the acceptable noise levels established in Section 6 of this report, the required noise reduction from road traffic is shown in Table 17:

Table 17 Required Road Traffic Noise Reduction (TNR)

Location	Room Description	Required TNR
Front of Site		
Penshurst Public School *(Windows Closed)*	Classrooms	Up to 24 dB
Penshurst Public School *(Windows Open)*	Classrooms	Up to 14 dB
Rear of Site		
Penshurst Public School *(Windows Closed)*	Classrooms	Up to 14 dB
Penshurst Public School *(Windows Open)*	Classrooms	Up to 4 dB

7.3 Mechanical Ventilation Requirements

For natural ventilation, with 20% of the windows and external doors open, the level of noise inside the rooms from road traffic should not exceed 10 dB above the internal noise criteria.

Up to 10 dB noise reduction can be achieved with the windows/doors open. A noise reduction of up to 14 dB is however required for the classrooms closest to Forest Road. An alternative method of ventilation, such as an air conditioning system with fresh air supply, will therefore be required to provide fresh air while the windows and doors are closed.

The noise emission from any ventilation plant should be acoustically treated, if necessary, to reduce the noise emission level inside the school buildings to levels complying with the recommended design sound levels in Australian Standard AS2107:2016.

8.0 RECOMMENDED ACOUSTICAL TREATMENT FOR TRAFFIC NOISE

We have modelled the proposed school classrooms based on preliminary architectural drawings by Perumal Pedavoli dated 1 September 2017 and calculated the level of road traffic noise intrusion through the roof, walls, glazed doors and windows using the noise levels established in Section 7.1.

We have assumed that classrooms will be carpeted. We have assumed that all other areas (hallways, wet areas) will have hard, reflective floors such as tiles or vinyl.

The necessary noise reduction for the rooms can be achieved if the following noise control recommendations are complied with, and there are no gaps at construction joints, around plumbing penetrations in external walls, at window sills, door frames, etc., through which sound may penetrate.

8.1 External Walls

- All external walls at ground floor level are of double brick or brick veneer construction which is acceptable.

At Levels 1 and 2, a lightweight wall is proposed. We recommend the following wall construction:

- Hardies' 'Linea' or 'Stria' cement composite cladding (or alternative cladding with equivalent surface density) on battens fixed to
- 16 mm fire rated (moisture resistant) plasterboard on the outside of 90 mm timber or 92 mm steel studs; and
- 25 mm insulation blankets between the battens, and
- two layers of 16 mm thick fire rated plasterboard on the internal side, with joints staggered; and
- wall cavity lined with 100 mm thick glasswool insulation (min 10 kg/m^3 density).

8.2 Ceiling and Roof System

- All roofs may be of concrete slab construction, minimum 200 mm thick.

8.3 Glazing and Glazed Doors

Unless otherwise specified, window frames may be either sliding / awning, or hinged casement style and be of robust sound-barrier construction having interlocking stiles and neoprene (Q-lon or similar) or vinyl finned seals to minimise sound leakage.

We have assumed that each of the homebases will have approximately 40 m^2 of glazing area.

Table 18 below specifies minimum sound reduction index (R_w) ratings required for various windows and glazed doors. Glazing in all rooms and units other than those specified in Table 18 below may be of standard thickness with a minimum R_w 26.

A typical glazing specification is given in Table 18, however an alternative glazing specification may be used if the R_w is achieved or exceeded.

Table 18 Schedule of Glazed Windows and Door Constructions

Room Description	Min R_w	Typical Glazing Specification
Classrooms within 25 metres of Forest Road	37	12.38 mm laminated glass in a fixed/sliding/awning frame with acoustic seals.
Classrooms within 25 to 50 metres of Forest Road	35	10.38 mm laminated glass in a fixed/sliding/awning frame with acoustic seals.
Classrooms within 50 to 100 metres of Forest Road	32	6.38 mm laminated glass in a fixed/sliding/awning frame with acoustic seals.
Classrooms within 100 to 200 metres of Forest Road	29	5 mm glass in a fixed/sliding/awning frame with acoustic seals.

This schedule of construction is typical and for general guidance to the architect in preparing final construction drawings and specifications. Other constructions that provide the same or better Sound Transmission Loss performance may also be acceptable.

It is most important that any sound leakage paths around the windows be sealed off. We recommend that prior to the fitting of the architraves around the windows, the space between the frames and the wall structure be sealed off with silicone or polyurethane mastic and backing rods installed behind. The window architraves can then be fitted.

8.4 Eligible Suppliers of Windows and Glass Doors

The windows and doors are the most critical sound paths in a building. Only those companies who have conducted laboratory testing of their windows should be considered as eligible suppliers. Companies that we are aware of having conducted satisfactory testing include:

- *Architectural Window Systems,* Wetherill Park, NSW Phone: 8783 7611
- *Micos Aluminium Pty Ltd,* Hillsdale, NSW Phone: 9661 5233
- *Christoffel Pty Ltd*, Riverstone, NSW Phone: 9627 4811
- *Aska Windows*, Greenacre, NSW Phone. 9642 8588
- *James Hardie (Trend) Windows*, Girraween, NSW Phone: 9840 2000
- *Boral Window Systems*, Smithfield, NSW Phone: 9757 0555
- *Stegbar (Windows) Pty Ltd*, Lansvale, NSW Phone: 9794 5200

Day Design should be consulted with before any other manufacturers' products are considered. R_w ratings claimed should be supported by acoustical laboratory test reports. We suggest that you obtain confirmation from the glazier that the glazing supplied will meet the required R_w rating above.

8.5 Mechanical Ventilation

To achieve the required internal noise levels many rooms need heavier than standard glazing with the windows and doors closed, identified as classrooms within 100 metres of Forest Road. These rooms may be seen from Table 16 and are to be ventilated to the standards set out in clause F4.5 of the Building Code of Australia and Australian Standards AS1668.2:1991.

An air conditioning system with fresh air supply may be used to provide fresh air while the windows and doors are closed.

The noise emission from the air conditioning system should be acoustically treated, if necessary, to reduce the noise emission level inside school buildings to levels complying with the criteria in Section 4.7 and 6.4 of this report.

8.6 Construction Disclaimer

Recommendations made in this report are intended to resolve acoustical problems only. We make no claim of expertise in other areas and draw your attention to the possibility that our recommendations may not meet the structural, fire, thermal or other aspects of building construction.

We encourage clients to check with us before using materials or equipment that are alternative to those specified in our Acoustical Report.

The integrity of acoustic structures is very dependent on installation techniques. For example, a small crack between the top of a wall and a ceiling can reduce the effective sound transmission loss of a wall from R_w 50 to R_w 40. Therefore the use of contractors that are experienced in acoustic construction is encouraged. Furthermore, two insulation products may have the same thermal R rating but the sound absorption of one may be entirely deficient, therefore the use of materials and equipment that are supported by acoustic laboratory test data is encouraged.

9.0 CONSTRUCTION NOISE AND VIBRATION CRITERIA

9.1 Australian Standard AS2436

The Australian Standard AS2436:2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"* provides guidance on noise control in respect to construction, demolition and maintenance sites. The Standard also provides guidance for the preparation of noise and vibration management plans.

Section 1.5 'Regulatory Requirements' of the Standard states:

"Legislation associated with the control of noise and vibration on and from construction, demolition and maintenance sites in Australia is generally the responsibility of the relevant State or Territory government, local council or a designated statutory authority."

Consequently the Standard does not provide specific noise criterion rather sets out practical methods for determining the potential for noise and vibration impact on the community from construction, demolition and maintenance sites.

A qualitative method is described in Section 3.3 of the standard, which is designed to avoid the need for complex noise predictions by following a series of questions relating to, for example, whether the noise is likely to be loud, have annoying characteristics or affect sleep.

In the event that any of these outcomes are likely, a more detailed and quantitative approach should be adopted.

In relation to carrying out detailed noise impact assessments, Section 4 'General' of the standard states:

"Regulatory authorities may have relevant polices and/or guidelines for the control of noise and vibration on construction sites. These should also be referred to when developing noise and vibration management plans for such projects."

In NSW this is the NSW Environment Protection Authority's *Interim Construction Noise Guideline 2009* as outlined in Section 9.2 below.

The Standard further states, in Section 4.6.1, that if noisy processes cannot be avoided, then the amount of noise reaching the receiver should be minimised and goes on to provide advice and recommendations to reduce noise and vibration impacts as far as reasonably practicable.

9.2 EPA Construction Noise Guideline

The NSW Environment Protection Authority published the *Interim Construction Noise Guideline* in July 2009. While some noise from construction sites is inevitable, the aim of the Guideline is to protect the majority of residences and other sensitive land uses from noise pollution most of the time.

The Guideline presents two ways of assessing construction noise impacts; the quantitative method and the qualitative method.

The quantitative method is generally suited to longer term construction projects and involves predicting noise levels from the construction phase and comparing them with noise management levels given in the guideline.

The qualitative method for assessing construction noise is a simplified way to identify the cause of potential noise impacts and may be used for short-term works, such as repair and maintenance projects of short duration.

In this instance, the quantitative method is the most appropriate and has been used in this assessment. Details of the quantitative method are given in Section 4 of the Guideline.

Normal construction hours are defined by the EPA as follows:

- 7.00 am to 6.00 pm Monday to Friday;
- 8.00 am to 1.00 pm Saturday; and
- No work on Sunday or Public Holiday.

Correspondence with Georges River Council indicates their standard conditions of consent for construction hours are 7 am to 5 pm Monday to Saturday. This is a slight variance of the standard EPA construction hours.

In certain cases, the community may prefer extended construction hours to achieve a shorter overall construction period. In this situation, we have been informed the preference for construction hours are 7 am to 6 pm Monday to Friday, and 7 am to 5 pm Saturdays. These proposed construction hours are still within the daytime period and are valid for the construction noise assessment.

Table 2 in Section 4 of the Guideline sets out noise management levels at affected residences and how they are to be applied during normal construction hours. The noise management level is derived from the rating background level (RBL) plus 10 dB in accordance with the Guideline. This level is considered to be the 'noise affected level' which represents the point above which there may be some community reaction to noise.

The 'highly noise affected' level of 75 dBA represents the point above which there may be strong community reaction to noise. This level is provided in the Guideline and is not based on the RBL. Restrictions to the hours of construction may apply to activities that generate noise at residences above the 'highly noise affected' noise management level.

Based on the RBL of 55 dBA (towards Forest Road) and 44 dBA (towards 13 Arcadia Street) in the daytime, the recommended noise management level during all aspects of the construction program are summarised in Table 19.

Table 19 L_{eq} Noise Management Levels from Construction Activities

Receptor Location	Noise Management Level	How to Apply
All Residential Receptors	**65 dBA (55 + 10) or 54 dBA (44 + 10)**	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ noise level is greater than the noise affected level, the proponent should apply all feasible and reasonable* work practices to meet the noise affected level. ▪ 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 75 dBA	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 relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

* Section 6, 'work practices' of The *Interim Construction Noise Guideline*, states: *"there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts.*

This approach gives construction site managers and construction workers the greatest flexibility to manage noise".

Definitions of the terms feasible and reasonable are given in Section 1.4 of the Guideline.

The Interim Construction Noise Guideline recommends the following noise levels for land uses other than residential, as shown in Table 20. The external noise levels should be assessed at the most affected occupied point on the premises. A conservative estimate of 10 dB is generally applied as the difference between the external and internal level for noise sensitive uses that require internal noise measurement.

Table 20 Other Sensitive Land Uses

Land Use	**Noise Management Level, $L_{Aeq,(15\ minute)}$ Applies when properties are being used.**
Classrooms at schools and other educational institutions	45 dBA – Internal Noise Level
Active Recreation Areas, (areas that generate their own noise and less sensitive to external noise intrusion)	65 dBA – External Noise Level

9.3 EPA Vibration Guideline

The NSW EPA published the *Assessing Vibration: a technical guideline* in February 2006. This guideline is based on the British Standard BS6472:1992 *"Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)."*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. The guideline considers vibration from construction activities as Intermittent Vibration. Table 2.4 of the guideline sets out limits for Vibration Dose Values to assess intermittent vibration and is replicated in Table 21 for residential receptor locations.

Table 21 Vibration Dose Values (VDV) from Construction Activities

Receptor Location	Daytime	
	Preferred value ($m/s^{1.75}$)	Maximum value ($m/s^{1.75}$)
All Residences	0.20	0.40

The British Standard BS7385-2:1993 *"Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration"* provides guide values for transient vibration relating to cosmetic damage, replicated in Table 22 for residential buildings.

Table 22 Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Residential	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

In our opinion, an overall peak particle velocity of **15 mm/s** at the boundaries is an acceptable criterion for intermittent vibration to prevent cosmetic damage to the adjacent residential buildings.

10.0 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

The main sources of noise on the site during the construction of the school buildings will be from heavy machinery such as excavators, dump trucks and hand held pneumatic and electric power tools, etc. Activities that may cause particular annoyance, due to tonality, spectral content or impulsiveness include generator motors, hand tools such as grinders, jackhammering and other activities involving impacts. These activities will require particular attention with regard to mitigation.

10.1 Stage 1 – Site Preparation

Site establishment works are likely to be completed within 2 months. Works will involve the use of excavators and regular truck movements transporting waste materials from the site. The equipment likely to be used and their corresponding sound power levels are presented in Table 23.

Table 23 Typical Site Preparation Equipment - Sound Power Levels

Description	Qty	Sound Power Level, dBA^
Excavators (up to 38 ton)	Up to 2	107 to 110
Trucks (up to 40 ton)	Up to 2	107 to 110
Bulldozer (21 ton)	1	108
Generator	2	Up to 89
Pneumatic and Electric Hand Tools	Up to 5 simultaneously	Up to 110

^All sound power levels are based on AS2436:2010 of various plant noise measurements.

As a conservative approach, it is assumed that all items of plant will be operating simultaneously.

Levels are based on the closest potential distance and furthest potential distance at which each item of plant may operate from each respective residential location. The calculated noise levels at nearby residential receptors are presented in Table 24.

Table 24 Calculated Receptor Sound Pressure Levels from Site Preparation

Receptor Location	Calculated Sound Pressure Levels (dBA)	Noise Management Level (dBA)	Compliance
R1 – 13 Arcadia Street (Ground Floor)	61 - 90	54	No
R2 – 12 Arcadia Street (Third Floor)	64 - 78	54	No
R3 – St Declan's Primary School (Second Floor)	65 - 90	55	No
R4 – 409 Forest Road (Third Floor)	59 - 70	65	No

10.2 Stage 2 – Earthworks

The Stage 2 Works will be completed within 5 months. The equipment likely to be used and their corresponding sound power levels are presented in Table 25.

Table 25 Typical Earthworks Equipment - Sound Power Levels

Description	Qty	Sound Power Level, dBA^
Excavators (up to 38 ton)	Up to 2	107 to 110
Trucks (up to 40 ton)	Up to 2	107 to 110
Compactor Rollers	Up to 2	110
Bulldozer (25 ton)	2	108
Front End Loader (25 ton)	1	110 to 115
Silenced Diesel Generator	Up to 2	Up to 89
Elevated Work Platforms	2	Up to 95
Pneumatic and Electric Hand Tools	Up to 5 simultaneous	Up to 110
Pile Driver	Up to 2	Up to 120
Screw Piling	Up to 2	Up to 105
Hydraulic Rock Breaker	Up to 2	Up to 118

^All sound power levels are based on AS2436:2010 and DEFRA database of various plant noise measurements.

As a conservative approach, it is assumed that all items of plant will be operating simultaneously. Levels are based on the closest potential distance and furthest potential distance at which each item of plant may operate from each respective residential location.

Given the intensity of work involved with pile driving and rock breaking, it is unlikely that these two activities will take place at the same time as any other activity. Therefore we have assessed the noise impact of these two activities individually.

The calculated noise levels at nearby residential receptors are presented in Table 26.

Table 26 Calculated Receptor Sound Pressure Levels from Earthworks

Receptor Location	Calculated Sound Pressure Levels (dBA)	Noise Management Level (dBA)	Compliance
R1 – 13 Arcadia Street (Ground Floor)	61 - 90	54	No
R2 – 12 Arcadia Street (Third Floor)	64 - 78	54	No
R3 – St Declan's Primary School (Second Floor)	65 - 90	55	No
R4 – 409 Forest Road (Third Floor)	59 - 70	65	No
Rock breaking or pile driving (If required)			
R1 – 13 Arcadia Street (Ground Floor)	71 - 100	54	No
R2 – 12 Arcadia Street (Third Floor)	74 - 88	54	No
R3 – St Declan's Primary School (Second Floor)	75 - 100	55	No
R4 – 409 Forest Road (Third Floor)	70 - 80	65	No

10.3 Vibration Impacts

Past measurements of ground borne vibration show that vibration levels can vary significantly at different distances and receptor locations. Recommended safe working distances for various items of vibration generating plant are given in Section 6.3 of Transport for NSW Construction Noise Strategy 2012. This information is shown below in Table 27.

Table 27 Recommended Safe Working Distances for Vibration Generating Plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS7385)	Human Response (OH&E Assessing Vibration – A Technical Guideline)
Small Hydraulic Hammer	300 kg - 5 to 12T Excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg - 12 to 18T Excavator	7 m	23 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

We recommend that compliance monitoring of ground borne vibration is carried out at the nearest residence, when vibratory machinery such as pile drivers, jackhammers and the like are used on site. Refer to Section 11.10 for the mitigation measures to be engaged to reduce the impact of adverse vibration.

10.4 Stage 3 – Construction

The construction of the School is estimated to take 60 weeks and will involve the use of power tools and portable mechanical plant such as generators and cement mixers. The equipment likely to be used and their corresponding sound power levels are presented in Table 28.

Table 28 Typical Construction Equipment - Sound Power Levels

Description	Qty	Sound Power Level, dBA^
Silenced Diesel Generator	Up to 2	Up to 89
Telehandler (3 ton)	1	Up to 99
Elevated Work Platforms	2	Up to 95
Pneumatic and Electric Hand Tools	Up to 5 simultaneous	Up to 110

^All sound power levels are based on AS2436:2010 and DEFRA database of various plant noise measurements.

During the construction phase, work will be more dispersed across the site as the scale of work, compared to the previous two phases, is less intensive. Calculations consider distance attenuation only and the range of levels are based on the closest potential distance and furthest potential distance at which each item of plant may operate from each respective residential location.

The calculated noise levels at nearby residential receptors are presented in Table 29.

Table 29 Calculated Receptor Sound Pressure Levels from Construction

Receptor Location	Calculated Sound Pressure Levels (dBA)	Noise Management Level (dBA)	Compliance
R1 – 13 Arcadia Street (Ground Floor)	60 - 89	54	No
R2 – 12 Arcadia Street (Third Floor)	63 - 77	54	No
R3 – St Declan's Primary School (Second Floor)	64 - 89	55	No
R4 – 409 Forest Road (Third Floor)	58 - 69	65	No

Note that once the school buildings begin to be erected, the buildings will act as a noise barrier to the adjoining receptor locations, reducing the level of construction noise as construction progresses.

11.0 CONSTRUCTION NOISE AND VIBRATION MITIGATION RECOMMENDATIONS

The predicted level of noise (Section 10.1, 10.2, and 10.4) and vibration (Section 10.3) emission from the construction of the School show that noise levels will likely exceed the Noise Management Levels established in Section 9.2 of this report. The highly affected noise level of 75 dBA will also likely be approached for the majority of the construction carried out close to the nearby affected locations.

The following work practices are recommended to be implemented where necessary and practicable, to reduce noise emission as far as reasonably practicable:

- Works to be staged to minimise noise impact,
- Methodology of demolition will be carried out so that noisy activities do not occur concurrently where possible,
- Impact noise will be limited,
- Substitution of equipment will be considered to minimise noise (Section 11.3),
- Impulsive and tonal noise to be restricted to the hours of 9.00 am to 4.00 pm Mon-Fri, and continuous blocks will not exceed three hours each with a minimum respite from those activities and works of not less than one hour between each block (Section 11.4),
- Management plan to ensure construction vehicles arrive and depart during construction hours only
- Reversing alarms to be of “quacker” broa,dband alarm style.

11.1 Engineering and Practical Noise Controls

Australian Standard AS2436:2010, Appendix C, Table C3 provides the relative effectiveness of various forms of noise control that may be applicable and implemented on various construction sites and projects. Table C3 is replicated in Table 24 below.

Table 30 Relative Effectiveness of Various Forms of Noise Control

Control by	Nominal Noise Reduction Possible, dB
Distance	Approximately 6 dB for each doubling of distance
Screening	Normally 5 dB to 10 dB maximum 15 dB
Enclosure	Normally 5 dB to 25 dB maximum 50 dB
Silencing	Normally 5 dB to 10 dB maximum 20 dB

Distance

Where applicable, we recommend locating mechanical plant near the north / west of the site (adjacent to the future retail precinct) such that it is as far as practically possible from the nearby existing residences.

Enclosure

Constructing acoustical enclosures around items of mobile plant such as generators is recommended where extended use for long periods of time is expected.

Screening

We recommend erecting temporary sound barrier screens along the boundaries of the site near adjacent residential buildings to remain throughout all construction phases, as far as reasonably practicable. Temporary sound barrier screens should be erected up to a height of 2.4 m along the northern boundaries, and constructed from, for example 19 mm plywood on steel posts or attached to temporary construction fencing. All sound barriers should be designed by a structural engineer to resist wind loads.

Silencing

Consideration should be given to any mobile plant already acoustically treated when assessing tenders. All plant and machinery should be selected with consideration to low noise options where practicable and available.

Care should be taken to ensure that not more than one item of plant is operating simultaneously within close proximity of any given residence as far as reasonably practicable, to minimise cumulative noise impacts.

11.2 Noise Measurement Equipment

All acoustic instrumentation employed throughout the monitoring programme will comply with the requirements of AS IEC 61672.1:2004 *Electroacoustics – Sound level Meters-Specifications*. All sound level meters must have a current calibration certificate from a NATA accredited laboratory in accordance with NATA guidelines. Instrument calibration shall be checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dB.

11.3 Attended Residential Noise Monitoring Procedure

Any attended noise measurements to be carried out as a result of a noise complaint should be conducted in accordance with the procedures outlined in Australian Standard AS1055 *Acoustics – Description and measurement of environmental noise* and in accordance with methods outlined in the NSW Industrial Noise Policy (INP). The following points should be followed when conducting noise monitoring:

- A field calibration should be conducted before and after measurements;
- The sound level meters must be set to A-weighting and Fast response;
- The sound level meters sample period should be set to 15 minutes;
- The following descriptors should be measured as a minimum: L_{A1}, L_{Aeq} and L_{A90}; and
- Measurements should be conducted a minimum of 3 metres from the nearest façade and/or solid fence/wall. If it is not possible to do this corrections for façade reflection should be applied to the measurement results.

11.4 Noise Monitoring of Equipment

In addition to the residential noise monitoring procedures described above, the following equipment measurements can be undertaken if a noise complaint arises:

- Noise emission levels of all critical items of mobile plant and equipment will be checked by the site environmental officer for compliance with noise limits appropriate to those items prior to the equipment going into regular service;
- For equipment and mobile plant used for construction works, L_{Aeq} measurements will be taken at an appropriate distance, normally 7 metres and converted to a Sound Power Level;
- An *Equipment Noise Certificate*, presenting relevant sound levels of the equipment tested, will be issued by the Construction Contractor's site environmental officer within the first week of the equipment commencing at the construction site.

The equipment sound power levels will be compared to the levels contained in Table 23, 25 and 28. If noise checks on any equipment result in a prediction of non-compliance, quieter equipment or alternate construction methods should be substituted. For example, screw piling instead of impact piling can result in a 15 dB noise reduction.

11.5 Periods of Respite

All activities associated with the construction shall take place within the proposed hours, as shown below:

- 7:00 am to 6:00 pm, Monday to Friday inclusive; and
- 7:00 am to 5:00 pm Saturdays;
- At no time on Sundays or public holidays.

Works that result in impulsive or tonal noise emissions shall only be undertaken:

- 8:00 am and 5:00 pm Monday to Friday inclusive;
- In continuous blocks, not exceeding 3 hours each, with a minimum respite from those activities and works of not less than one hour between each block.

11.6 Reducing Noise from Plant and Equipment

- Use alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric controlled units where feasible and reasonable. Where there is no electricity supply, use an electrical generator located away from residences.
- Examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled tractors can be less noisy than steel tracked tractors.
- Noise labels are required by NSW legislation for pavement breakers, mobile compressors, chainsaws and mobile garbage compactors. These noise labels can be used to assist in selecting less noisy plant.
- Pneumatic equipment is traditionally a problem – select supersilenced compressors, silenced jackhammers and damped bits where possible.
- Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.

11.7 Work Practices

Workers and contractors shall be trained in work practices to minimise noise emission such as the following:

- Avoid dropping materials from a height.
- Avoid shouting and talking loudly outdoors.
- Avoid the use of radios outdoors that can be heard at the boundary of residences.
- Turn off equipment when not being used.
- Carry out work only within the approved hours of operation.
- Construction vehicles to arrive and depart during construction hours only.

11.8 Heavy Vehicles and Staff Vehicles

- Truck drivers shall be informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Site vehicle entrances shall be located away from residences where practicable.
- The number of vehicle trips shall be configured to reduce the number of trips to and from the site – movements shall be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Parking and queuing of construction staff vehicles and other construction vehicles shall be avoided as far as is practicable on streets outside of the site.
- There shall be no access for construction vehicles to the site or park within residential areas prior to 7 am on any occasion, in order to avoid sleep disturbance.
- Vehicles shall be fitted with broadband reversing alarms or alternative, non-tonal proximity warning systems.
- For the duration of construction, use of compression braking shall not be permitted on the site or nearby the site, such as on access roads within close proximity to residential premises.

11.9 Community Relations

- A Community Liaison Officer shall to be appointed by the contractor prior to the commencement of any works.
- The officer will approach all potentially affected residents prior to the commencement of any works as an initial introduction and provide their contact details.
- The officer will explain the project, duration of works, potentially noisy periods as well as determine any particularly sensitive receivers or sensitive time periods and schedule works accordingly, as far as reasonably practical.
- A community information telephone number may be established to provide access and information about the project.
- Community notifications and newsletters shall be prepared and distributed, at least 7 days prior to commencement of any works, to the community in areas that are potentially affected by the project. The contents of the notifications shall include information on the nature of the works, location of works being carried out, possible impacts to amenity, traffic flow or services, and the contact details as listed above.
- Community drop-in sessions shall be organised to engage with the community and to provide a conduit for direct consultation between those affected, or with an interest in the project, and the project team. To encourage the widest attendance and accessibility to the community, drop-in sessions shall be arranged outside of business hours such as weeknights or on Saturday.
- Information cards with the above contact details shall be prepared and distributed to the project management team and other staff on site. These cards shall be given to members of the community or other interested parties should they approach staff on site for information.

Once works commence, communication with the community shall be maintained by the Community Liaison Officer. Communication shall be maintained via the aforementioned methods.

Consultation and cooperation between the contractor and the neighbours and the removal of uncertainty and rumour can help to reduce adverse reaction to noise.

11.10 Managing a Noise Complaint

The Liaison Officer shall receive and manage noise complaints and implement a Construction Complaints Management System.

All complaints shall be treated promptly and with courtesy.

In the event that a noise complaint is received, noise monitoring will be carried out at the affected receptor location and appropriate measures be taken to reduce the noise emission as far as reasonably practicable.

Where it is not practicable to stop the noise, or reduce the noise, a full explanation of the event taking place, the reason for the noise and times when it will stop shall be given to the complainant.

The following guidelines are recommended in Section 6 of the *Interim Construction Noise Guideline* to manage a noise complaint:

- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
- Give complaints a fair hearing.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night-time only if requested by the complainant to avoid further disturbance.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint, which may include standing equipment down.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area, time of verbal response and timeframe for written response where appropriate.

11.11 Noise Monitoring

In the event of a noise complaint, monitoring shall be carried out at the complainant's residence to determine which activities are generating excessive noise. If practicable, noise mitigation measures, such as those outlined above, shall be implemented and further monitoring shall then be employed to determine the efficacy of noise mitigation.

11.12 Vibration Monitoring

If high impact activities, such as rock hammering or piling are to be conducted at any time during each stage, vibration measurements may be carried out at a residence within each of the nearest receptor locations at the commencement of high impact activities to determine the maximum levels of vibration during these peak vibration generating events.

In the event of an exceedance of the Peak Particle Velocity (PPV) vibration criteria as defined in Table 22, unattended vibration monitor or monitors shall be installed at each residential location where an exceedance was measured.

Unattended vibration monitors shall have the capability to trigger an alert to make the site manager and/or plant operator aware immediately when the vibration limit is exceeded. The vibration monitor should be set to trigger the alert when the overall PPV exceeds the criteria within each frequency range, as stipulated in Table 22, at the nearest residential building.

In the event that levels of ground-borne vibration exceed the recommended acceptable levels for cosmetic damage vibration causing works should cease immediately and alternative methods shall be considered.

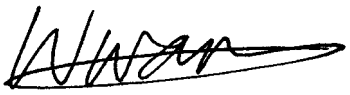
12.0 NOISE ASSESSMENT STATEMENT

Day Design Pty Ltd was engaged by Perumal Pedavoli Pty Ltd to provide acoustical advice for the proposed new Penshurst Public School, located at Arcadia Street, Penshurst, NSW.

Measurements and calculations show that the level of noise emitted by the proposed redevelopment of Penshurst Public School will be able to meet the acceptable noise level requirements of the EPA NSW Industrial Noise Policy as detailed in Section 4 of this report.

The level of road traffic noise intrusion has been assessed and recommendations for façade construction has been provided to meet the recommended internal noise levels as detailed in Section 6 of this report.

The noise impact due to the proposed construction activities have been predicted at all nearby receptor locations. The Noise Management Level is predicted to be exceeded at times and therefore recommendations for noise controls have been provided in Section 11 of this report.



William Wang, BE (Mechatronics), MIEAust, MAAS

Senior Acoustical Engineer

for and on behalf of Day Design Pty Ltd

AAAC MEMBERSHIP

Day Design Pty Ltd is a member company of the Association of Australasian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

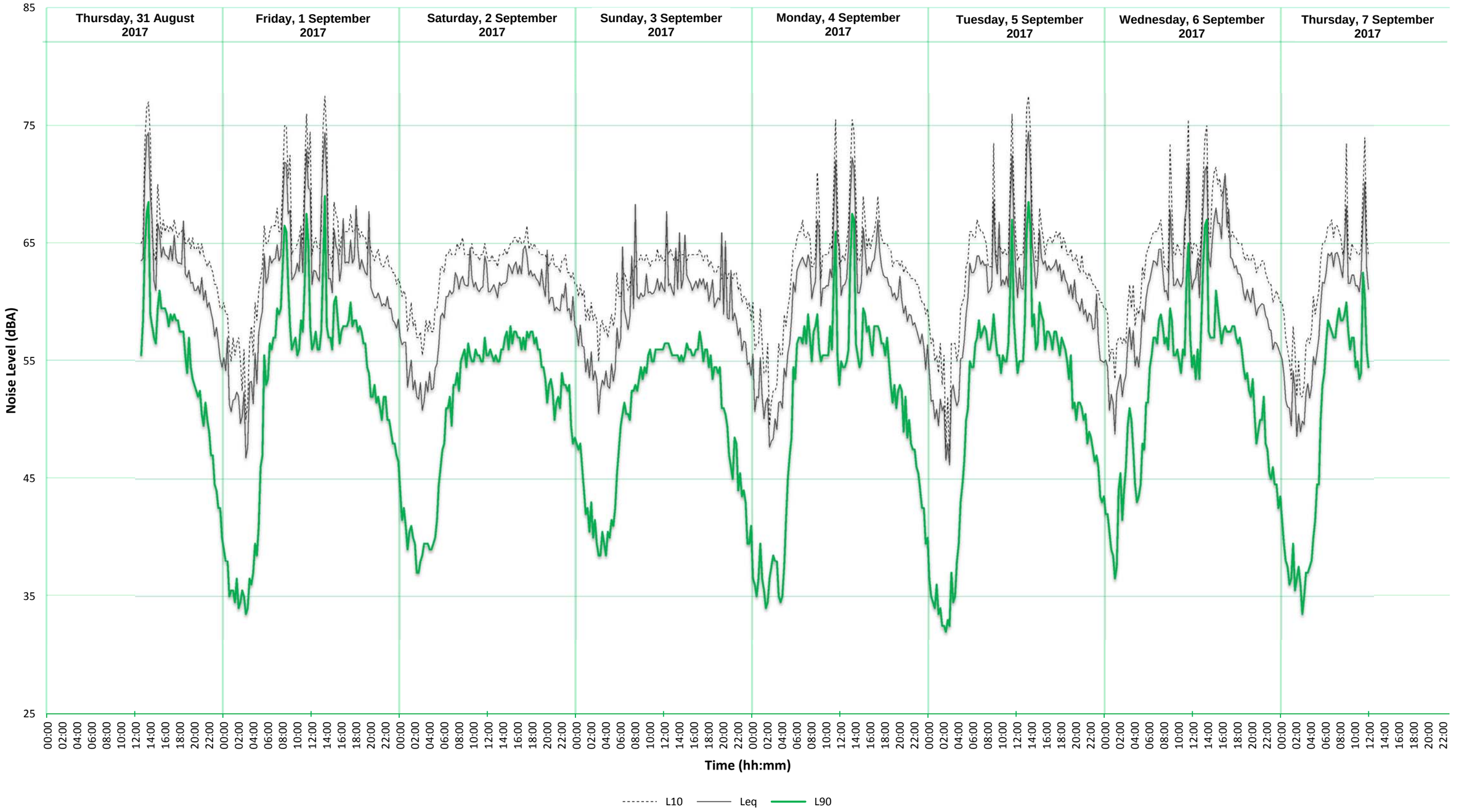
Attachments:

- Appendix A – Ambient Noise Survey
- Appendix B – Architectural Drawings
- Appendix C – Possible Air Condenser Plant Locations
- Appendix D – NSW EPA Presentation “Noise Impact Assessment Issues”
- AC108-1 to 4 – Glossary of Acoustical Terms
- AC500-9 – Modifying Factor Corrections

AMBIENT NOISE SURVEY

6320-1
Appendix A1

Located at Front - 18 Arcadia Street, Penshurst, NSW



Located at Front - 18 Arcadia Street, Penshurst, NSW

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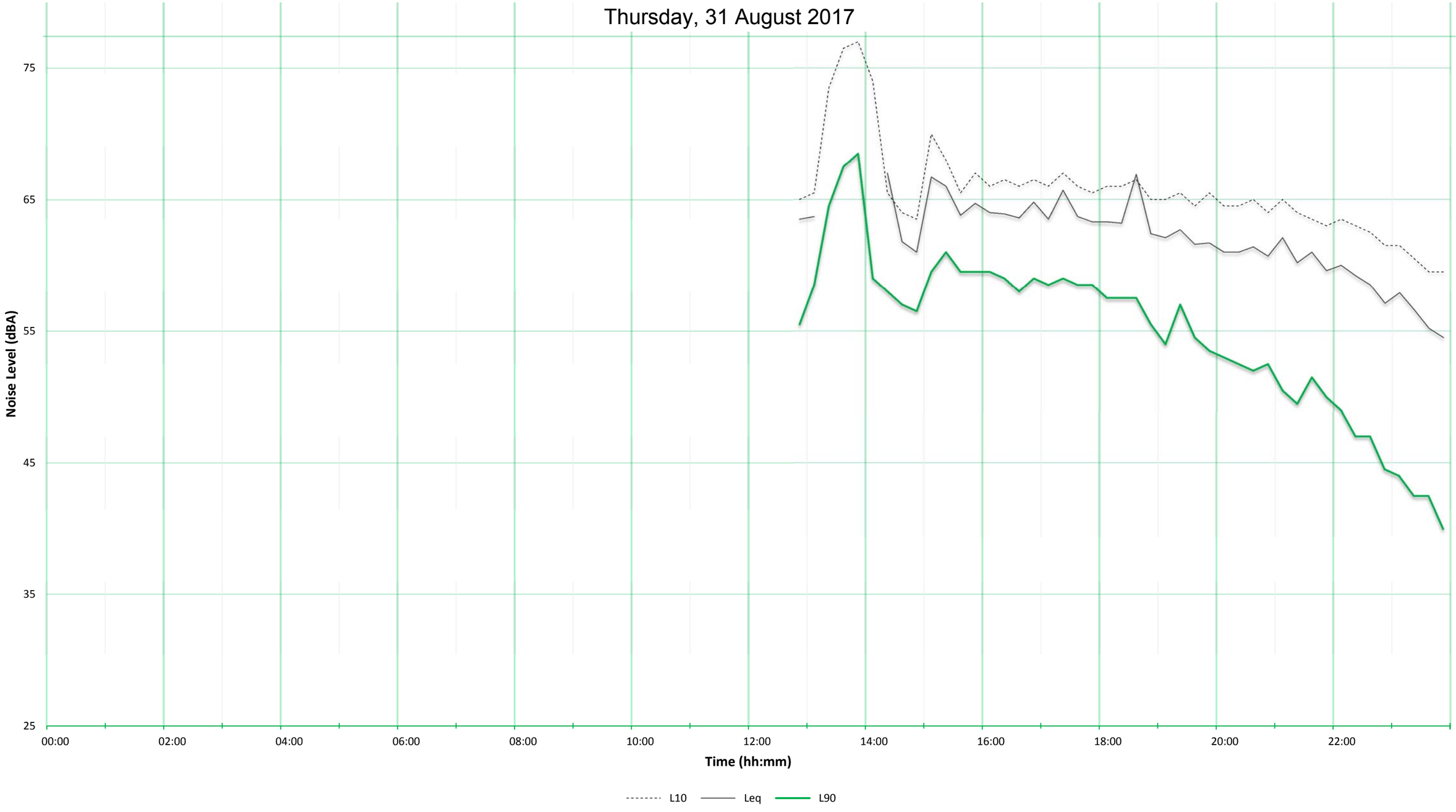

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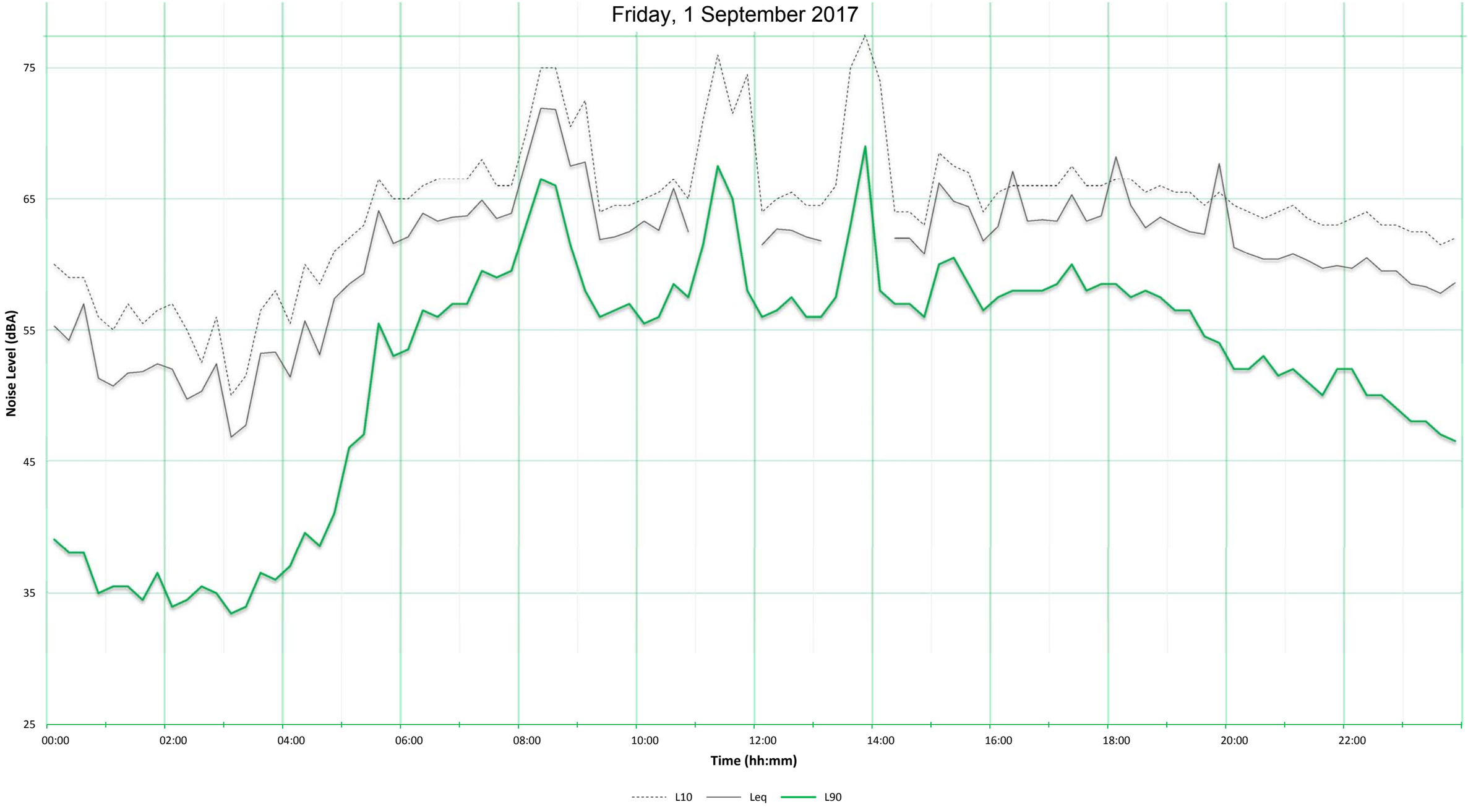

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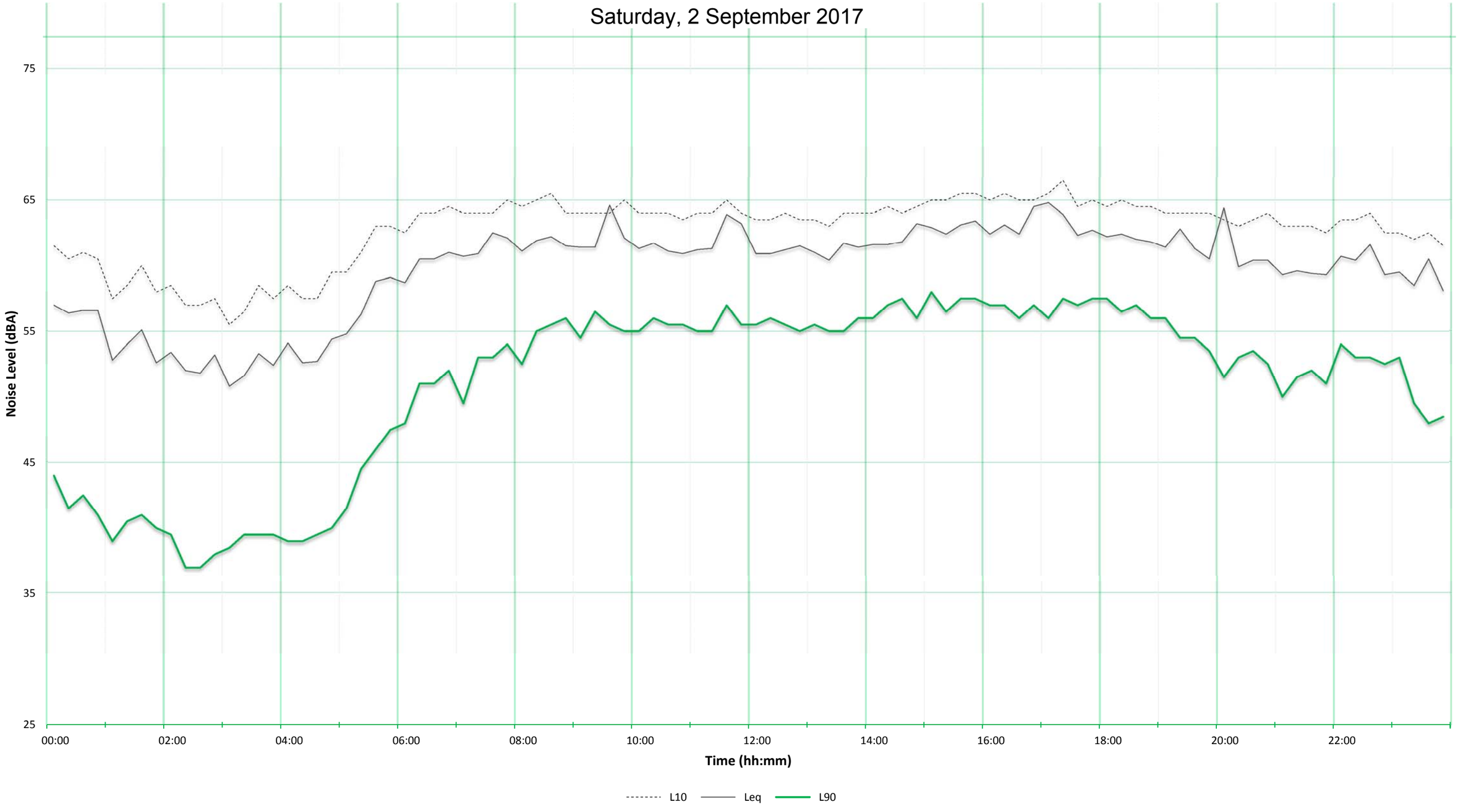

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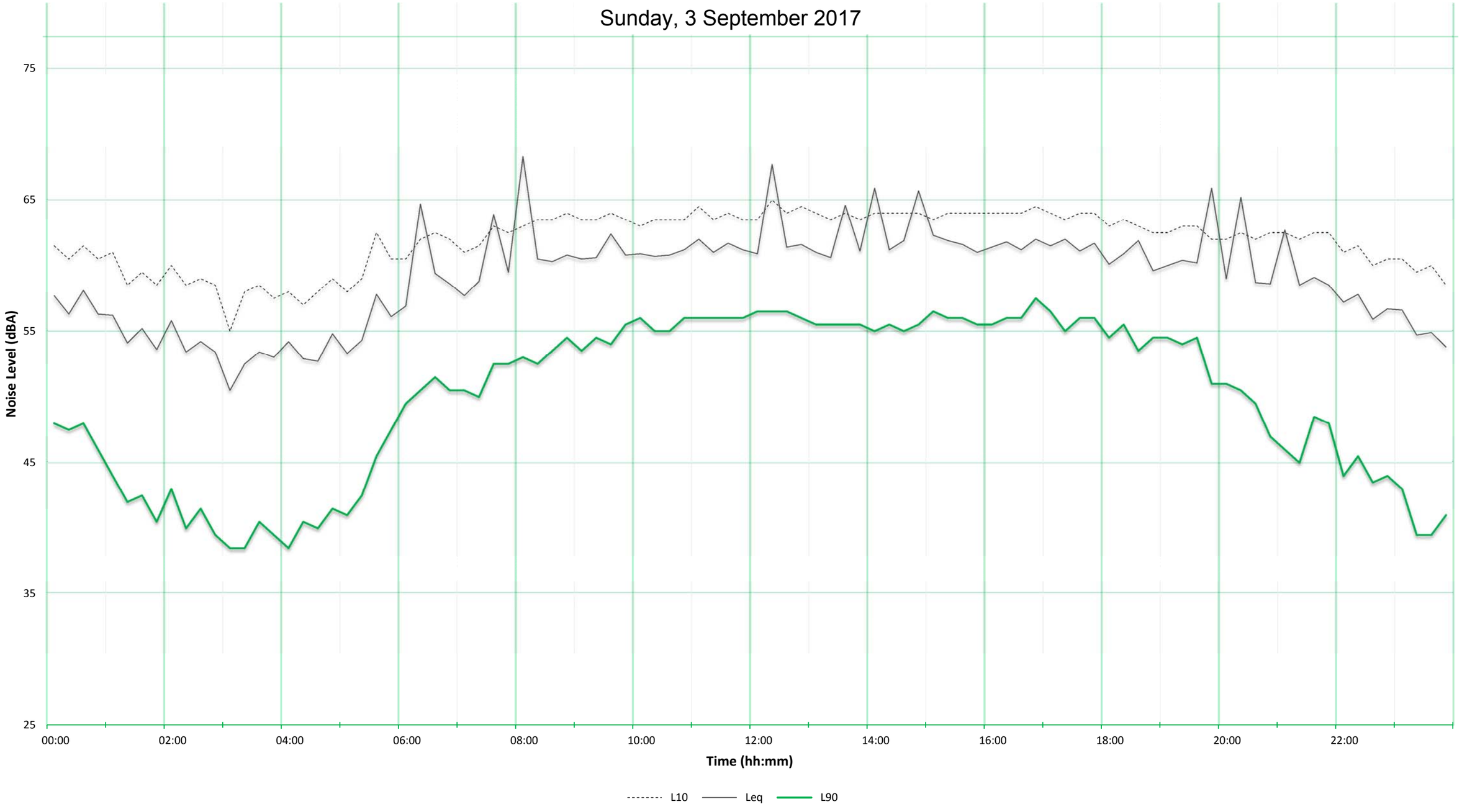

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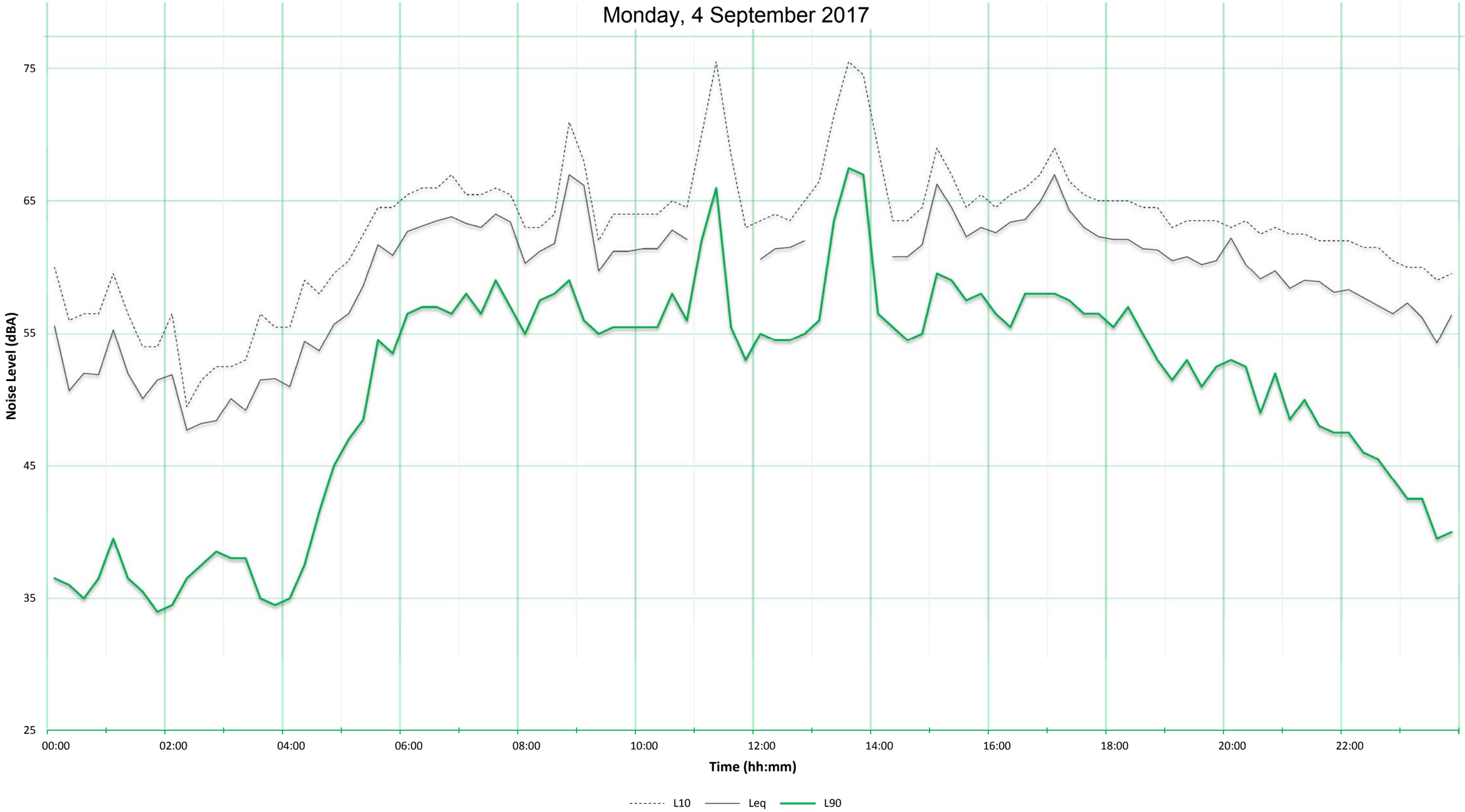

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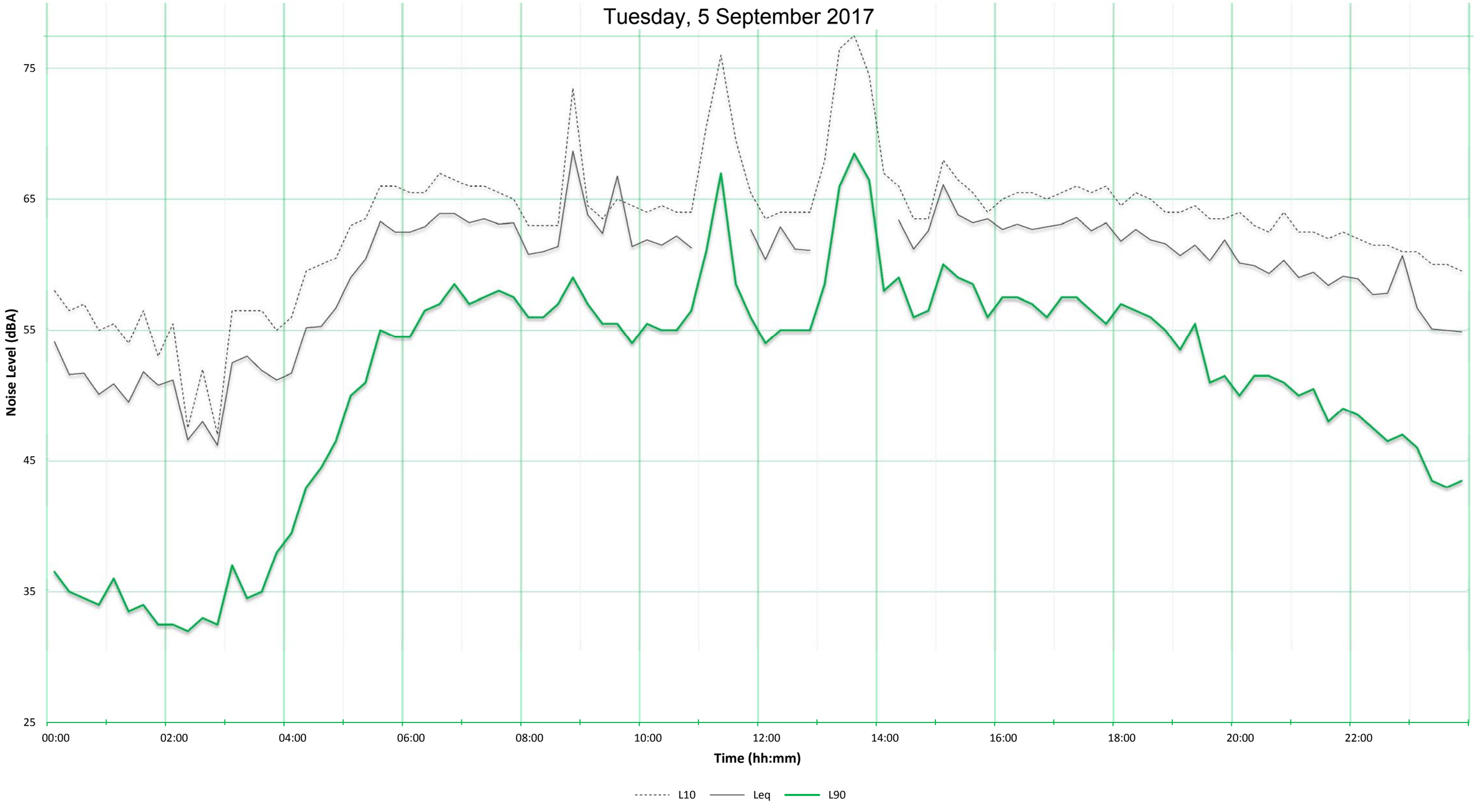

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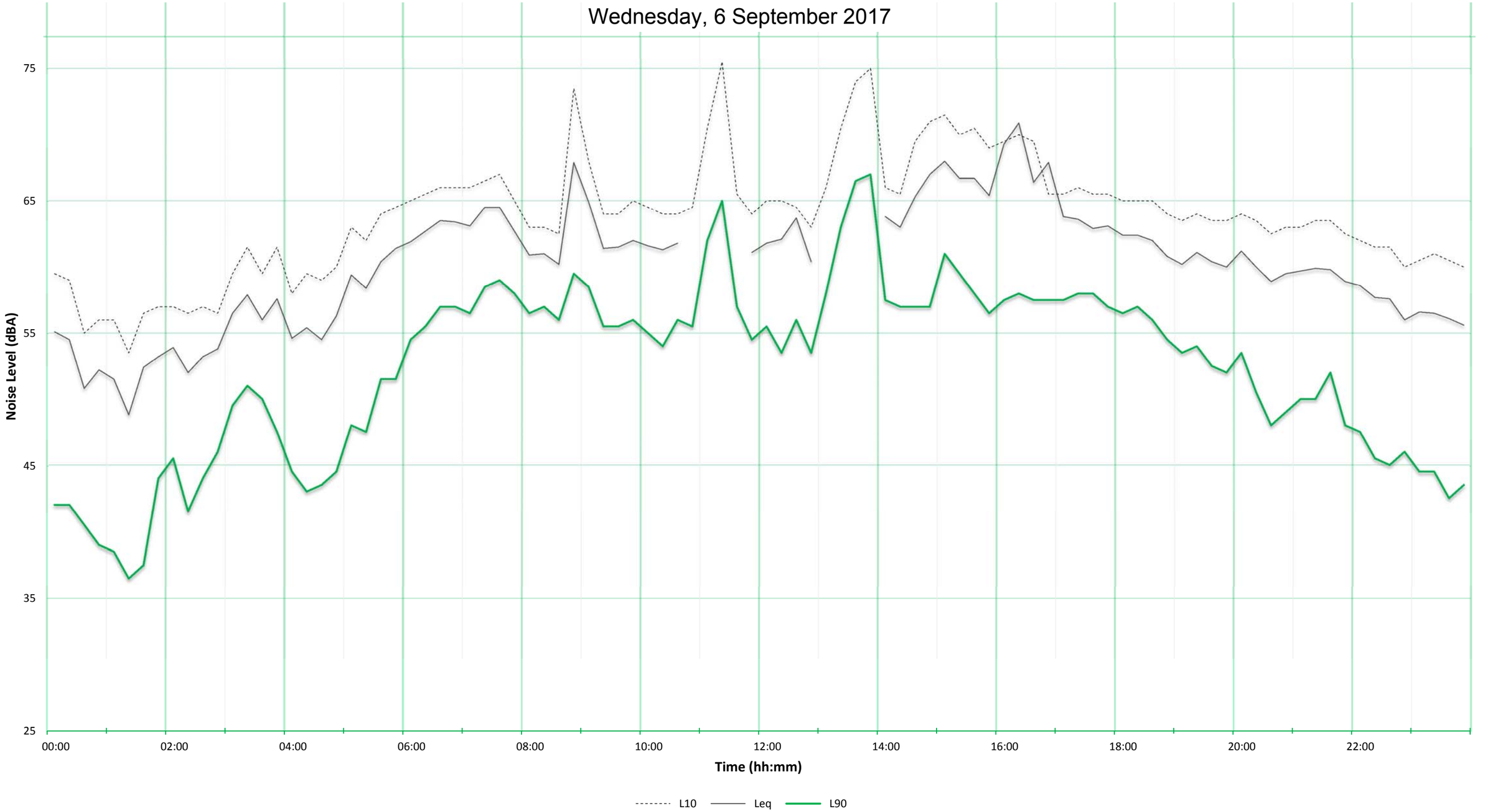

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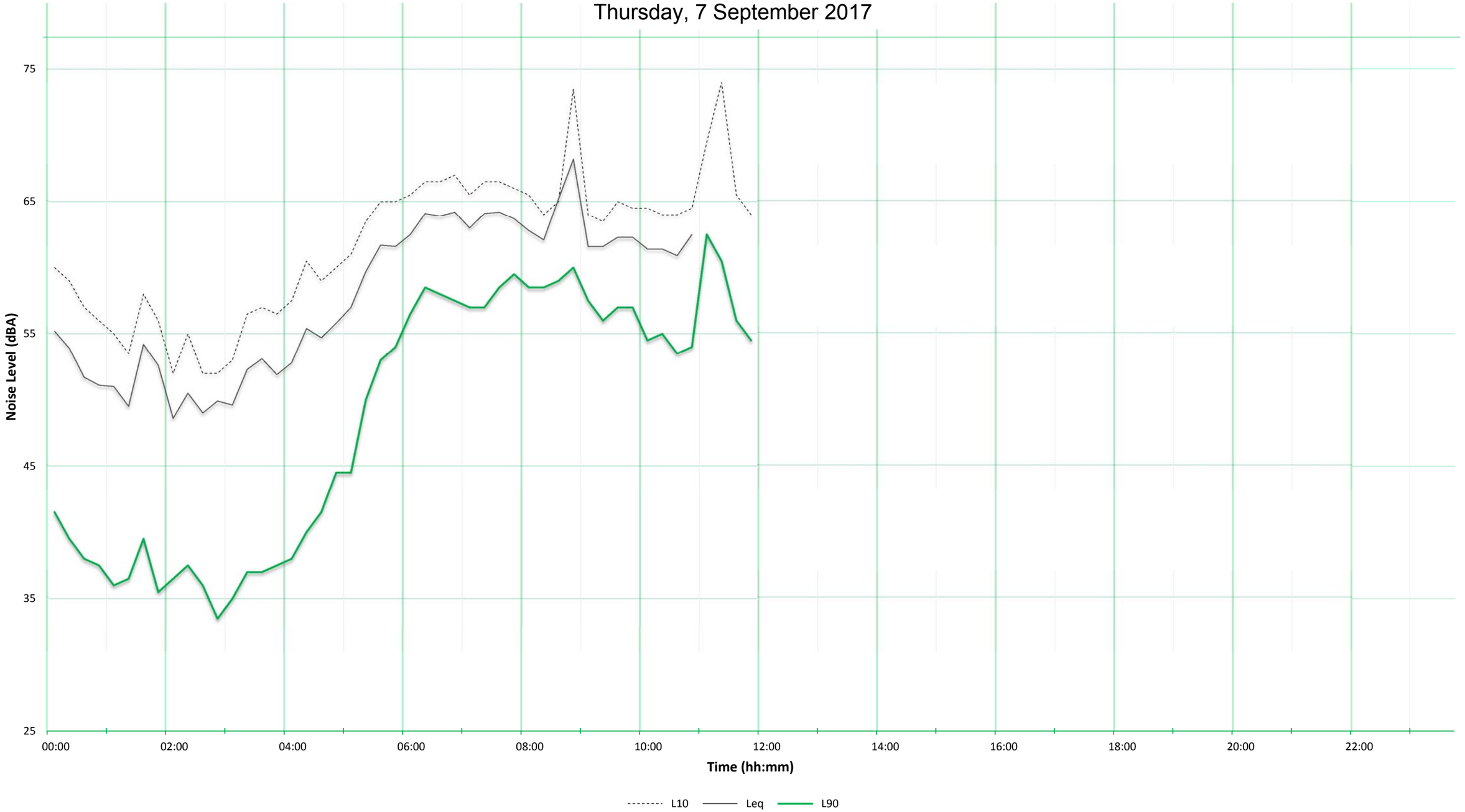

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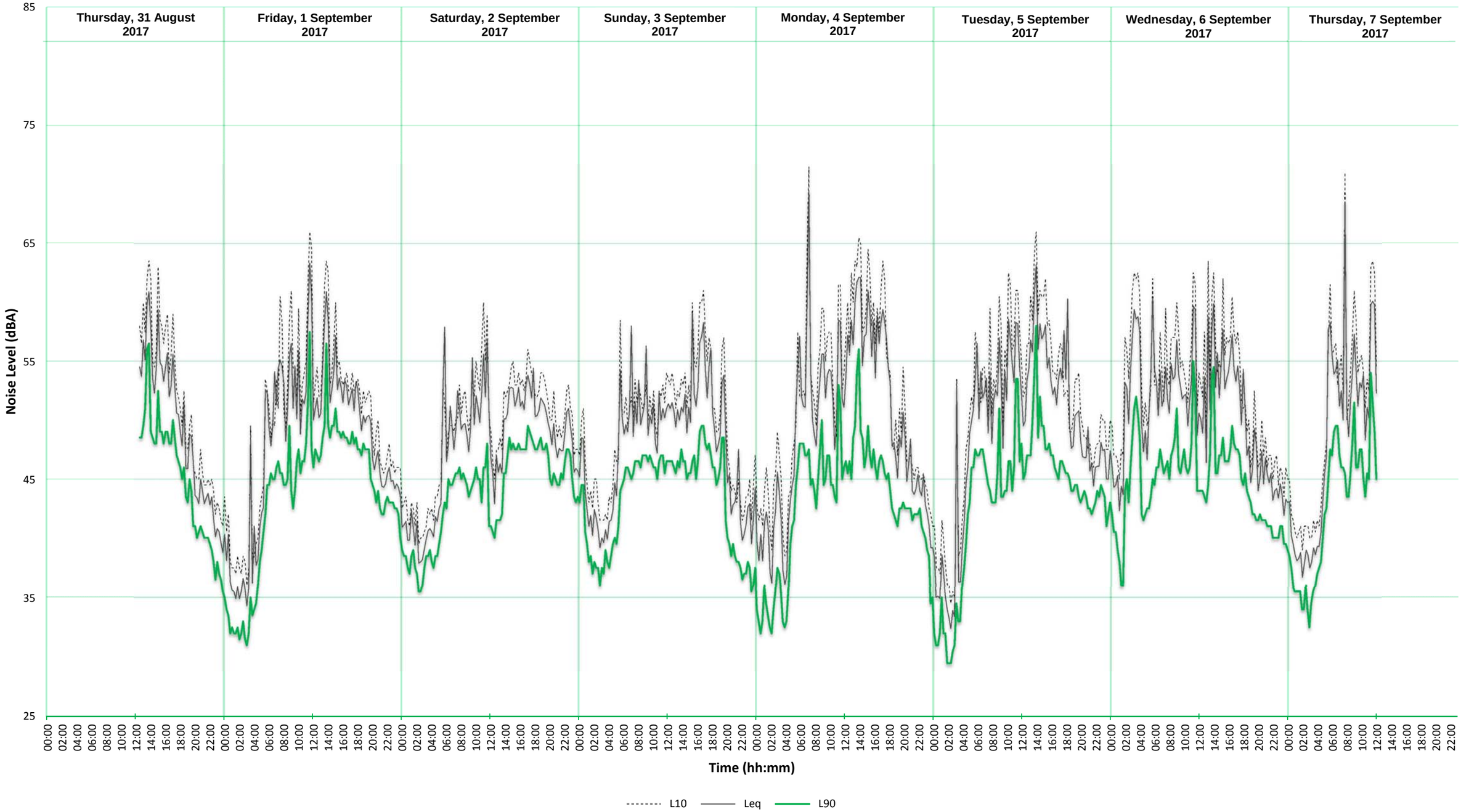
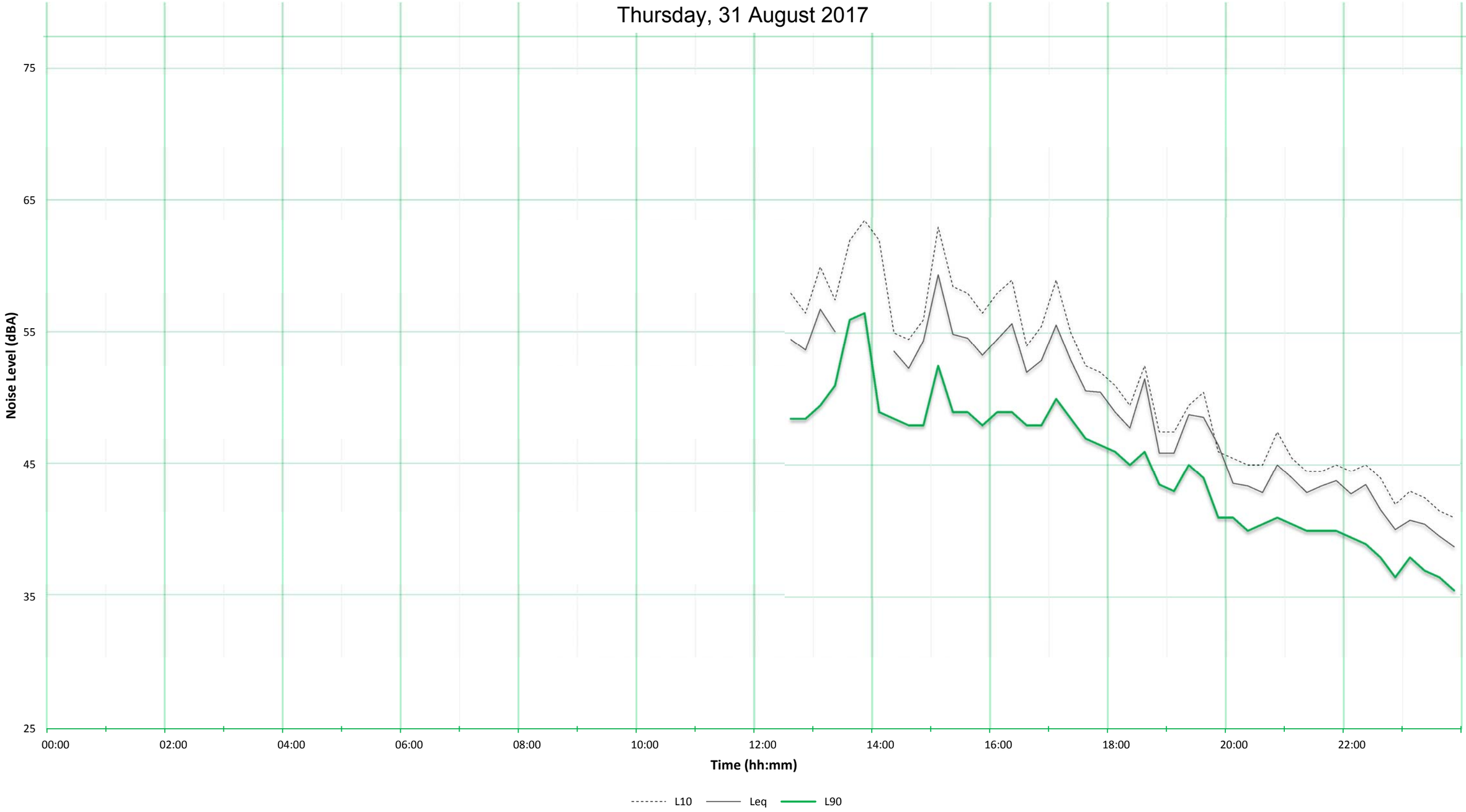


Located at Rear - 18 Arcadia Street, Penshurst, NSW

Thursday, 31 August 2017



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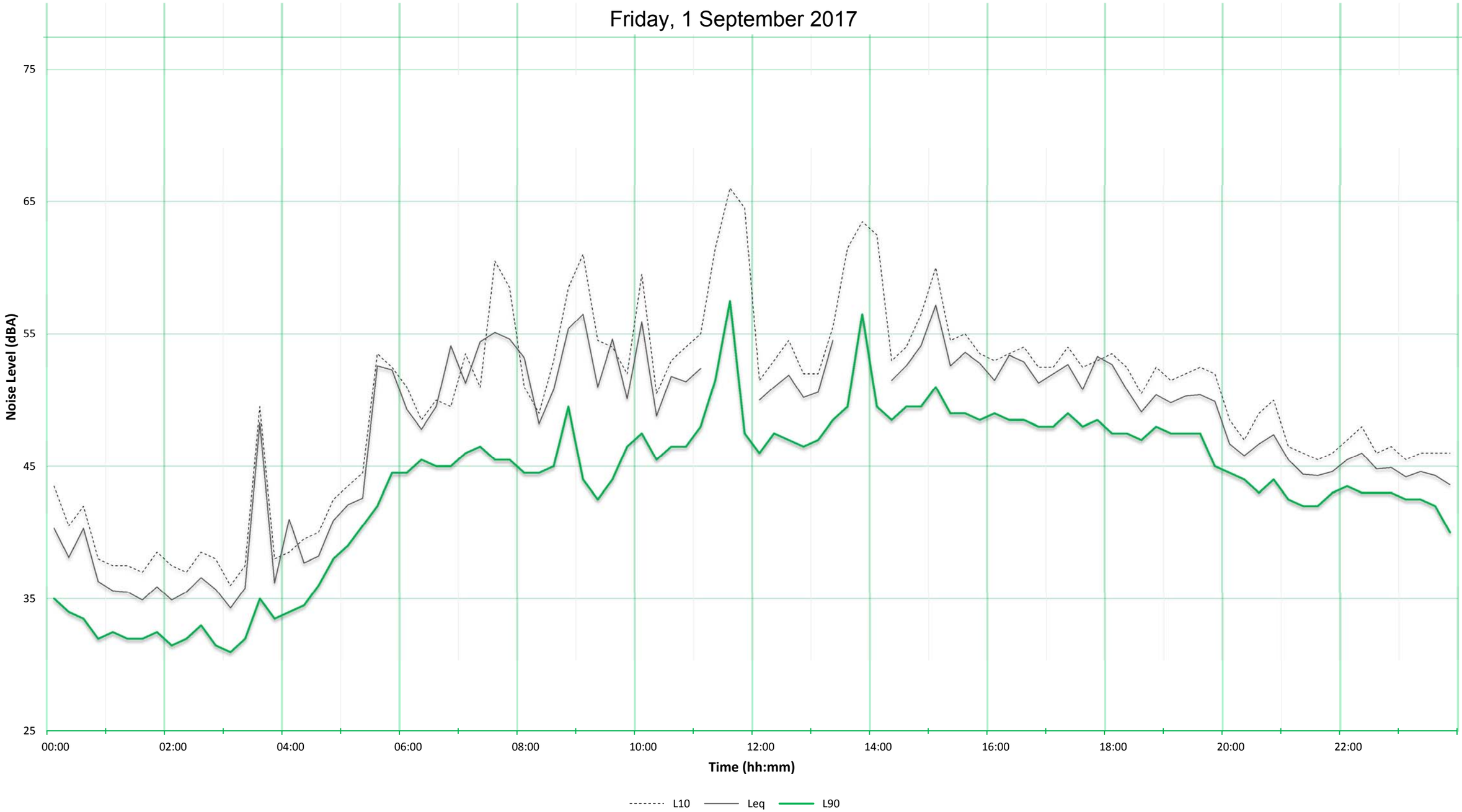

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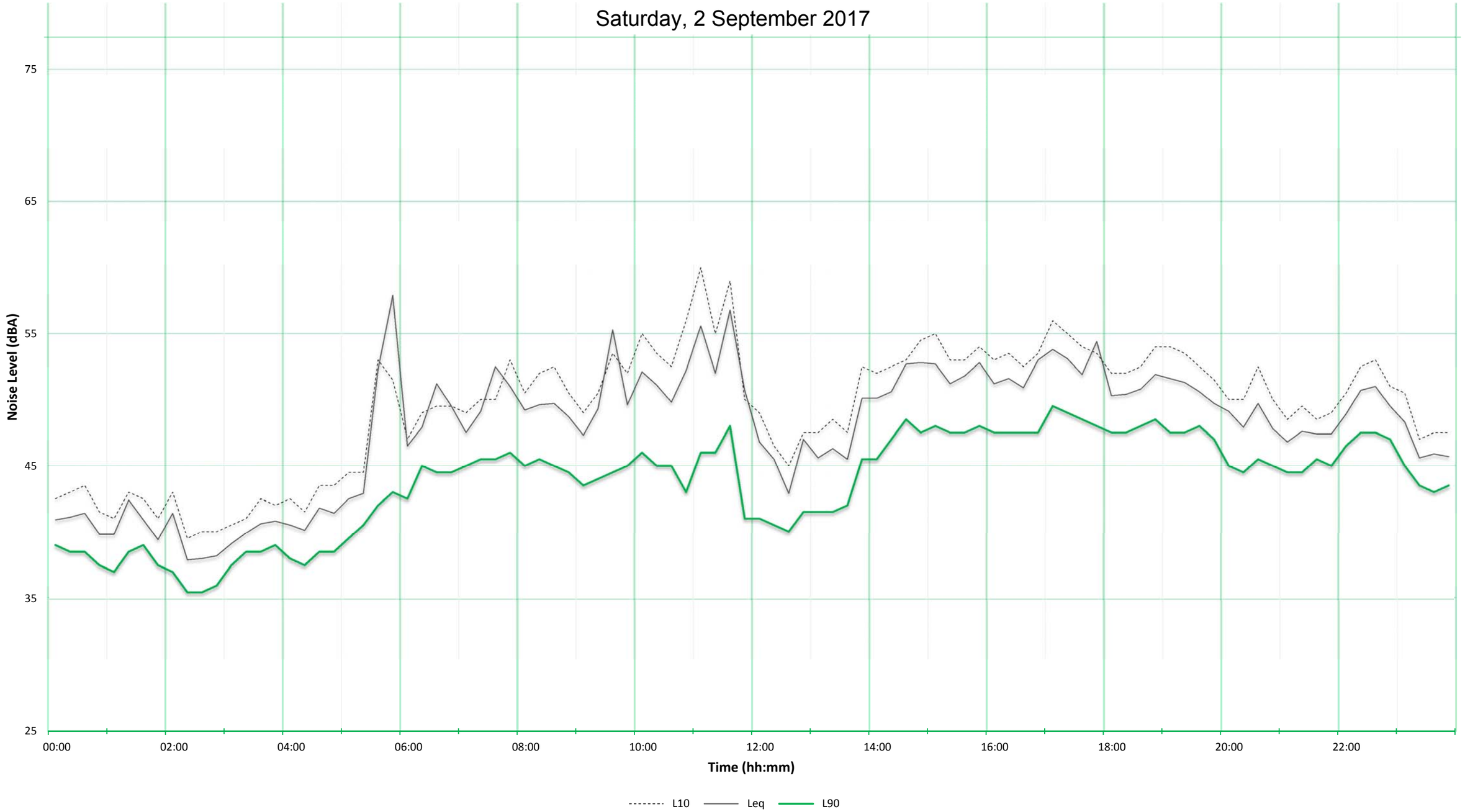

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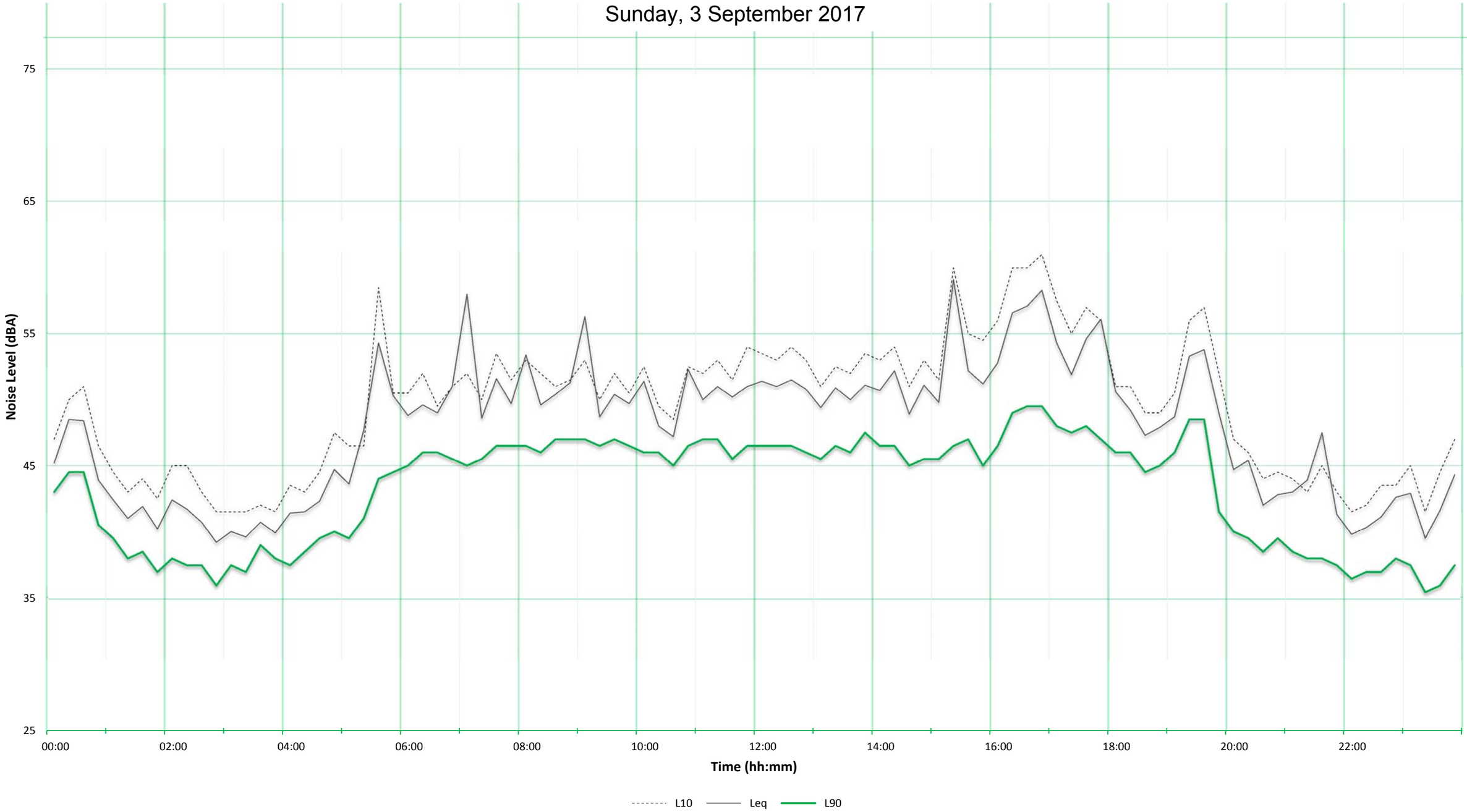

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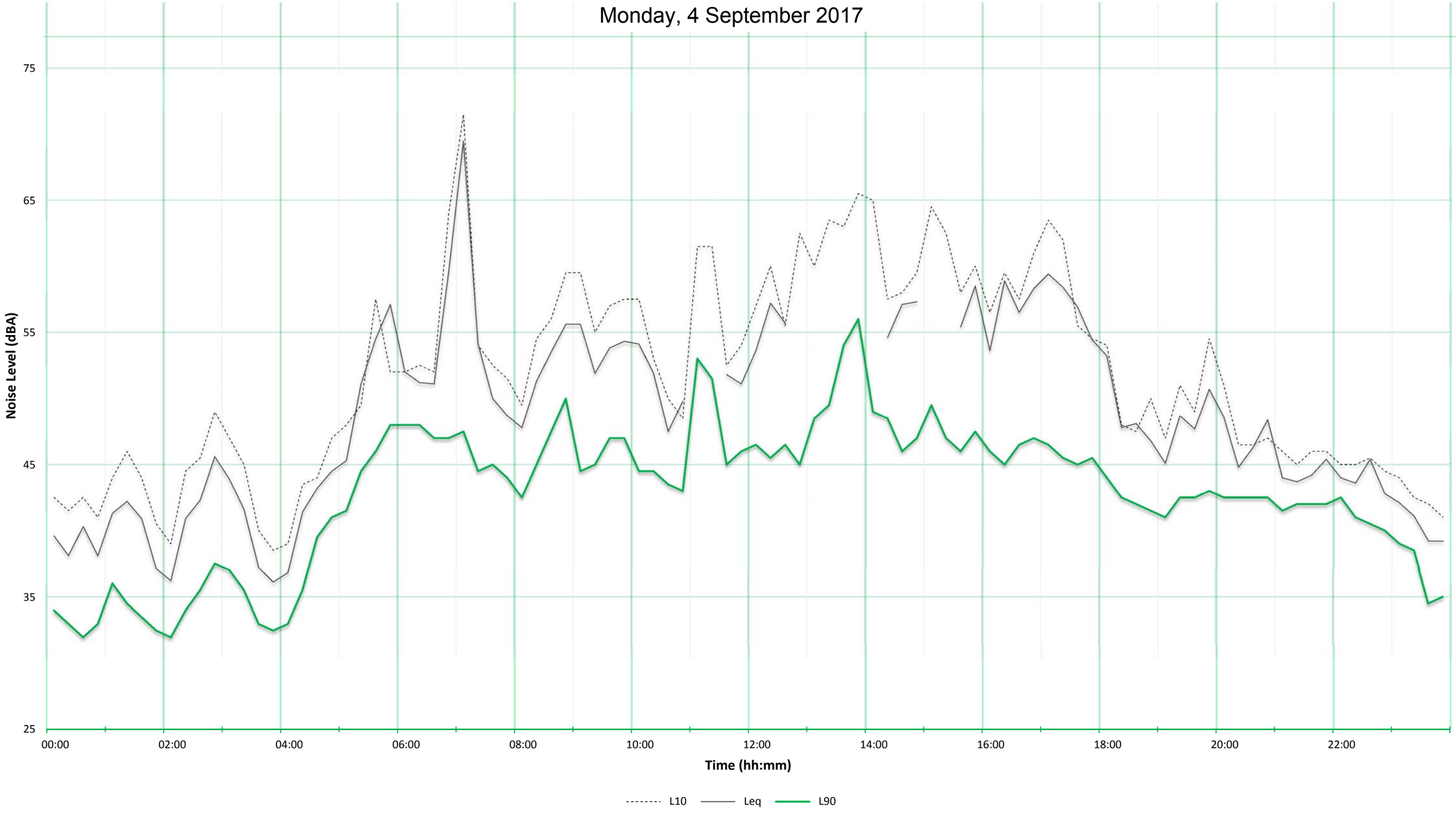

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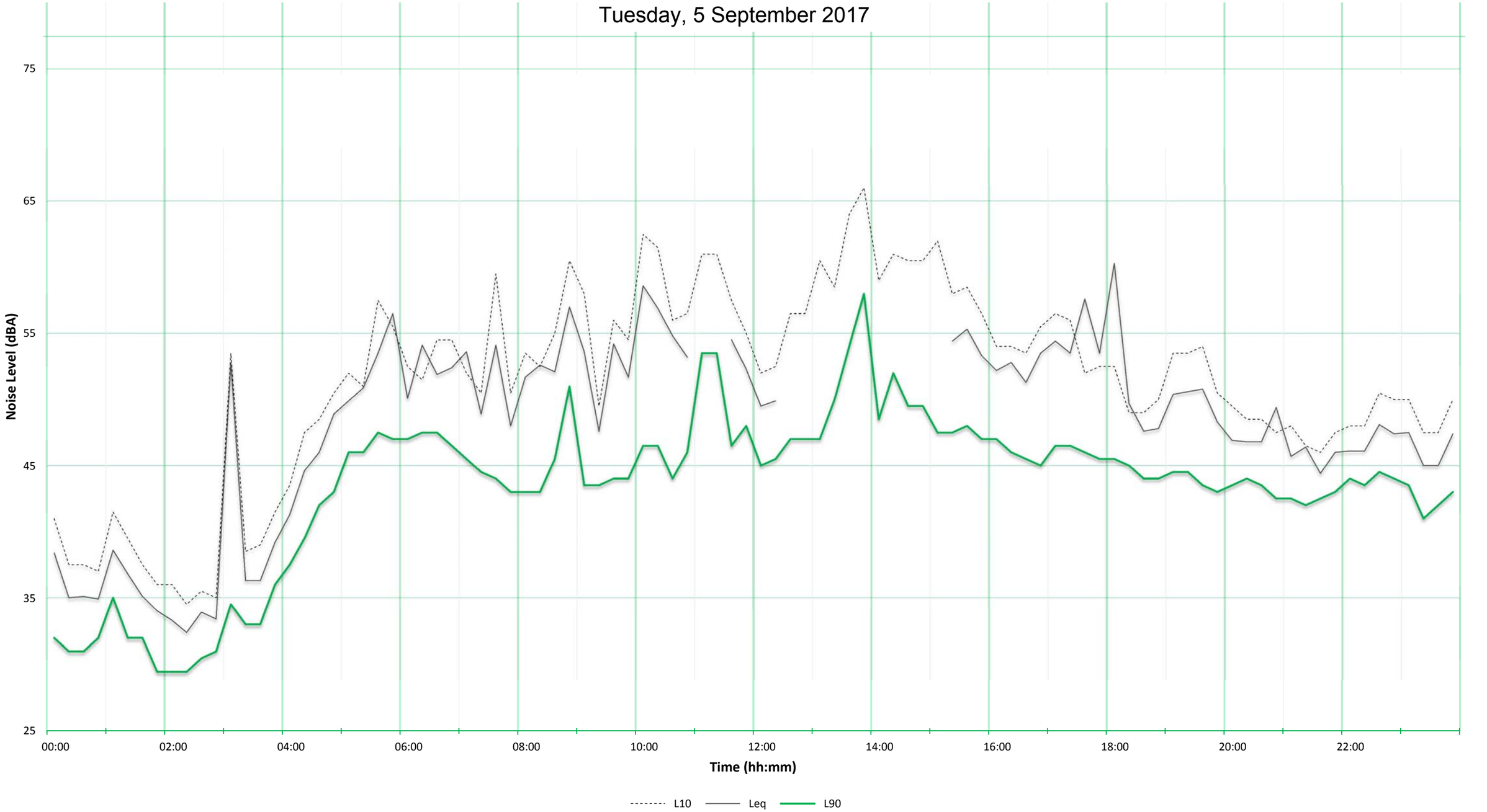

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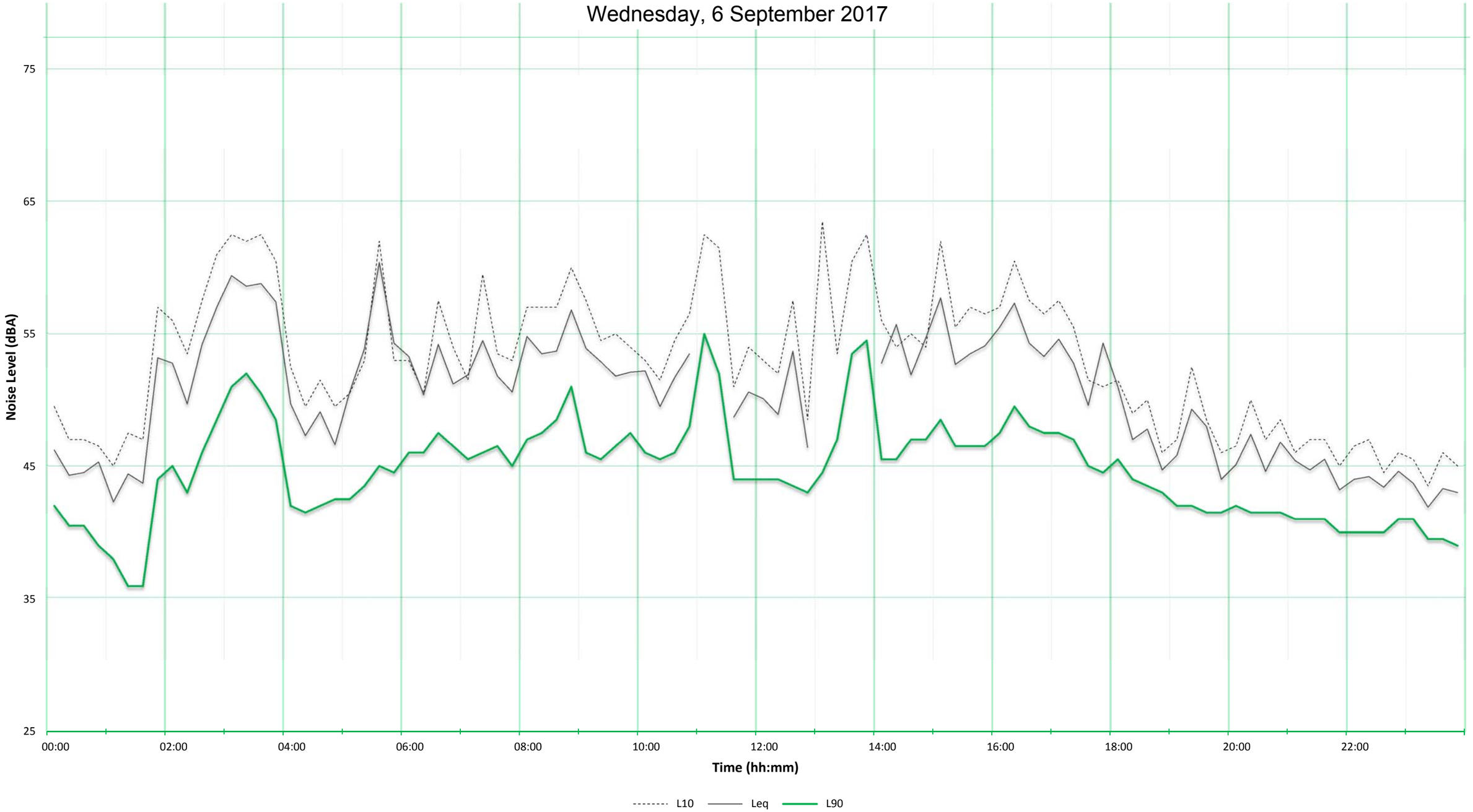

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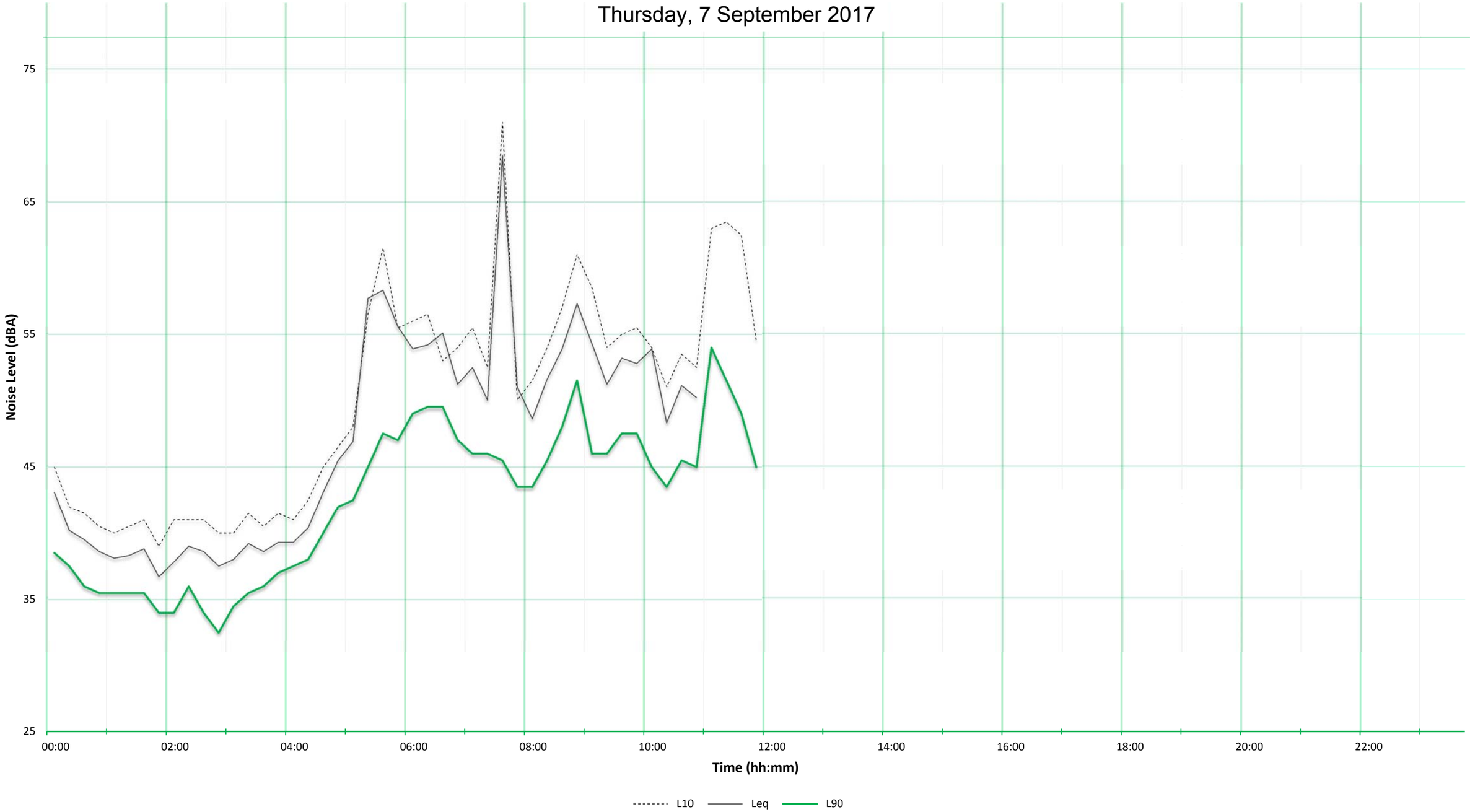

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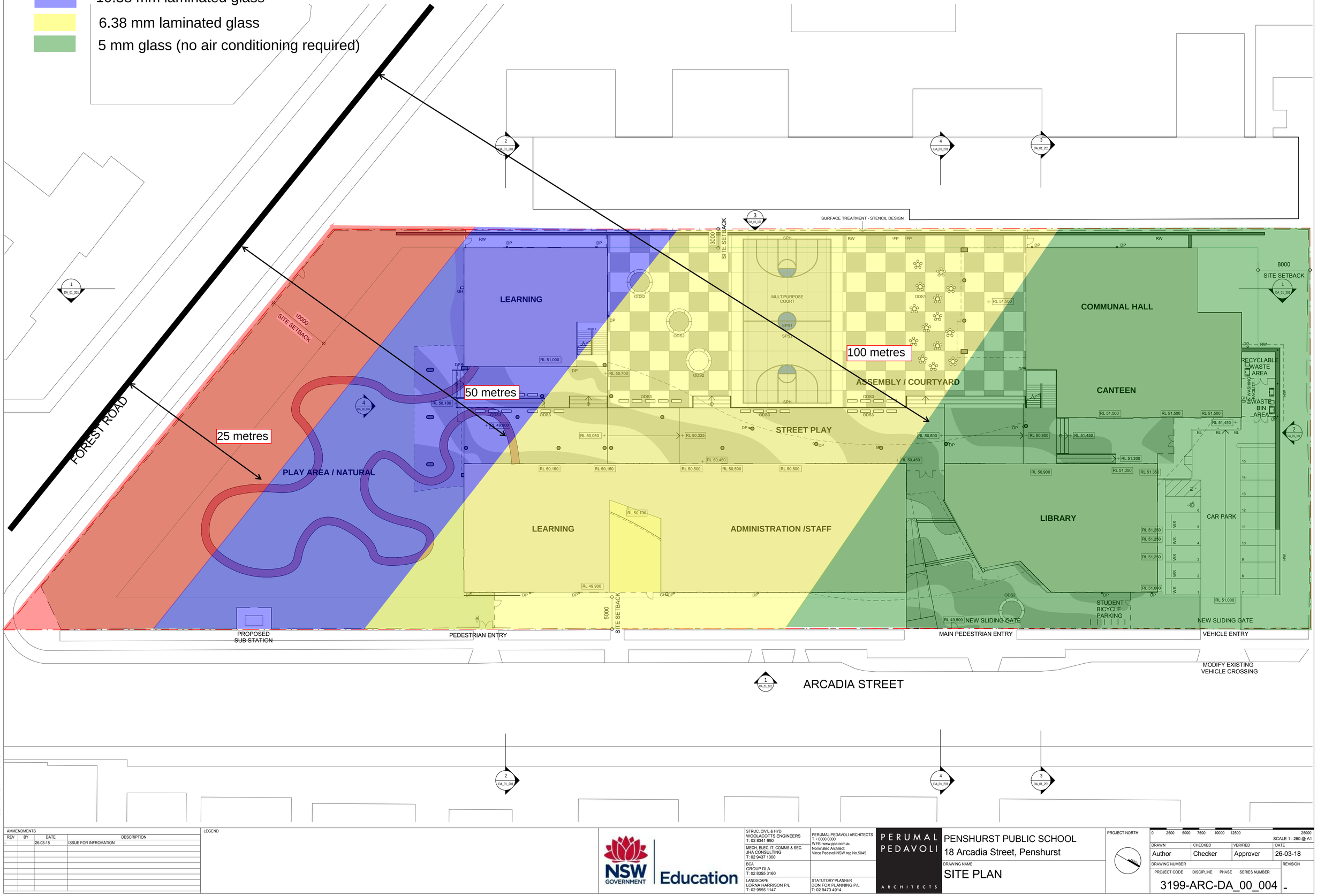
10.38 mm laminated glass
6.38 mm laminated glass
5 mm glass (no air conditioning required)



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JHA CONSULTING
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BCA
GROUP DLA
T: 02 8355 3160

LANDSCAPE
LORNA HARRISON P/L
T: 02 9555 1147

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T + 0000 0000
WEB: www.ppa.com.au
Nominated Architect:
Vince Pedavoli NSW reg No.5045

STATUTORY PLANNER
DON FOX PLANNING P/L
T: 02 8473 4914

PERUMAL PEDAVOLI ARCHITECTS

PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst

DRAWING NAME
SITE PLAN

PROJECT NORTH

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SCALE 1 : 250 @ A1

DRAWN	CHECKED	VERIFIED	DATE
Author	Checker	Approver	26-03-18

DRAWING NUMBER: 3199-ARC-DA_00_004
PROJECT CODE | DISCIPLINE | PHASE | SERIES NUMBER
REVISION: -

6320-1 Appendix B

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- 10.38 mm laminated glass
- 6.38 mm laminated glass
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DRAWING NAME
FLOOR PLAN - LEVEL 0

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REVISION: -

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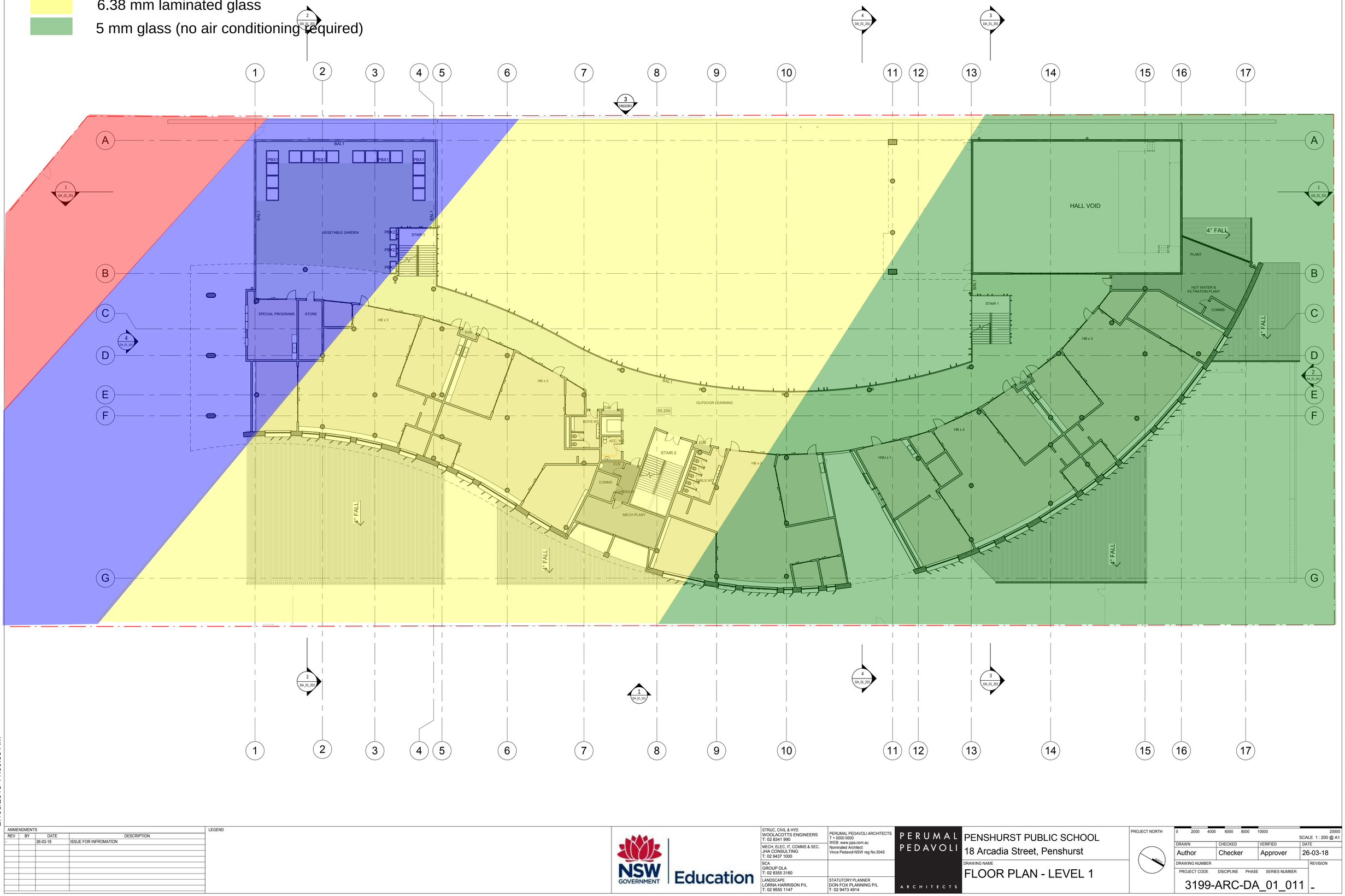

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PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst

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FLOOR PLAN - LEVEL 1

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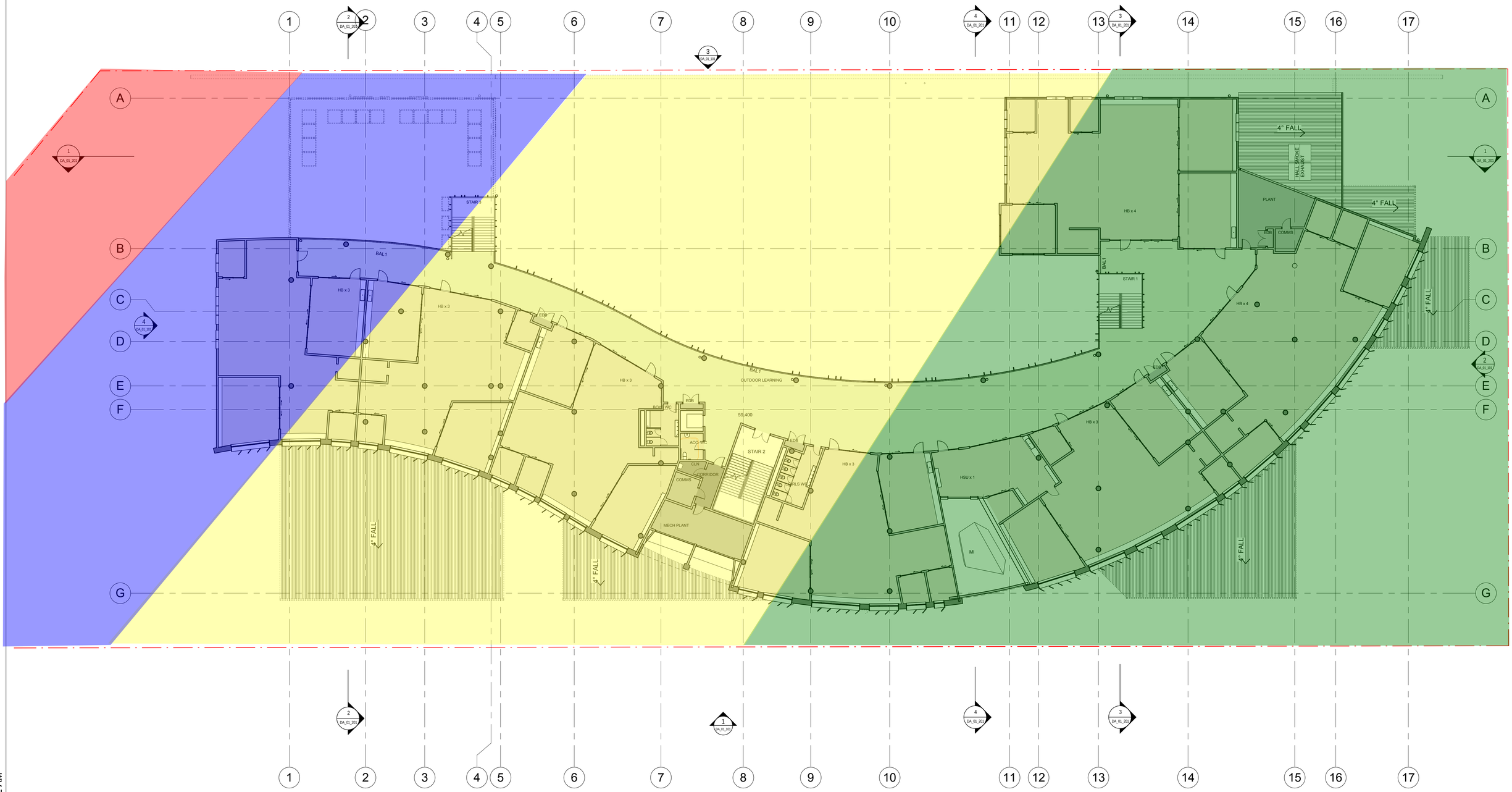
6320-1 Appendix B



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PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst

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FLOOR PLAN - LEVEL 2

PROJECT NORTH

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SCALE 1 : 200 @ A1

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DRAWING NUMBER				REVISION
PROJECT CODE	DISCIPLINE	PHASE	SERIES NUMBER	
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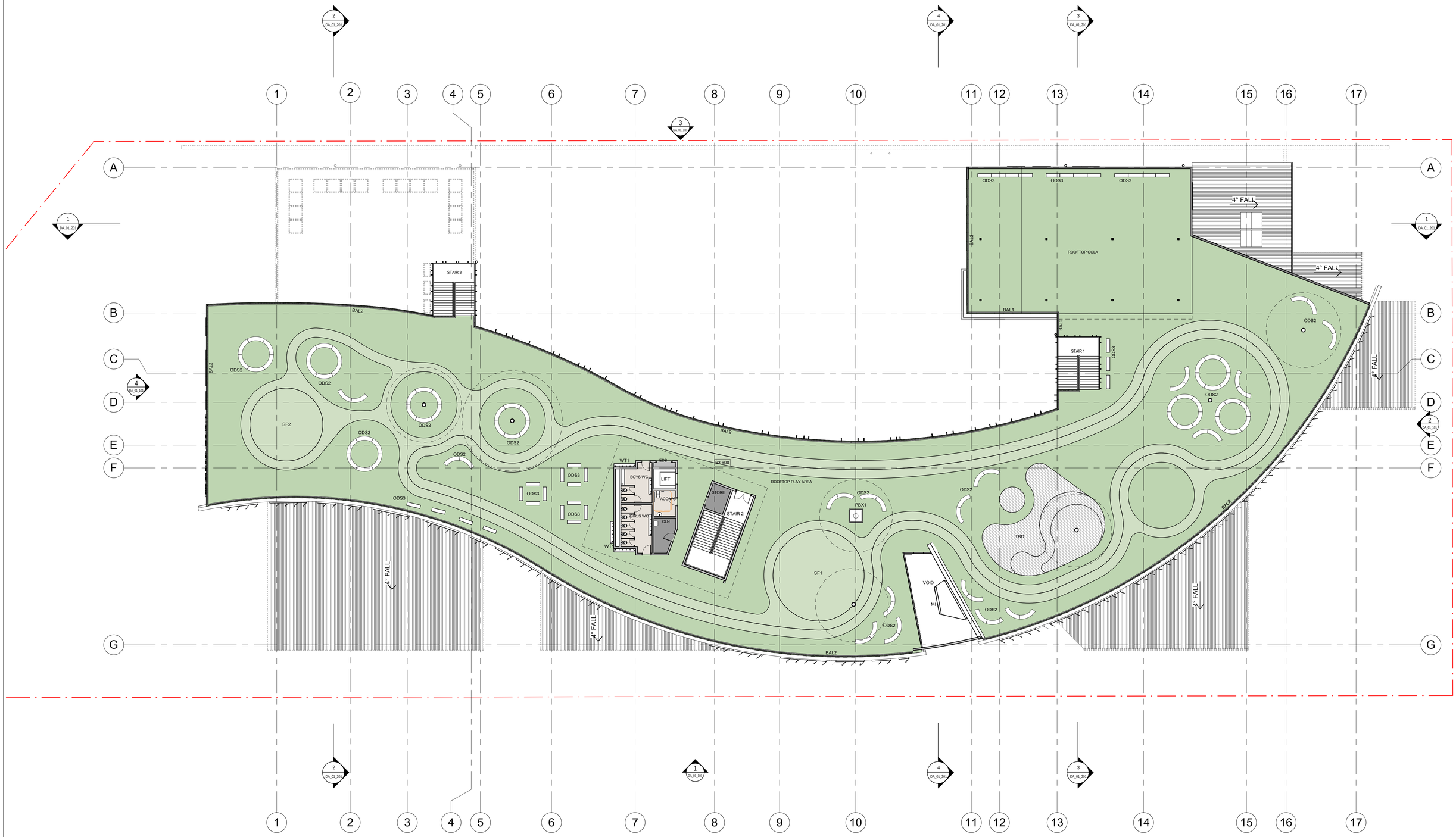

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MECH, ELEC, IT, COMMS & SEC JHA CONSULTING T: 02 9437 1000	
BCA GROUP DLA T: 02 8355 3160	
LANDSCAPE LORNA HARRISON P/L T: 02 9555 1147	STATUTORY PLANNER DON FOX PLANNING P/L T: 02 9473 4914

PERUMAL PEDAVOLI ARCHITECTS

PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst

DRAWING NAME
FLOOR PLAN - LEVEL 3

PROJECT NORTH

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DRAWING NUMBER				REVISION
PROJECT CODE	DISCIPLINE	PHASE	SERIES NUMBER	
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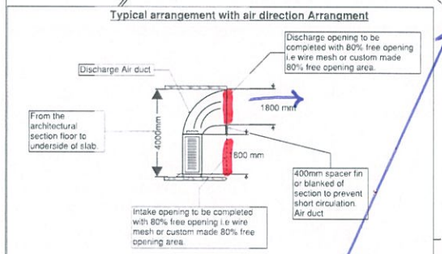
JHA
MARKUP / SKETCH

DOCUMENT No.: SK_01_CONDENSING UNIT PLANT LOCATION
DOCUMENT TITLE: GOUND FLOOR CONDENSING UNIT PLANT LOCATION
DOCUMENT REV: 02 03 21.02.2018
DOCUMENT BY: TEJA KSHATRI DATE: ~~12/01/2018~~

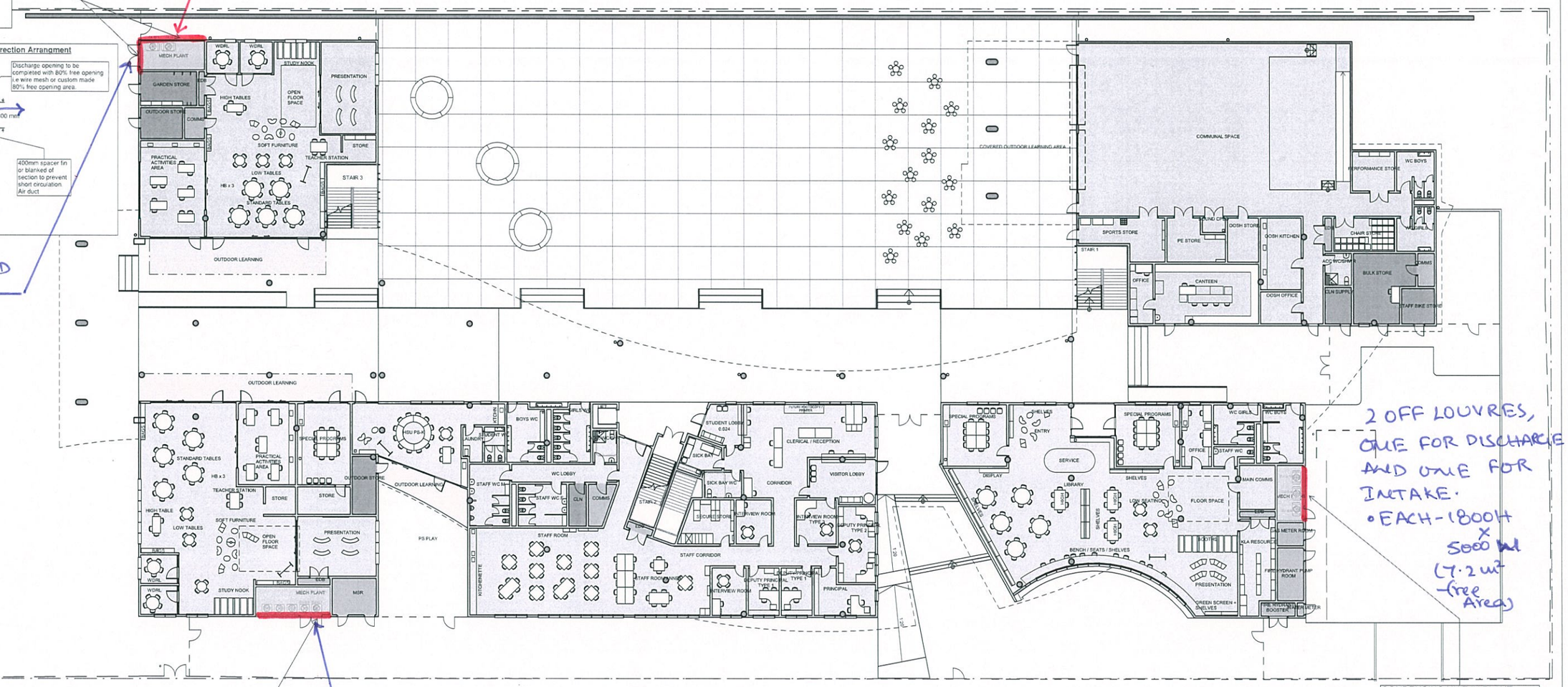
2 OFF LOUVRES, ONE FOR DISCHARGE AND ONE FOR INTAKE.
• EACH – 1800mmH X 5800W (FREE AREA 8.4 m²)

CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING i.e. WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE . UNITS TO BE FITTED WITH AIR DIRECTION ARRANGMENT.

Typical arrangement with air direction Arrangment



LOUVRED DOOR

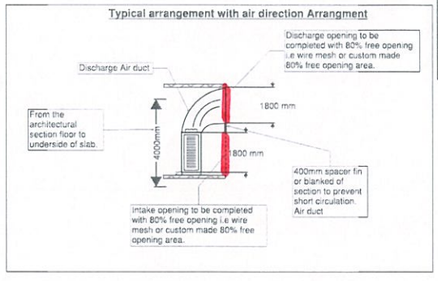


2 OFF LOUVRES, ONE FOR DISCHARGE AND ONE FOR INTAKE.
• EACH- 1800H X 5000 W (7.2 m² Free Area)

CONDENSING UNITS IN PLANT AREA. CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING (WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE) AND WITH NO ROOF LEVEL OVER THE PLANT AREA.

2 OFF LOUVRES, ONE FOR DISCHARGE AND ONE FOR INTAKE.
• EACH- 1800H X 6800 W (9.8m² FREE AREA)

Typical arrangement with air direction Arrangment



CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING i.e. WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE . UNITS TO BE FITTED WITH AIR DIRECTION ARRANGMENT.

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AMMENDMENTS

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-	CH	18-10-17	ISSUE FOR INFORMATION
-	CH	20-10-17	ISSUE FOR INFORMATION
—	CH	31-10-17	ISSUE FOR INFORMATION
/	CH	03-11-17	ISSUE FOR INFORMATION - 95% SCHEMATIC DESIGN
//	CH	13-11-17	ISSUE FOR INFORMATION
///	CH	10-01-18	ISSUE FOR INFORMATION

LEGEND

NSW GOVERNMENT Education

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PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst

DRAWING NAME
FURNITURE PLAN - LEVEL 0

PROJECT NORTH

0 2000 4000 6000 8000 10000 20000
SCALE: 1 : 200 @ A1

DRAWN	CHECKED	VERIFIED	DATE
Author	Checker	Approver	10-01-18

DRAWING NUMBER: 3199-ARC-DD-01_500
PROJECT CODE | DISCIPLINE | PHASE | SERIES NUMBER
REVISION: ///

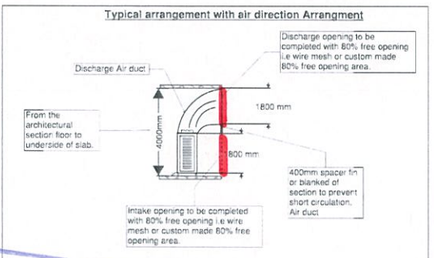
ISSUE FOR INFORMATION

JHA
MARKUP / SKETCH

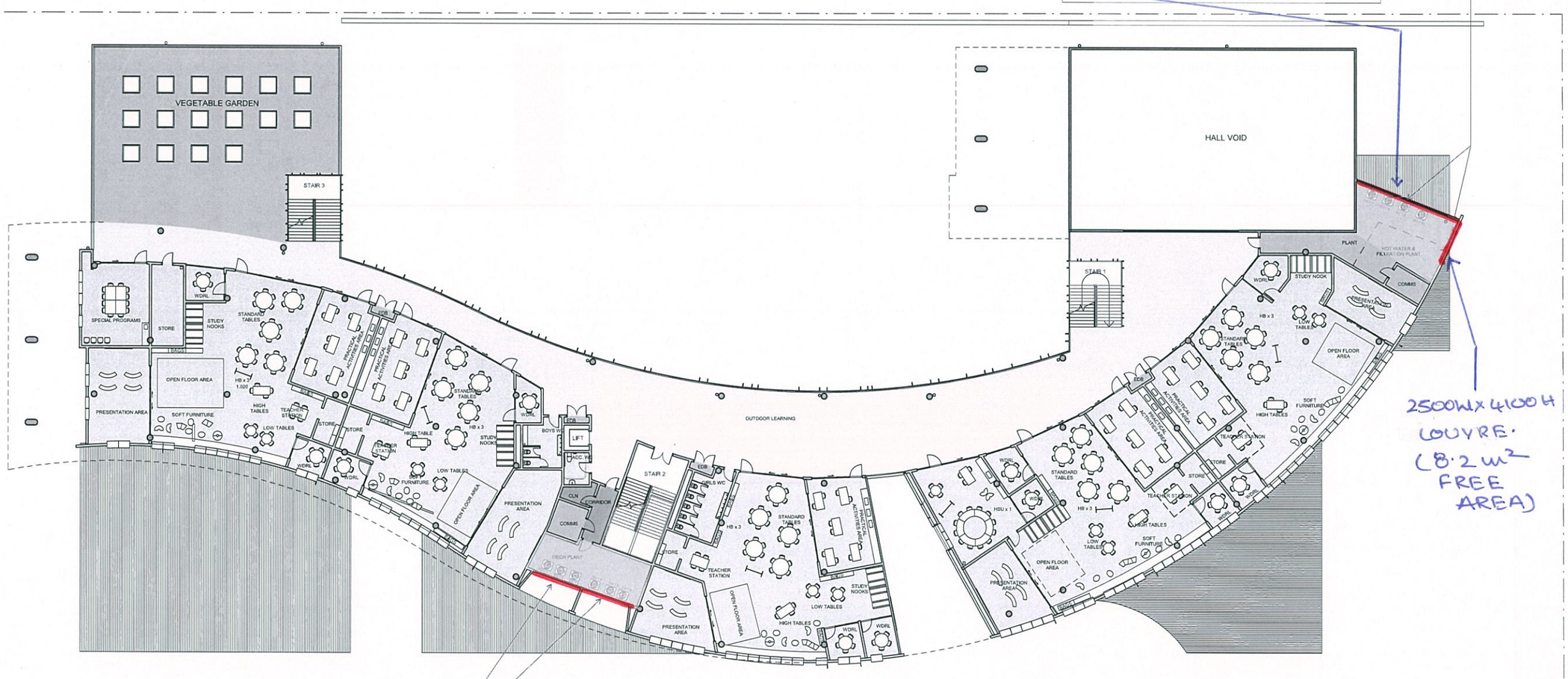
DOCUMENT No.: SK_02_CONDENSING UNIT PLANT LOCATION
DOCUMENT TITLE: FIRST FLOOR CONDENSING UNIT PLANT LOCATION
DOCUMENT REV: ~~02~~ 03 21/02/2018
DOCUMENT BY: TEJA KSHATRI DATE: ~~12/01/2018~~

2 OFF LOUVRES, ONE FOR DISCHARGE AND ONE FOR INTAKE.
- EACH - 1800H x 8900W (12m² FREE AREA)

Typical arrangement with air direction Arrangment



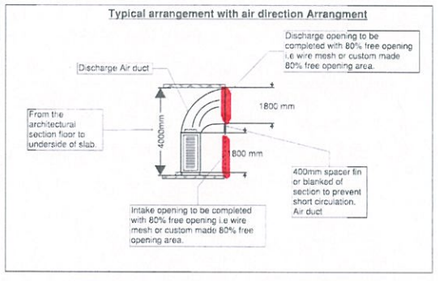
CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING i.e. WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE . UNITS TO BE FITTED WITH AIR DIRECTION ARRANGMENT.



2500W x 4100H LOUVRE. (8.2m² FREE AREA)

CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING i.e. WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE . UNITS TO BE FITTED WITH AIR DIRECTION ARRANGMENT.

Typical arrangement with air direction Arrangment



2 OFF LOUVRES, ONE FOR DISCHARGE AND ONE FOR INTAKE
- EACH - 1800H x 8900W (13m² FREE AREA)

10/01/2018 6:07:28 PM

ISSUE FOR INFORMATION

AMMENDMENTS

REV	BY	DATE	DESCRIPTION
-	CH	05-10-17	ISSUE FOR INFORMATION
-	CH	13-10-17	ISSUE FOR INFORMATION
-	CH	18-10-17	ISSUE FOR INFORMATION
-	CH	26-10-17	ISSUE FOR INFORMATION
/	CH	31-10-17	ISSUE FOR INFORMATION
//	CH	03-11-17	ISSUE FOR INFORMATION - 95% SCHEMATIC DESIGN
///	CH	13-11-17	ISSUE FOR INFORMATION
////	CH	10-01-18	ISSUE FOR INFORMATION

LEGEND

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PERUMAL PEDAVOLI ARCHITECTS

PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst

DRAWING NAME
FURNITURE PLAN - LEVEL 1

PROJECT NORTH

0 2000 4000 6000 8000 10000 20000
SCALE 1 : 200 @ A1

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Author	Checker	Approver	10-01-18

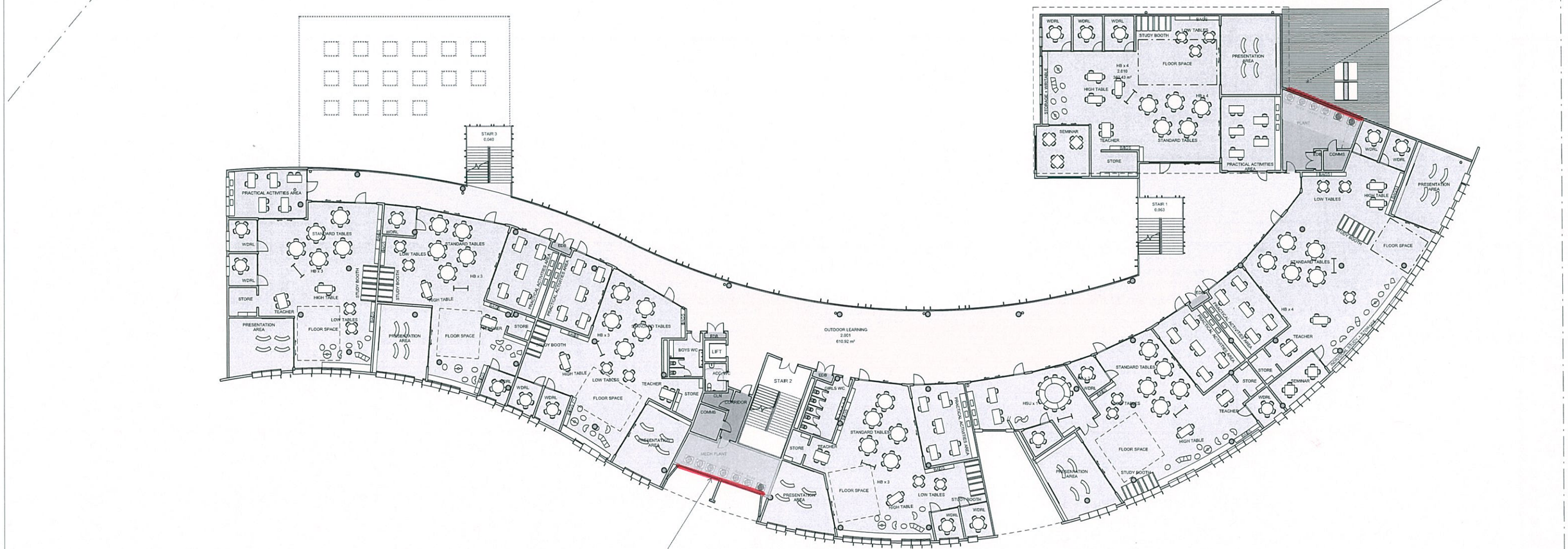
DRAWING NUMBER				REVISION
PROJECT CODE	DISCIPLINE	PHASE	SERIES NUMBER	
3199	ARC	DD	01_501	////

JHA
MARKUP / SKETCH

DOCUMENT No.: SK_03_CONDENSING UNIT PLANT LOCATION
DOCUMENT TITLE: SECOND FLOOR CONDENSING UNIT PLANT LOCATION
DOCUMENT REV: 02 03 21/02/2019
DOCUMENT BY: TEJA KSHATRI DATE: 12/01/2018

2 OFF LOUVRES, ONE FOR DISCHARGE AND ONE FOR INTAKE.
• EACH - 1800H x 8700W (12.5m² FREE AREA)

CONDENSING UNITS IN PLANT AREA. CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING (WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE) ~~AND WITH NO ROOF LEVEL OVER THE PLANT AREA OR VERTICAL DISCHAGE DUCTS.~~



CONDENSING UNITS IN PLANT AREA. CONDENSING UNIT IN PLANT AREA. EXTERNAL FACADE TO BE COMPLETED WITH 80% OPENING (WIRE MESH OR CUSTUM MADE 80% OPEN LOUVRE) ~~AND WITH NO ROOF LEVEL OVER THE PLANT AREA OR VERTICAL DISCHAGE DUCTS.~~

2 OFF LOUVRES, ONE FOR DISCHARGE AND FOR INTAKE.
• EACH - 1800H x 9000W (13m² FREE AREA)

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ISSUE FOR INFORMATION

AMMENDMENTS			
REV	BY	DATE	DESCRIPTION
-	CH	13-10-17	ISSUE FOR INFORMATION
-	CH	18-10-17	ISSUE FOR INFORMATION
-	CH	20-10-17	ISSUE FOR INFORMATION
—	CH	31-10-17	ISSUE FOR INFORMATION
/	CH	03-11-17	ISSUE FOR INFORMATION - 95% SCHEMATIC DESIGN
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///	CH	10-01-18	ISSUE FOR INFORMATION

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PERUMAL PEDAVOLI ARCHITECTS

PENSHURST PUBLIC SCHOOL
18 Arcadia Street, Penshurst
DRAWING NAME: FURNITURE PLAN - LEVEL 2

PROJECT NORTH

0 2000 4000 6000 8000 10000 20000 SCALE 1 : 200 @ A1

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Author	Checker	Approver	10-01-18

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School Infrastructure Program Workshop

Noise Impact Assessment Issues

Schools “then” vs “now”

- Pop-up school
- Staggered playtimes
- High-rise schools
- Hall hire and grounds use
- Future ?

People “then” vs “now”

- Less tolerant?
- Higher expectations?
- More demanding?
- Less patient?

Background Noise

- Industrial Noise Policy
- Measurement location
  - At noise sensitive receiver location
    - Where the impact will occur – a legislative requirement.
  - Not at the subject site!

Background Noise

- Measurement duration
  - Minimum of one weeks valid data – diurnal and weekday / weekend variation.
  - Excluding data potentially affected by wind or rain.
  - Table of ABLs and RBLs
  - Graphical presentation of data, one 24hr period per graph.

Construction and Construction – type activities.

- Standard hours from ICNG
  - Respite for “Highly Noise Affected”
  - Outside of Standard Hours
    - Clear justification other than convenience
- Feasible and reasonable mitigation where > NMLs

Operation

- Industrial Noise Policy
  - For plant and equipment
    - Eg air conditioning, refrigeration, fans, motors, generators
    - Background + 5, free of tones and other annoying characterisitics

Education Facilities Standards and Guidelines (EFSG)

- Education Design Guideline 11 Acoustics
  - 11.04 Noise Emission (To the Environment)
    - “Noise associated with school activity (such as music or sport within a hall) are not a stationary noise source and is not subject to the INP requirements.”

School Bells and Loudspeakers

- Good design
  - Level, character, frequency, duration.
  - Many, smaller, distributed speakers, aimed to achieve the desired outcome.

Maintenance Machinery

- Appropriate for time of day and day of week
  - Mowing, edging, **leaf blowing**, rubbish collection, gurneys
    - Plan of management?
- POEO Regulation and Offensive noise.

Playground Noise

- Meriden School v Pedavoli

  Did not assess the school activities in a planning sense.

  Absence of specific controls for schools as the AAAC Guidelines relate to child care centres.

  The school is in an appropriate zoning;

  The use is what is expected of a school – it only occurs at certain times in accordance with school hours.

Playground Noise

- Meriden School v Pedavoli

  The use is what is expected of a school – it only occurs at certain times in accordance with school hours.

  A school is a land use…considered appropriate and acceptable in a residential environment based on the …zoning.

Community and Fund Raising Activities

- Appropriate for time of day and day of week

DPE Design Guide / Draft SEPP?

- Spatial separation of incompatible land use through appropriate zoning and placement of activities to minimise noise-related land use conflicts.
- Minimising noise emissions at source through best practice selection, design, siting, construction and operation as appropriate.

Out Of Hours Construction Works

- Post Approval
  - Out of Hour Work – Can only be approved if detailed in application
- EIS
  - Outline intention and identify impact on sensitive receivers
  - Justify need - i.e redevelopment of existing school, safety
  - Detail how impacts mitigated, managed and notified
- Out of Hours Protocol
  - Single agency protocol or template

ACOUSTICAL – Pertaining to the science of sound, including the generation, propagation, effects and control of both noise and vibration.

AMBIENT NOISE – The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including road traffic, factories, wind in the trees, birds, insects, animals, etc.

AUDIBLE – means that a sound can be heard. However, there are a wide range of audibility grades, varying from "barely audible" to "just audible", "clearly audible" and "prominent". Chapter 83 of the NSW Environment Protection Authority – Environmental Noise Control Manual (1985) states:
"noise from a particular source might be offensive if it is clearly audible, distinct from the prevailing background noise and of a volume or character that a reasonable person would be conscious of the intrusion and find it annoying or disruptive".

It follows that the word "audible" in an environmental noise context means "clearly audible".

BACKGROUND NOISE LEVEL – Silence does not exist in the natural or the built-environment, only varying degrees of noise. The Background Noise Level is the average minimum dBA level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by cicadas, lawnmowers, etc. It is quantified by the L_{A90} or the dBA noise level that is exceeded for 90 % of the measurement period (usually 15 minutes).

- **Assessment Background Level (ABL)** is the single figure background level representing each assessment period – day, evening and night (ie three assessment background levels are determined for each 24hr period of the monitoring period). Determination of the assessment background level is by calculating the tenth percentile (the lowest tenth percent value) of the background levels (L_{A90}) for each period (refer: NSW Industrial Noise Policy, 2000).
- **Rating Background Level (RBL)** as specified by the Environment Protection Authority is the overall single figure (L_{A90}) background noise level representing an assessment period (day, evening or night) over a monitoring period of (normally) three to seven days.

  The RBL for an assessment period is the median of the daily lowest tenth percentile of L_{90} background noise levels.

  If the measured background noise level is less than 30 dBA, then the Rating Background Level (RBL) is considered to be 30 dBA.

DECIBEL – The human ear has a vast sound-sensitivity range of over a thousand billion to one. The decibel is a logarithmic unit that allows this same range to be compressed into a somewhat more comprehensible range of 0 to 120 dB. The decibel is ten times the logarithm of the ratio of a sound level to a reference sound level. See also Sound Pressure Level and Sound Power Level.

Decibel noise levels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dBA, and another similar machine is placed beside it, the level will increase to 53 dBA, not 100 dBA. Ten similar machines placed side by side increase the sound level by 10 dBA, and one hundred machines increase the sound level by 20 dBA.

dBA – The human ear is less sensitive to low frequency sound than high frequency sound. We are most sensitive to high frequency sounds, such as a child's scream. Sound level meters have an inbuilt weighting network, termed the dBA scale, that approximates the human loudness response at quiet sound levels (roughly approximates the 40 phon equal loudness contour).

However, the dBA sound level provides a poor indication of loudness for sounds that are dominated by low frequency components (below 250 Hz). If the difference between the "C" weighted and the "A" weighted sound level is 15 dB or more, then the NSW Industrial Noise Policy recommends a 5 dBA penalty be applied to the measured dBA level.

dBC – The dBC scale of a sound level meter is similar to the dBA scale defined above, except that at high sound intensity levels, the human ear frequency response is more linear. The dBC scale approximates the 100 phon equal loudness contour.

EQUIVALENT CONTINUOUS NOISE LEVEL, L_{Aeq} – Many noises, such as road traffic or construction noise, vary continually in level over a period of time. More sophisticated sound level meters have an integrating electronic device inbuilt, which average the A weighted sound pressure levels over a period of time and then display the energy average or L_{Aeq} sound level. Because the decibel scale is a logarithmic ratio the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closely to the L_{Aeq} noise level.

FREE FIELD – This is a sound field not subject to significant reflection of acoustical energy. A free field over a reflecting plane is usually outdoors with the noise source resting on hard flat ground, and not closer than 6 metres to any large flat object such as a fence or wall; or inside an anechoic chamber.

FREQUENCY – The number of oscillations or cycles of a wave motion per unit time, the SI unit being the Hertz, or one cycle per second.

IMPACT ISOLATION CLASS (IIC) – The American Society for Testing and Materials (ASTM) has specified that the IIC of a floor/ceiling system shall be determined by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The IIC is a number found by fitting a reference curve to the measured octave band levels and then deducting the sound pressure level at 500 Hz from 110 decibels. Thus the higher the IIC, the better the impact sound isolation.

IMPACT SOUND INSULATION ($L_{nT,w}$) – Australian Standard AS ISO 717.2 – 2004 has specified that the Impact Sound Insulation of a floor/ceiling system be quantified by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The Weighted Standardised Impact Sound Pressure Level ($L_{nT,w}$) is the sound pressure level at 500 Hz for a reference curve fitted to the measured octave band levels. Thus the lower $L_{nT,w}$ the better the impact sound insulation.

IMPULSE NOISE – An impulse noise is typified by a sudden rise time and a rapid sound decay, such as a hammer blow, rifle shot or balloon burst.

INTRUSIVE NOISE LEVEL, L_{Aeq} – The level of noise from a factory, place of entertainment, etc. in NSW is assessed on the basis of the average maximum noise level, or the $L_{Aeq\ (15\ min)}$. This is the energy average A weighted noise level measured over any 15 minute period.

LOUDNESS – The degree to which a sound is audible to a listener is termed the loudness. The human ear perceives a 10 dBA noise level increase as a doubling of loudness and a 20 dBA noise increase as a quadrupling of the loudness.

MAXIMUM NOISE LEVEL, L_{Amax} – The rms maximum sound pressure level measured on the "A" scale of a sound level meter during a noise survey is the L_{Amax} noise level. It may be measured using either the Fast or Slow response time of the meter. This should be stated.

NOISE RATING NUMBERS – A set of empirically developed equal loudness curves has been adopted as Australian Standard AS1469-1983. These curves allow the loudness of a noise to be described with a single NR number. The Noise Rating number is that curve which touches the highest level on the measured spectrum of the subject noise. For broadband noise such as fans and engines, the NR number often equals the dBA level minus five.

NOISE – Noise is unwanted sound. Sound is wave motion within matter, be it gaseous, liquid or solid. "Noise includes sound and vibration".

NOISE REDUCTION COEFFICIENT – See: "Sound Absorption Coefficient".

OFFENSIVE NOISE - (Reference: Dictionary of the Protection of the Environment Operations Act 1997). *"Offensive Noise means noise:*

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

PINK NOISE – Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

REVERBERATION TIME, T_{60} – The time in seconds, after a sound signal has ceased, for the sound level inside a room to decay by 60 dB. The first 5 dB decay is often ignored, because of fluctuations that occur while reverberant sound conditions are being established in the room. The decay time for the next 30 dB is measured and the result doubled to determine the T_{60}. The Early Decay Time (EDT) is the slope of the decay curve in the first 10 dB normalised to 60 dB.

SOUND ABSORPTION COEFFICIENT, α – α Sound is absorbed in porous materials by the viscous conversion of sound energy to heat energy as the sound waves pass through it. Sound is similarly absorbed by the flexural bending of internally damped panels. The fraction of incident energy that is absorbed is termed the Sound Absorption Coefficient, α. An absorption coefficient of 0.9 indicates that 90 % of the incident sound energy is absorbed. The average α from 250 to 2000 Hz is termed the Noise Reduction Coefficient (NRC).

SOUND ATTENUATION – If an enclosure is placed around a machine, or a silencer is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 30 dBA, reduces the sound energy by one thousand times.

SOUND EXPOSURE LEVEL (SEL) – The total sound energy of a single noise event condensed into a one second duration or in other words it is an L_{eq} (1 sec).

SOUND PRESSURE LEVEL, L_p – The level of sound measured on a sound level meter and expressed in decibels, dB, dBA, dBC, etc. $L_p = 20 \times \log (P/P_o)$ ... dB

where P is the rms sound pressure in Pascal and P_o is a reference sound pressure of 20 µPa. L_p varies with distance from a noise source.

SOUND POWER LEVEL, L_w – The Sound Power Level of a noise source is an absolute that does not vary with distance or with a different acoustic environment.

$L_w = L_p + 10 \log A$ ... dB, re: 1pW,
where A is the measurement noise-emission area in square metres in a free field.

SOUND TRANSMISSION CLASS (STC) – An internationally standardised method of rating the sound transmission loss of partition walls to indicate the decibels of noise reduction of a human voice from one side to the other. (Refer: Australian Standard AS1276 – 1979)

SOUND TRANSMISSION LOSS – The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS1191 - 2002.

STATISTICAL EXCEEDENCE SOUND LEVELS, L_{A90}, L_{A10}, L_{A1}, etc – Noise which varies in level over a specific period of time (usually 15 minutes) may be quantified in terms of various statistical descriptors:

The L_{A90} is the dBA level exceeded for 90 % of the time. In NSW the L_{A90} is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

The L_{A10} is the dBA level that is exceeded for 10 % of the time. In NSW the L_{A10} measured over a period of 10 to 15 minutes. It was until recently used to describe the average maximum noise level, but has largely been replaced by the L_{Aeq} for describing level-varying noise.

The L_{A1} is the dBA level that is exceeded for 1 % of the time. In NSW the L_{A1} may be used for describing short-term noise levels such as could cause sleep arousal during the night.

STEADY NOISE – Noise, which varies in level by 6 dBA or less, over the period of interest with the time-weighting set to "Fast", is considered to be "steady". (Refer AS 1055.1 1997)

WEIGHTED SOUND REDUCTION INDEX, R_w – This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 to 3,150 Hertz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999).

Internal partition wall $R_w + C$ ratings are frequency weighted to simulate insulation from human voice noise. The $R_w + C$ is always similar in value to the STC rating value. External walls, doors and windows may be $R_w + C_{tr}$ rated to simulate insulation from road traffic noise. This is normally a lower number than the STC rating value.

WHITE NOISE – White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.

Table 4.1 Modifying factor corrections
(See definitions in Section 4.2)

Factor	Assessment/ Measurement	When to apply	Correction[1]	Comments
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: **- 5 dB** or more if the centre frequency of the band containing the tone is above 400 Hz **- 8 dB** or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive - **15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise
Impulsive noise	A-weighted fast response and impulse response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5s
Intermittent noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any 24-hour period	0 to –20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise. *(See Table 4.2)*
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10 dB(A)[2] (excluding duration correction)	

Notes:
1. *Corrections to be added to the measured or predicted levels.*
2. *Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range.*