Pymble Ladies College, Grey house Precinct

Noise Impact Assessment

Pymble Ladies College

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1 INTRODUCTION

This Acoustic Assessment has been undertaken for the proposed new Grey Building Precinct building to be constructed within the Pymble Ladies College campus.

This Noise Impact Assessment has been prepared by Pulse White Noise Acoustics on behalf of Pymble Ladies College and accompanies the submission for the Development Application for the new Grey Building Precinct building.

The Pymble Ladies College, Grey House Precinct project includes the development of a new school facility to be constructed on the exiting school site and will provide a new home for Dance, OSHC (after School Care), Health and Wellbeing, Stem and classrooms for Years 5 and 6. The site will also provide a brand new Early Learning Centre (ELC) catering for 0-5 year olds.

1.1 Relevant Guidelines

Acoustic criteria which have been adopted in this assessment include requirements from the following guidelines or legislative documents:

- NSW EPA *Noise Policy for Industry (NPI) 2017*;
- NSW EPA *Road Noise Policy (RNP) 2011*;
- NSW EPA *Interim Construction Noise Guideline (ICNG) 2009;*
- NSW EPA *Environmental Noise Control Manual (ENCM) 1994;*
- NSW EPA (formerly, Department of Environment and Climate Change) *Assessing Vibration: a technical guideline 2006 (AV-TG)*;
- Australian Standard AS 2670.2 1990 - *Evaluation of Human Exposure to Whole Body Vibration - Part 2: Continuous and Shock Induced Vibration in Buildings (1 Hz to 80 Hz)*
- British Standard BS 6472 - 2008 - *Evaluation of Human Exposure Vibration in Buildings (1 Hz to 80 Hz)*
- Australian & New Zealand Standard AS/NZS 2107:2016 *Acoustics–Recommended design sound levels and reverberation times for building interiors*;
- German DIN 4150: Part 3 – 1999 *"Effects of Vibration on Structure"* (DIN 1999); and
- ASHRAE *"Sound and Vibration Control" 2007.*

1.2 Proposal

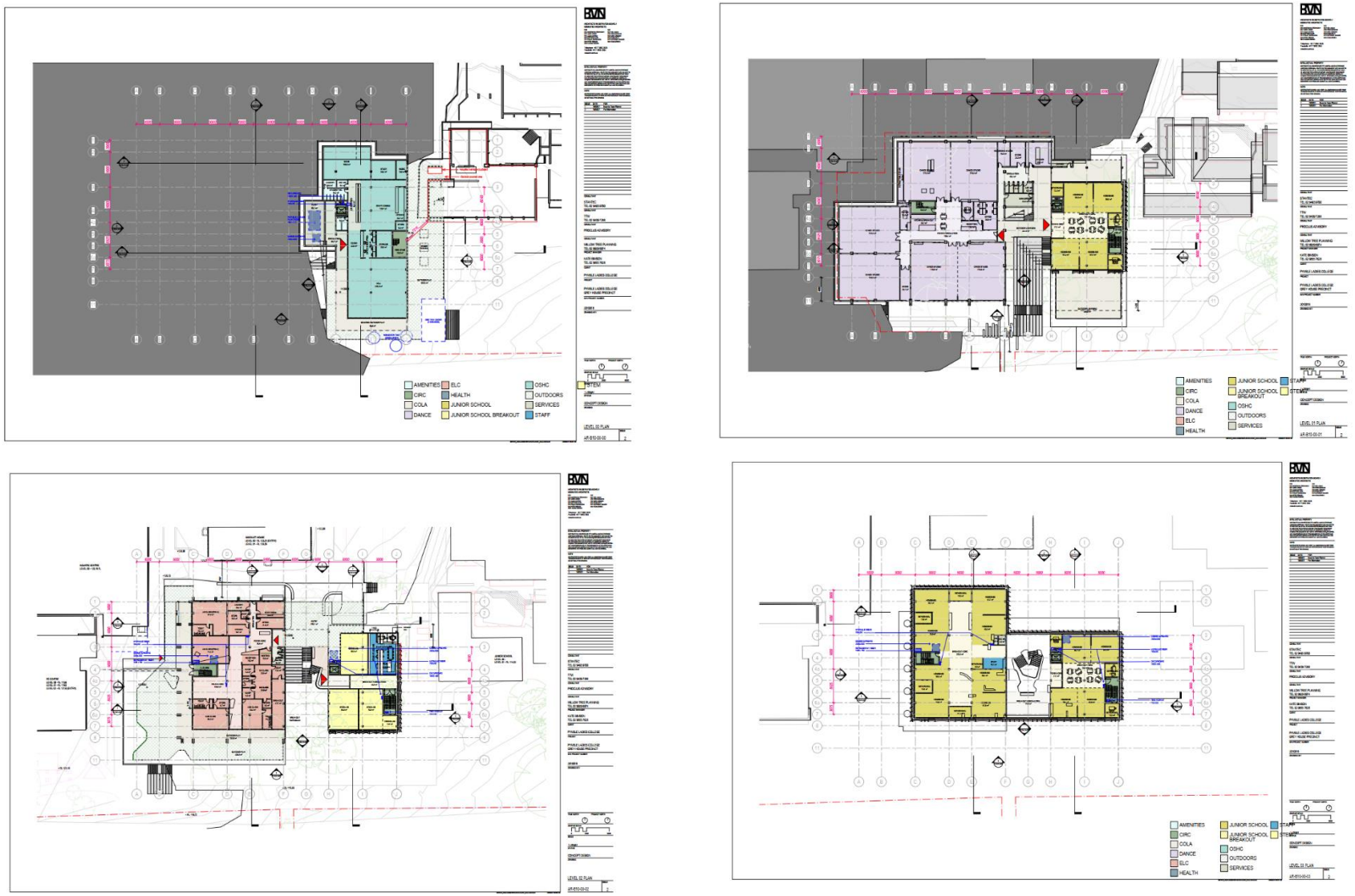
The proposed development is for construction and operation of a new Grey House Precinct building.

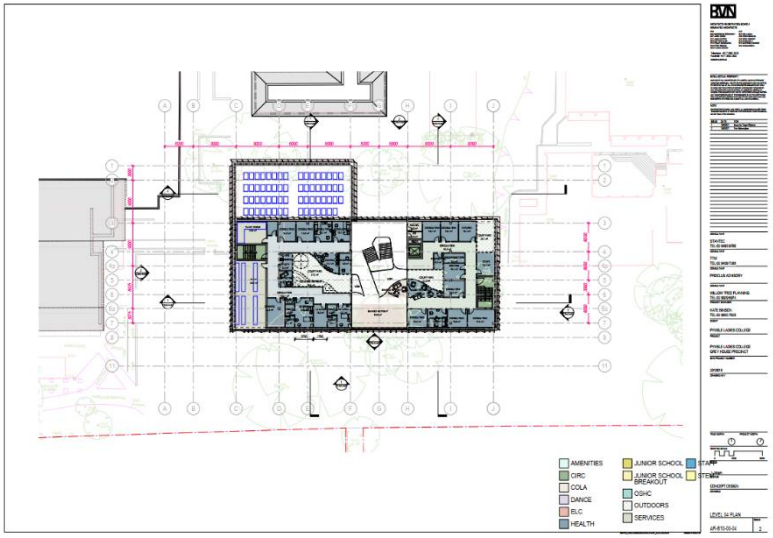
The proposed development will include the following:

- A 4 story building including:
  - A new home for Dance contained internally within the building.
  - OSHC (after School Care).
  - Health and Wellbeing.
  - Stem and classrooms for Years 5 and 6.
  - The site will also provide a brand new Early Learning Centre (ELC) catering for 0-5 year olds.

The proposed building layouts are included in the figures below.

Figure 1 Proposed Building Layouts




AMENITIES
CIRC
COLA
DANCE
ELC
HEALTH
JUNIOR SCHOOL
JUNIOR SCHOOL BREAKOUT
OSHC
OUTDOORS
SERVICES

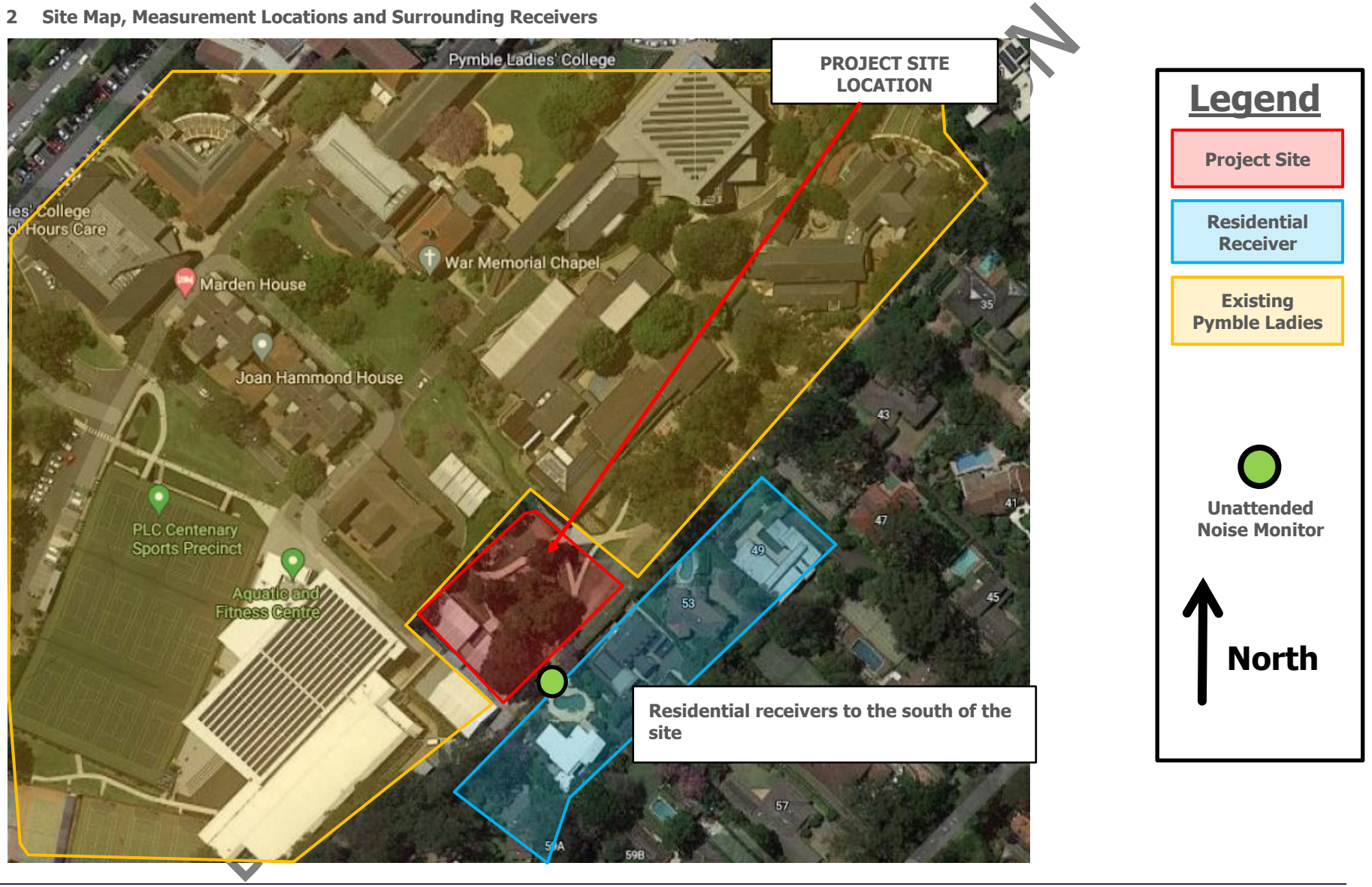
1.3 Site Description

The site is located within the existing Pymble Ladies College grounds including a site location to the south west of the exiting grounds. The site is located within the Ku-ring-gai Council local government area.

The site of the proposed Grey House Precinct includes an areas within the exiting Pymble Ladies College grounds and is bordered by existing residential properties to the south of the site located off Pymble Avenue. All other orientations to the site include exiting Pymble Ladies College buildings and facilities.

The site location, including the location of the neighbouring receivers as well noise measurement locations is included in the figure below.

Figure 2 Site Map, Measurement Locations and Surrounding Receivers



2 ACOUSTIC NOISE SURVEY

As part of the acoustic assessment of the site existing background and ambient noise levels have been surveyed at the site. Details of the on site acoustic surveys are detailed in this section of the report.

2.1 Unattended Noise Monitoring

An unattended noise survey was conducted at the site continuously between the 12th and 26th April, 2021 at a location representative of the residential receivers to the south of the site and detailed Figure 2 above. This survey was conducted to measure the existing background noise levels. All data in the graphs presented in Appendix B have not been corrected (i.e., raw data is presented). Background noise monitoring was undertaken in accordance with the measurement requirements of the Australian Standard AS1055.

Instrumentation for the survey comprised one Rion NL-42 sound level meter (serial number 00409024). Calibration of the logger was checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the measured daily noise data are attached in Appendix B. The charts present each 24-hour period and show the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise levels for the corresponding 15-minute periods. This data has been filtered to remove periods affected by adverse weather conditions based on weather information.

Based on the unattended noise measurements, the results of the survey have been presented below.

2.1.1.1 Results in accordance with the NSW *EPA Noise Policy for Industry (NPI) 2017* (RBL's)

In order to assess the acoustical implications of the development at nearby noise sensitive receivers, the measured background noise data of the logger was processed in accordance with the NSW EPA's *Noise Policy for Industry* (NPI, 2017).

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver. It is the 90th percentile of the daily background noise levels during each assessment period, being day, evening and night. RBL $L_{A90\ (15minute)}$ and L_{Aeq} noise levels are presented in Table 1 below.

Data affected by adverse meteorological conditions and by spurious and uncharacteristic events have been excluded from the results, and also excluded from the data used to determine the noise emission criteria. Meteorological information has been obtained from Sydney Olympic Park (ID 066212) which is the most representative weather station with published results within proximity to the site. Levels presented below are processed results with extraneous weather events removed.

Table 1 Measured Ambient Noise Levels corresponding to the NPI's Assessment Time Periods

Measurement Location	Daytime[1] 7:00 am to 6:00 pm		Evening[1] 6:00 pm to 10:00 pm		Night-time[1] 10:00 pm to 7:00 am	
	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)
Pymble Ladies College, Greys Building See Figure 2.	41	52	37	49	30	46

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{A90} noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Based on analysis of the measured noise levels and onsite observations we note:

- Measured L_{A90} noise levels during the evening and night periods are equal to the recommended minimum noise levels to be adopted by the NSW EPA NPI.
- All measured noise levels are similar to those typically found in a suburban amenity area.

3 NOISE & VIBRATION CRITERIA

All relevant noise and vibration criteria for the project is presented below. It has been separated into four main components: external noise emission criteria, building envelope criteria (façade), vibration criteria and construction noise/ vibration criteria, which are discussed in the following sections.

3.1 External Noise Emission Criteria

The relevant noise emissions for various elements of the project are detailed in the following sections.

3.1.1 NSW EPA Noise Policy for Industry (NPI) 2017

The *Noise Policy for Industry* includes relevant assessment criteria for the limits of noise emissions from the operation of the site including building services and the like.

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The NSW EPA has recently released a document titled *Noise Policy for Industry* (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

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

3.1.1.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

3.1.1.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

Project amenity noise level for industrial developments is specified as the recommended amenity noise level (Table 2.2 of the NPI) minus 5 dB(A). To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Where the resultant project amenity noise level is 10 dB or more lower than the existing traffic noise level, the project amenity noise levels can be set at 15 dB below existing traffic noise levels (i.e. *LAeq,period(traffic) minus 15 dBA*).

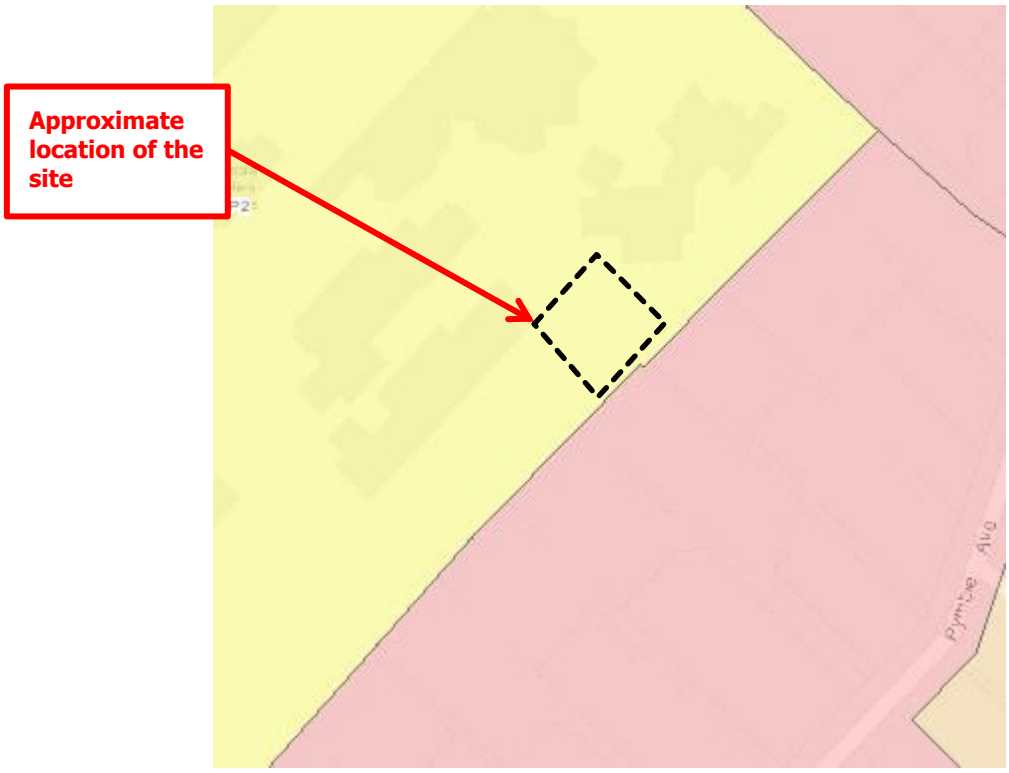
3.1.1.3 Residential Receivers – Area Classification

The NSW NPI characterises the "Suburban Residential" noise environment as an area that has the following characteristics:

- An acoustical environment that:
  - An area that has local traffic with characteristically intermittent traffic flows or with some limited commercial industry.
  - This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.

Error! Reference source not found. is obtained from the NSW ePlanning Spatial Viewer and shows the land zoning m ap of the proposed site and the nearest sensitive receivers.

Figure 3 NSW ePlanning Spatial Viewer



As shown above, the site and its surrounding receivers are within an area made up of R2 (residential). Based on the measured onsite noise levels and the classification of R2, the surrounding residential receivers are defined as suburban residential.

Resultant amenity levels for urban receivers are shown below.

Table 3-1 NSW NPI – Recommended L_{Aeq} Noise Levels from Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2] (dBA)
Residence	Suburban	Day	55
		Evening	45
		Night	40

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound

3.1.1.4 Maximum Noise Level Event (Sleeping Disturbance)

Section 2.5 of the NPI states the following:

> *The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.*
>
> *Where the subject development/premises night-time noise levels at a residential location exceed:*
>
> - *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
> - *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*
>
> *a detailed maximum noise level event assessment should be undertaken.*

As outlined in section **Error! Reference source not found.** above, the measured rating background noise level d uring the night hours (10:00pm to 7:00am) is 30dBAL_{A90}. Therefore, the resultant RBL + 15dB is 45dBA which is below the minimum 52dBA L_{AFmax}. As such the 52dBA will be adopted for this assessment.

3.1.1.5 Project Specific External Noise Emission Criteria

The intrusive, amenity and maximum noise event criteria for noise emissions, derived from the measured data, are presented in Table 3-2. These criteria are nominated for the purpose of determining the operational noise limits for building services associated with the development which can potentially affect noise sensitive receivers including the residence to the south of the site.

For each assessment period, the lower (i.e., the more stringent) of the amenity or intrusive criteria are adopted. These are shown in bold text in Table 3-2.

Table 3-2 External noise level criteria in accordance with the NSW NPI

Receiver Type	Time of Day [1]	Project Amenity Noise Level, $L_{Aeq, period}$ [2] (dBA)	Measured $L_{A90, 15\ min}$ (RBL) [3] (dBA)	Measured $L_{Aeq, period}$ Noise Level [4] (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)
Surrounding Residences	Day	50	41	52	**46**	53
	Evening	45	37	49	**42**	48
	Night	40	30	46	**35**	43

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am.

Note 2: Project Amenity Noise Levels corresponding to "Suburban" areas, equivalent to the Recommended Amenity Noise Levels minus 5 dBA.

Note 3: L_{A90} Background Noise or Rating Background Level.

Note 4: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound

Note 5: According to Section 2.2 of the NSW NPI, the $L_{Aeq, 15\ minutes}$ is equal to the $L_{Aeq, period}$ + 3 dB.

Note 6: Project Noise Trigger Levels are shown in bold.

In addition, a maximum noise level criterion of 52dBA L_{AFmax} during the night period (10:00pm to 7:00am) at residential receivers also applies.

3.1.2 NSW EPA (Formerly DECCW) NSW Road Noise Policy (RNP) 2011

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

3.1.3 School Activity Noise

Noise associated with school activities (i.e., playgrounds, school halls, outdoor learning spaces etc.) is not well addressed in NSW. The Council LEP/DCP and the NSW EPA NPI are not intended for the application of noise associated with these types of areas. School activity noise is also not listed under Schedule 1 of the *Protection of the Environmental Operations Act* (POEO) of 1997.

In the absence of any applicable acoustic criteria related to the activity noise associated with schools we believe in our professional guidance should be sought from the Association of Australasian Acoustical Consultants (AAAC) document *Guideline for Child Care Centre Acoustic Assessment*. The Child Care Centre Guideline was first prepared in 2008 as a guide for AAAC members in conducting assessments of these type of facilities due to the absence of acoustic criteria.

In the current revision of the guideline, the AAAC recommends the following criteria be adopted for residential receivers:

> ***Up to 4 hours (total) per day –*** *If outdoor play is limited to no more than 2 hours in the morning and 2 hours in the afternoon, the contributed Leq, 15minute noise level emitted from the outdoor play shall not exceed the background noise level by more than 10 dB at the assessment location.*

Also, the guideline recommends the following criteria be adopted for other types of surrounding receivers:

> *The cumulative $L_{eq,15min}$ noise level emitted from the use and operation of the childcare centre shall not exceed 65 dB(A), from all activities (including outdoor play), when assessed at the most affected point on or within any commercial property boundary.*
>
> *Where appropriate, assessment should include consideration of noise emission to other sensitive uses including schools, hospitals, places of worship and parks (active and passive). Depending on the requirements of the state or territory where the centre is located, in the absence of applicable noise criteria for such a sensitive use, the cumulative Leq,15min noise level emitted from the use and operation of the child care centre shall not exceed 65 dB(A), from all activities (including outdoor play), when assessed at the most affected point on or within the sensitive property boundary, and shall not exceed 45 dB(A) internally, with windows or doors of the sensitive receiver open.*

A typical structure of a public-school day will include use of the outdoor play areas before school (typically 8:00am to 9:00am), a short break mid-morning (typically 11:00am to 11:30am) and finally an hour in the middle/early afternoon (typically 12:30pm to 1:30pm). This would result in approximately 2.5 hours of outdoor play with a buffer of 1.5 hours for additional activities.

For this assessment, it is proposed that the levels outlined in the AAAC guideline are adopted.

3.2 Noise Intrusion Criteria

Internal noise levels within the proposed building have been assessed in accordance with the recommended internal noise levels included within Table 1 of the AS/NZS 2107:2016 standard.

Recommended internal noise levels within the building as a result of environmental noise levels are included in the following table.

Table 3-3 Recommended Internal Noise Levels (AS2107:2016)

Type of Occupancy/Activity	Design sound level maximum, ($L_{Aeq,t}$)
Common Spaces	45
Breakout/Circulation Space/Retreat/ Well Being	40
ELC Dining/Play area	45
ELC Sleeping Aras	35
STEM Laboratories	40
Casual Eating and Meeting Areas	45
Kitchens/Breakout areas	50
Change Rooms	50
Equipment and Workshops	45
Corridors and Lobbies	45
Administration Offices	40
Teachers and staff common areas	40
Store rooms	50
Dance Studios	35
Interview/ Counselling Rooms/ Physio Room	35
Kitchens	50
Recording Studio	30
Office areas	40

Type of Occupancy/Activity	Design sound level maximum, ($L_{Aeq,t}$)
OSHC Hall	30
Teaching spaces	40
Withdrawal rooms	40
Toilet/change rooms	50
Health Wards	35

Notes: 1. All noise levels are to be free of tonal or annoying characteristics
2. Internal noise levels to include the combined noise from environmental noise intrusion as well as building services operations.
3. Internal noise levels detailed above comply with the requirements of the Green Star Design and As Built v1.2 tool including credit 10.1.

3.2.1 NSW EPA Road Noise Policy (RNP) 2011

External noise impacts also include noise targets for outdoor passive and active areas of a School Playground. Table 4 of the NSW EPA RNP 2011 recommends that a school playground (deemed a passive area) should have traffic noise levels which are below 55dBA$L_{Aeq\ (15hour)}$ when in use.

3.3 Vibration Criteria

3.3.1 NSW EPA (formerly, Department of Environment and Climate Change) *Assessing Vibration: a technical guideline 2006* – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled *"Assessing Vibration – A Technical Guideline"*. (AV-TG). This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources
- Impulsive vibration – up to three instances of sudden impact e.g., dropping heavy items, per monitoring period.
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously.

Table 3-4 Continuous vibration acceleration criteria (m/s²) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Critical areas (Assumed operating theatres, surgical areas or similar)	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences (Assumed ward areas)	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, education institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058

Table 3-5 Impulsive vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Critical areas (Assumed operating theatres, surgical areas or similar)	Day- or night-time	0.0050	0.0036	0.010	0.0072
Residences (Assumed ward areas)	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, education institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Table 3-6 Continuous vibration velocity criteria (mm/s and dB re 10^{-9} m/s) 1 Hz-80 Hz, Z axis

Location	Assessment period	Z axis	
		Preferred Values	Maximum Values
Critical Spaces (Assumed operating theatres, surgical areas or similar)	Day or night-time	0.10 mm/s 100 dB	0.20 mm/s 106 dB
Residences (Assumed ward areas)	Daytime	0.20 mm/s 106 dB	0.40 mm/s 112 dB
	Night-time	0.14 mm/s 103 dB	0.28 mm/s 109 dB
Offices	Day or night-time	0.40 mm/s 112 dB	0.80 mm/s 118 dB
Workshops	Day- or night-time	0.80 mm/s 118 dB	1.6 mm/s 124 dB

Table 3-7 Impulsive vibration velocity criteria (mm/s and dB re 10^{-9} m/s) 1 Hz-80 Hz, Z axis

Location	Assessment period	Z axis	
		Preferred Values	Maximum Values
Critical Spaces (Assumed operating theatres, surgical areas or similar)	Day or night-time	0.10 mm/s 100 dB	0.20 mm/s 106 dB
Residences (Assumed ward areas)	Daytime	6 mm/s 136 dB	12 mm/s 142 dB
	Night-time	2 mm/s 126 dB	4 mm/s 132 dB
Offices	Day or night-time	13 mm/s 142 dB	26 mm/s 148 dB
Workshops	Day- or night-time	13 mm/s 142 dB	26 mm/s 148 dB

Table 3-8 Intermittent vibration impacts criteria (m/s$^{1.75}$) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Critical Spaces (Assumed operating theatres, surgical areas or similar)	0.10	0.20	0.10	0.20
Residences (Assumed ward areas)	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

3.3.2 British Standard BS 7385: Part 2-1993 AND German DIN 4150: Part 3 – 1999 – Building Damage

It is expected that the human comfort criteria discussed in Section 3.3.1 will be more stringent than that corresponding to building damage.

Therefore, it is our opinion that a vibration assessment for building damage from light rail activity is not relevant to our investigations since compliance with the human comfort criteria will also achieve compliance with building damage criteria.

Table 3-9 Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note 1: For frequencies above 100Hz, at least the values specified in this column shall be applied.

3.4 Construction Noise & Vibration Criteria

This section of the report details the relevant construction noise and vibration criteria for activities undertaken during the construction of the proposed development.

3.4.1 Construction Noise Criteria

Relevant construction noise criteria applicable to this project are outlined below.

3.4.1.1 NSW EPA (Former DECC) Interim Construction Noise Guideline (ICNG) 2009

Noise criteria for construction and demolition activities are discussed in the *Interim Construction Noise Guideline* (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works;
- Focus on applying all "feasible" and "reasonable" work practices to minimise construction noise impacts;
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours;
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage; and
- Provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for residential receivers have been reproduced from the guideline and are listed in the table below.

Table 3-10 NMLs for quantitative assessment at residences

Time of Day	Noise Management Level $L_{Aeq(15minute)}$ [1,2]	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq(15minute) 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.
Outside the recommended standard hours above	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should notify the community.

Note 1 Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA 2000).

Construction noise levels at other noise receivers are outlined below:

- Construction noise levels within classrooms other educational institutions is not to exceed 45dBA $L_{Aeq,15minute}$, when measured internally.
- Construction noise levels at offices and retail outlets are not to exceed 70dBA LAeq,15minute, when measured externally.

Based on the measured background noise levels summarised in section 2.1, and the NMLs outlined above, the construction noise criteria to be used in this assessment are listed in Table 3-11.

Table 3-11 NMLs as basis for the acoustic assessment

Receiver Types	NML, dB $L_{Aeq(15minute)}$	
	Standard Hours **Monday to Friday: 7:00am to 6:00pm** **Saturday: 8:00am to 1:00pm**	**Outside Standard Hours** **All hours not listed in the adjacent column.**
Residences (Measured externally)	**NAFL:** (RBL (41) + 10dB) = **51** **HNAL** **75**	RBL + 5dB

3.4.2 Construction Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself.

3.4.2.1 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from AV-TG. This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources.
- Impulsive vibration – up to three instances of sudden impact e.g., dropping heavy items, per monitoring period.
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously.

Table 3-12 Continuous vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.0050	0.010	0.10	0.20
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 3-13 Impulsive vibration acceleration criteria (m/s^2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or night-time	0.0050	0.010	0.10	0.20
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 3-14 Intermittent vibration impacts criteria (m/s$^{1.75}$) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Critical working areas (e.g. hospital operating theatres, precision laboratories)	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

3.4.2.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration"* (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 *"Effects of Vibration on Structure"* (DIN 1999).

3.4.2.3 Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 3-15 and illustrated in **Error! Reference source not found.**.

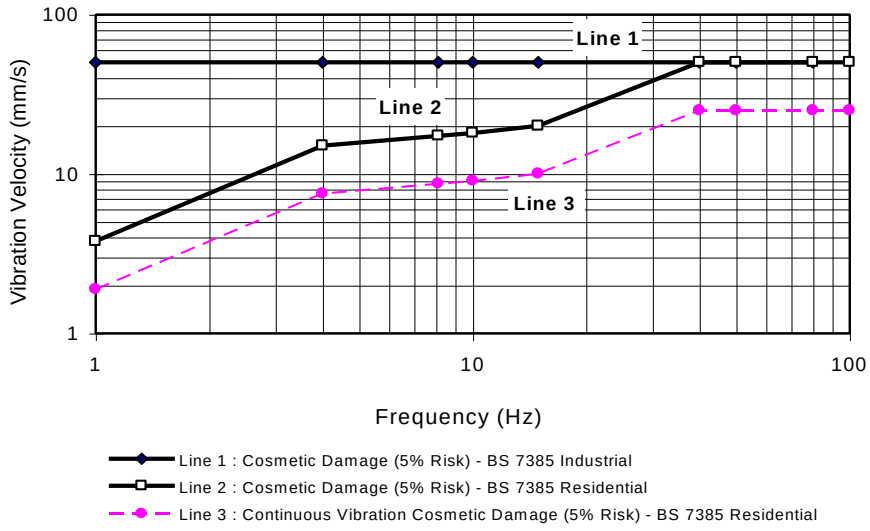
Table 3-15 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Error! Reference source not found.	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	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

Standard BS 7385 Part 2 – 1993 states that the values in Table 3-15 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such that it results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 3-15 may need to be reduced by up to 50% (refer to Line 3 in **Error! Reference source not found.**).

Figure 4 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 3-15, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless the calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 3-15 should not be reduced for fatigue considerations.

3.4.2.4 Standard DIN 4150 Part 3 - 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in Table 3-16. The criteria are frequency dependent and specific to particular categories of structures.

Table 3-16 Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note 1: For frequencies above 100Hz, at least the values specified in this column shall be applied.

3.4.3 Construction Traffic Noise Criteria

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW *Road Noise Policy (RNP)* states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

The management of construction traffic accessing the site during the construction of the project will be undertaken in accordance with a *Construction Management Plan* which will be developed once a building contractor has been appointed.

4 EXTERNAL NOISE INTRUSION ASSESSMENT

This section of the report details the assessment of environmental noise intrusion into the proposed development.

4.1 Façade Acoustic Treatments

Preliminary façade acoustic treatments based on the external levels from surrounding roads and other commercial operations as discussed in section 2.1 above are provided below.

4.1.1 Glazing Recommendations

The recommended sound transmission loss requirement required to satisfy the specified internal noise level criteria outlined above are summarised in

Table 4-1 below.

Please note these recommendations are also based on the floor details shown in the architectural drawings of the project.

Please note for windows, this performance is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Therefore, it is recommended that the window manufacturer should confirm that the required sound insulation can be achieved. It is anticipated that the window system should comprise Q-Lon (or equivalent) or fin seals with deep C channels as part of the window track (i.e., Performance levels outlined above need to be achieved with glazed panels + frame + seals).

Table 4-1 In-principle Glazing Recommendations.

Building Level	Façade Orientation	Occupancy Area [1]	Minimum Glazing System Rating Requirements [1]	Indicative Construction [1]
All Levels	All façade orientation	Dance Studios	Rw (C;Ctr): 35 (-0;-3)	10.38mm laminated glass.[3]
		Teaching Areas	Rw (C;Ctr): 30 (-0;-3)	6.38mm laminated glass.
		Labs	Rw (C;Ctr): 30 (-0;-3)	6.38mm laminated glass.
		Consulting Areas	Rw (C;Ctr): 30 (-0;-3)	6.38mm laminated glass.

Note 1: These are preliminary selections will be confirmed in the detailed design stage once the layouts and façade orientations are finalised.

Note 2: Glazing recommendations have been formulated in conjunction with noise emission control mitigation measures.

Note 3: The section of glass for the dance studios includes requirements for the emissions of noise from the areas and included in the following sections of this report.

4.1.2 External Wall Construction

External wall constructions which are constructed from a concrete or masonry construction will be acoustically sufficient and no further acoustic upgrading is required. However, for wall systems constructed from a lightweight cladding system, the following construction is recommended.

Table 4-2 Recommended Light Weight External Wall Construction

Location	Façade Orientation	External Lining	Studwork System	Internal Lining
Dance Studios	All Orientations	Minimum 4mm Aluminium Composite Panel (similar to Alucobond®)	Min. 92mm Steel Studwork with 75mm thick 14kg/m^3 glasswool insulation in the cavity	1 x 13mm Fyrchek Plasterboard **OR** 1 x 9mm Fibre Cement Sheeting
All other Facades				1 x 13mm Standard Plasterboard **OR** 1 x 6mm Fibre Cement Sheeting

Note 1: Recommended constructions are identical for each level.
Note 2: These are preliminary selections will be confirmed in the detailed design stage once the layouts and façade orientations are finalised.
Note 3: Alternate constructions are suitable on assumption equal acoustic performance is achieved.

If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

4.1.3 External Roof Construction

External roofs will be constructed from a lightweight sheet metal cladding. It is recommended the following minimum construction is installed.

Table 4-3 Recommended Light Weight Roof Construction

Occupancy Area	External Lining	Ceiling Constructions	Internal Lining
All Spaces	Sheet metal (similar to colorbond®)	Ceining cavity to include an insulation similar to a 50mm thick, 14kg/m^3 insulation	1 x 13mm Fyrchek Plasterboard or mineral fibre tile ceilings.

Note 1: These are preliminary selections will be confirmed in the detailed design stage once the layouts and façade orientations are finalised.
Note 3: Alternate constructions are suitable on assumption equal acoustic performance is achieved.
Note 4: Recommendations have been formulated in conjunction with noise emission control mitigation measures.

If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

4.2 External Noise Levels within Play Areas

As outlined in section 3.2.1 above, the NSW EPA RNP recommends open passive open spaces to have a 55dBA $L_{Aeq(15\text{-}hour)}$ noise level exposure.

Measured onsite noise levels indicate compliance with the 55dBA objective will be achieved without the need for acoustic screens to control noise within external play areas.

5 OPERATIONAL NOISE EMISSION ASSESSMENT

Assessment of the potential noise emissions from the operation of the proposed Pymble Ladies College, Grey House Precinct project impacts on the adjacent land users are outlined below. Noise emissions expected from the operation of the building are mainly from any base building services (mechanical, electrical, hydraulic) and activity noise. Each major component is discussed in detail below.

5.1 Noise from Engineering Services

At this stage of the project, the following information is known regarding the mechanical conditioning/ventilation strategies:

- Locations of external plant areas are known and are provided on the architectural drawings.
- Indicatively, types and number of units are known.
- Exact selections and their associated noise level are not known at this stage.

As such, a detailed acoustic review cannot be undertaken at this stage. However, to ensure that proposed locations of external plant items are capable of being acoustically compliant with the noise objectives outlined in section 3.1 a proof-of-concept assessment is undertaken below based off our experience on similar projects.

In our experience, for this type of development the following mechanical systems would be installed, and their associated sound power levels are outlined below.

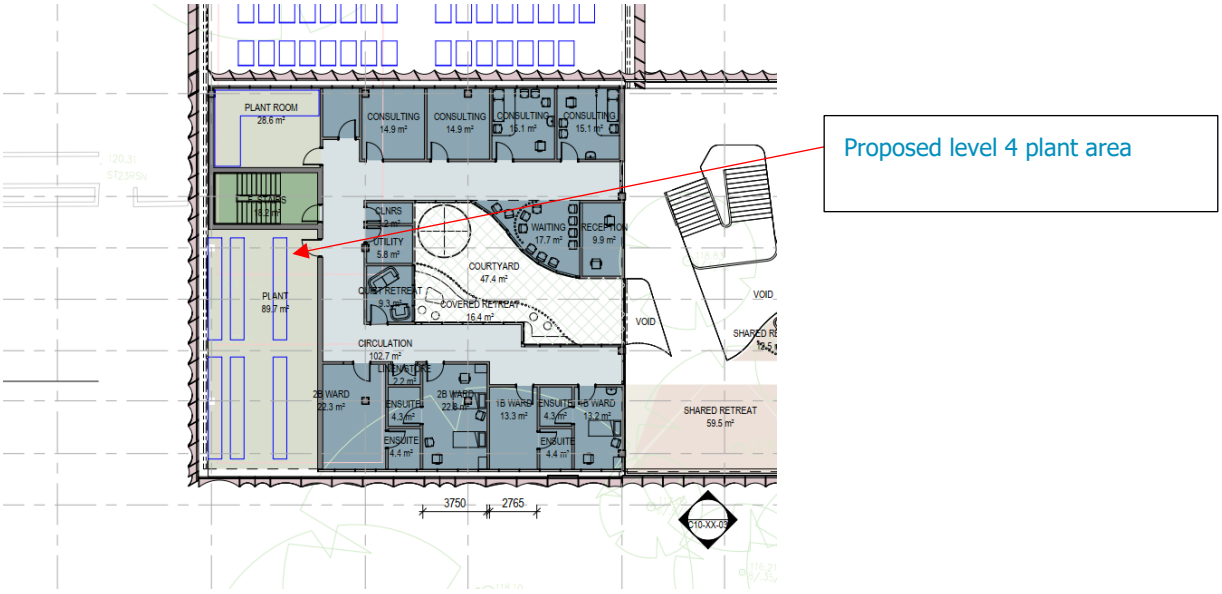
- Kitchen Exhaust Fan (KEF) - Canteen – 75dBA (Lw) per unit.
- Air Conditioning Equipment – 70dBA (Lw) per unit.
- Toilet Exhaust Fans (TEF) – Bathrooms – 55dBA (Lw)

It is anticipated that the building will include mechanical plant and equipment which service the building including roof top fans the like. Based on the assessment of expected equipment to achieve compliance at neighbouring residential receivers acoustic treatment to a equipment will be required. As such we would recommend the consideration of any of the following acoustic treatments (subject to final selection).

- Vibration isolation of the fan from the base building structure utilising a correctly sized isolation mount.
- Variable Speed Drive's (VSD) are recommended to the installed.
- In the event the final selection is an inline fan, internally line ductwork or attenuators are recommended; or
- In the case the fan is a roof mounted system an acoustic screen may be required around the unit to shield noise to adjacent properties.

Regarding Air Conditioning condensers, there is a dedicated roof plant area as shown in **Error! Reference source not found.** below. From our review of the proposed location and likely number of units, our recommended acoustic treatments are also provided below.

Figure 5 Proposed Mechanical Plant Areas



- All plant are to be isolated from the base building structure with a rubber pad.
- Night operation mode must be in operation between 6:00pm and 7:00am and provide a minimum of 4-5dBA.
- Internally lined ductwork/bends or silencers may be required for the discharge side of all equipment.
- Screening to equipment within the plantroom, including blanking off of inactive louver areas may be required.

For toilet exhaust fans exhausting air from bathrooms will be required to have the following:

- Ventilation plant are to be isolated from the base building structure with a rubber pad.
- Internally lined ductwork on the discharge side of the fan.

Details of the acoustic treatment of plant and equipment will be provided during the normal detailed design of the project once plant selections have been finalised. Details of the required acoustic treatments will be provided as part of the CC of the project.

5.2 Vehicle Movements

Vehicle movements in and out of the Pymble Ladies College includes those from the existing drive way accessing the school off Avon Road. There will be no proposed vehicle access to the proposed Grey House Precinct building as part of the normal operation of the development.

Based on the proposed operation of the project there will not be any resulting noise impact on surrounding receivers resulting from viceless movements accessing the site.

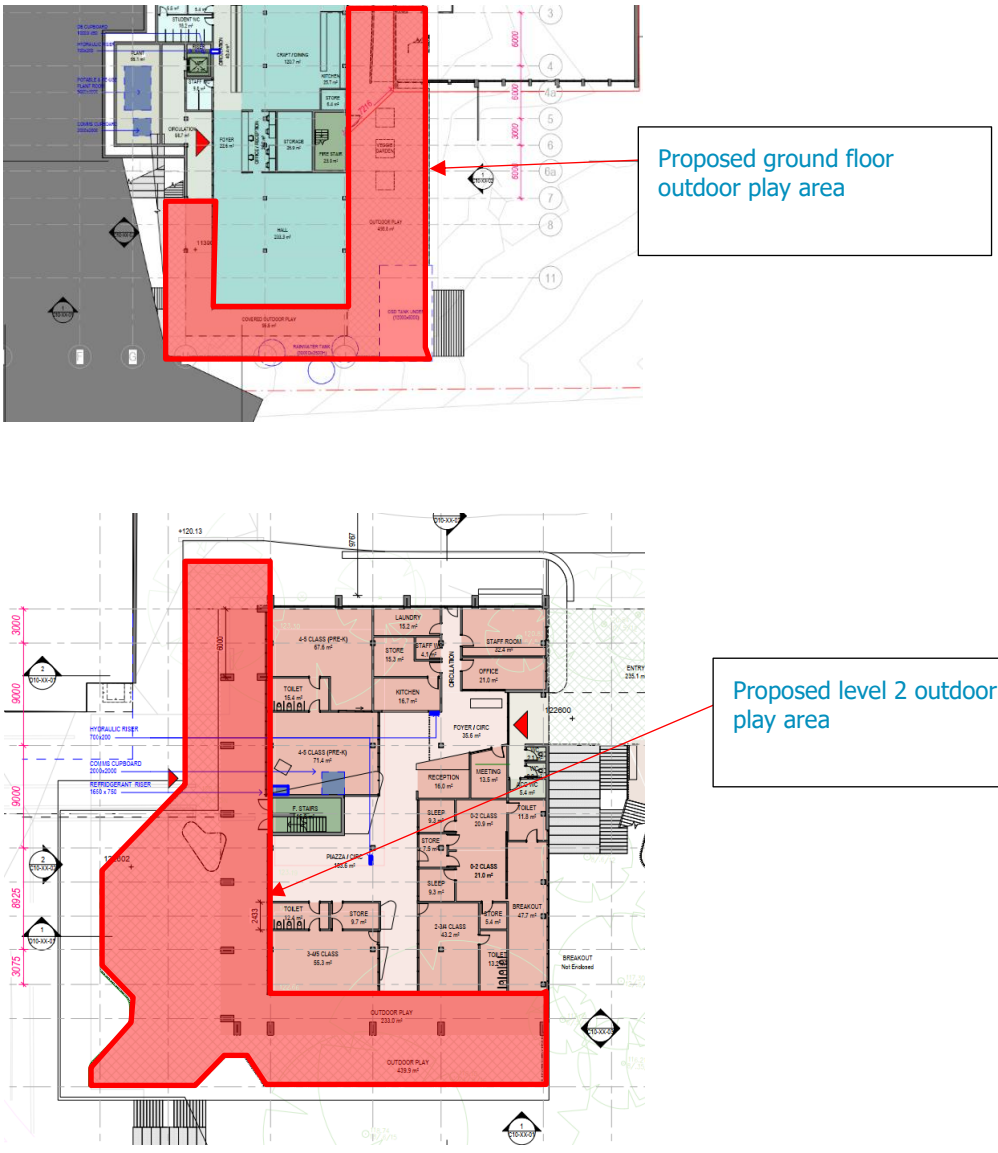
5.3 Activity Noise

Noise levels associated with the operation of the proposed Grey House Precinct are outlined below. It has been separated into four sections: outdoor play areas, internal areas classrooms, hall and proposed dance studios; see below.

5.3.1 Noise from Outdoor Play Areas

Assessment of the use of the proposed external outdoor play areas is detailed below. The proposed project will include use of the external play areas by students during a recess or lunch period is detailed below. Regarding the modelling of student's coverage across the site, Figure 6 below indicates the area used in the modelling.

Figure 6 Proposed Outdoor Play Aras



Noise levels of students playing in outdoor areas which have been adopted in this assessment are provided below. These are determined based on PWNA professional experience and noise measurements undertaken at other school playgrounds during break periods (i.e., recess/lunch) for other School projects.

Table 5-1 Sound power levels for outdoor play activities

Parameter	Octave Band Centre Frequency, Hz								Overall dBA
	63	125	250	500	1000	2000	4000	8000	
Active Sports Play	85	95	100	104	107	104	98	96	**110**
Passive Play	79	89	94	98	101	98	92	90	**104**

Based on the assumptions outlined above, predicted noise levels during outdoor play times are presented below. The predicted noise levels include the assumption that the play areas are being used simultaneously and that the recommendations included in this report are included in the design and operation of the project.

Table 5-2 Predicted Outdoor Play Noise Levels – $L_{Aeq(15\text{-}minute)}$

Receiver Location	Predicted Maximum Noise Level dBA $L_{Aeq\ (15\text{-}minute)}$	Criteria dBA $L_{Aeq\ (15\text{-}minute)}$	Compliance?
Residential receivers to the south of the site	54	Day: 51 Based on AAAC criteria for play	No, see discussion below.

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am.

Note 2: The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

See discussion below.

Predicted noise levels during periods of the day when the outdoor play areas are being used simultaneously are likely to exceed the formulated noise objectives. A review of the modelling undertaken has indicated that the exceedances arise due to several site constraints:

- The location of the residence to the south of the site with a distance separation including the proposed landscaping areas to the south of the building.
- Secondly, due to the site's topography, number of floors at receiver locations and the limited availability of acoustic shielding mitigate noise levels from children playing on the ground floor.
- Screening of the level 2 external play area will be acoustically effective and includes the recommended built controls included in this section of the report.
- As part of the existing operation of the school la number of external dance practice events (including amplified music) are conducted externally on the proposed site. As part of the proposed development the proposed dance will be provided for within the dance studios within the building structure and will include acoustic mitigation to the residential receivers.

  As part of the proposed development noise impacting resulting from the currently conducted external dance events will be mitigated to the residential receivers to the south of the site.

In addressing the exceedances and constraints identified above, a review of the possible reasonable and feasible mitigation measures has been undertaken.

- The use of the outdoor play areas is not proposed to be used by the public community unlike some other schools in which community sport can be undertaken on weekends. Additionally, use of the play areas will only operate at maximum capacity during recess and lunch times. All other times of the days the spaces will be used a very limited capacity.

  The resulting noise levels from the use of the external play areas will be limited to short periods of daytime hours.

- It is recommended to include a solid barrier to the perimeter of the level 2 external play area. The screen should include a solid material such as glass or the like with a height of no less than 1.5m above the floor of level 2.

Additionally, we do note that in an NSW Land and Environment Court (LEC) proceeding on the 22nd October 2009, the court noted *"All noise that emanates from the normal activities at a school is not offensive"*.

Based on the details include in the section above the resulting noise impact resulting from the use of the proposed external play areas will not result in an unacceptable or offensive noise levels on the residential receivers to the south of the site and is therefore considered to be acceptable.

5.3.2 Noise from Internal Areas (Classrooms and Early Learning Aras)

In the assessment of noise from the homebases and associated teaching areas including early learning areas has been conducted on the assumption of a highly noise activity being undertaken with a sound pressure level within the internal rooms of up to 75 dB(A) sound pressure level and windows open for natural ventilation purposes which would be considered a worst-case scenario. Predicted noise levels at surrounding receivers is provided below.

Table 5-3 Predicted Noise Levels From Internal Teaching Areas – $L_{Aeq(15\text{-}minute)}$

Receiver Location	Predicted Noise Level dBA $L_{Aeq\ (15\text{-}minute)}$	Criteria dBA $L_{Aeq\ (15\text{-}minute)}$	Compliance?
Residence to the south of the site	37	Day: 46 (*NPfI)*	Yes

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am.

Note 2: The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Based on the assessment of noise impacts from the proposed teaching areas within the project noise emissions will comply with the relevant noise emissions criteria.

5.3.3 Noise from Internal Areas (Dance Studios)

In the assessment of noise from the proposed dance studios located on the first floor of the project an assessment of noise emissions from the use of these areas has been conducted. The assessment of noise emissions from the dance studios has been undertaken based on the inclusions of the recommended building treatments and management controls including the following:

1. Internal noise levels within the dance studions will include shouting and the playing of amplified music with an expected internal noise levels of 100 dB(A) L_{Aeq} Sound Pressure Level.

2. External glass to the dance studios to include a minimum of 10.38mm laminated glass with a minimum acoustic performance of Rw 35.

3. During periods when the dance studios are being used for high noise generating events such as the playing of amplified music the external façade elements are to be closed.

Based on the assumptions detailed above the predicted noise levels at surrounding receivers is provided below.

Table 5-4 Predicted Dance Studio Noise Emission Levels – $L_{Aeq(15\text{-}minute)}$

Receiver Location	Predicted Noise Level dBA $L_{Aeq\ (15\text{-}minute)}$	Criteria dBA $L_{Aeq\ (15\text{-}minute)}$	Compliance?
Residence to the south of the site	41	Day: 46 (*NPfI)*	Yes

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am.

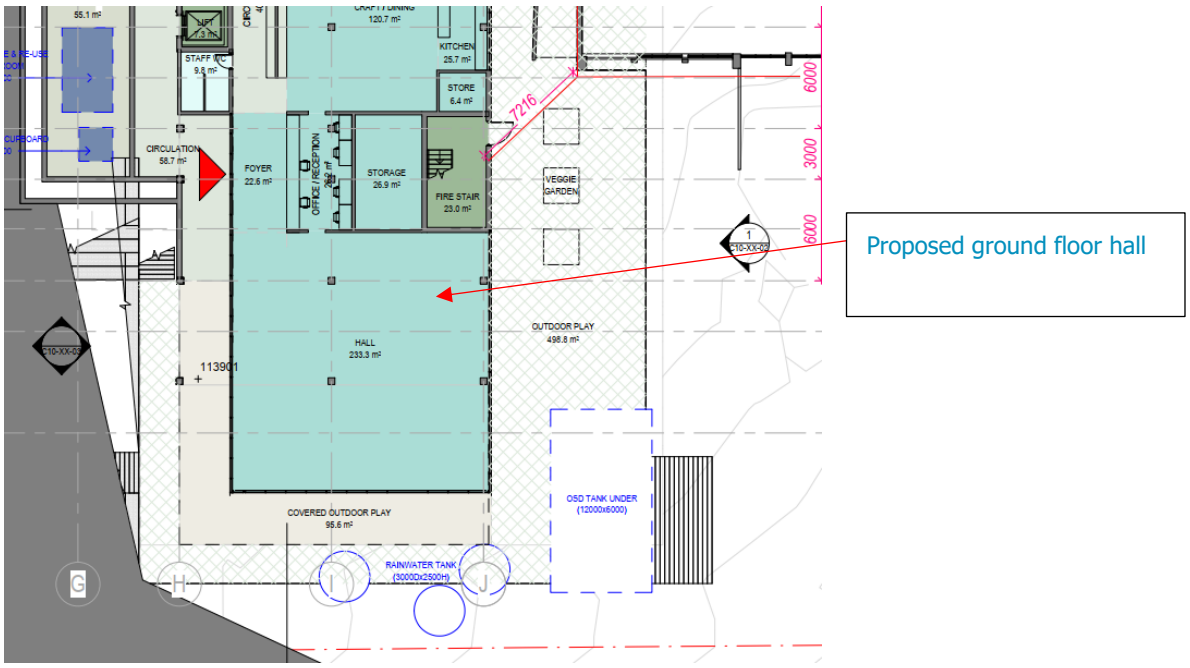
Note 2: The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Based on the assessment of noise impacts from the proposed use of the dance studios within the project noise emissions will comply with the relevant noise emissions criteria.

5.3.4 Noise from Ground Floor Hall

The proposed development includes a hall to be located on the ground floor, as detailed in the figure below.

Figure 7 Proposed Ground Floor Hall



The proposed hall is to be used for regular school activities during typical school hours as well as regular use of the hall for out of school hours activities. As such an assessment of the hall is undertaken for both during daytime representing use by the Pymble Ladies College including evening time periods representing use outside of school hours. For both assessments amplified speech and music will be assessed. Regarding internal noise levels the following is assumed:

- Sound pressure level within the hall during amplified music or speech is 90dBA.
- During events which create these type of noise levels, all windows and doors will be required to remain closed and is reflected in the modelling below.
- All external openings are to be closed when the hall is in use after 7pm.
- Building fabric constructions are as per those presented in section 4.1, noting an upgrade façade construction has been recommended including minimum 6.38mm laminated glass with an acoustic performance of Rw 30.

Predicted noise levels from the day and evening time use of the community hall is presented below.

Table 5-5 Predicted Community Hall Noise Levels – $L_{Aeq(15\text{-}minute)}$

Receiver Location	Predicted Noise Level dBA $L_{Aeq\ (15\text{-}minute)}$	Criteria dBA $L_{Aeq\ (15\text{-}minute)}$	Compliance?
Residential receiver to the south of the site.	37	Day: 46(*NPfI)* Evening: 42 (*NPfI)*	Yes

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 1:00 am.

Note 2: The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Based on the assessment undertaken on the potential use of the ground floor hall will be acoustically acceptable based on the proposed acoustic treatments and controls included in this report.

5.4 Public Address Systems

The location and design of any Public Address/Bell system has not been undertaken at this stage, however, will be required from an operation perspective. As such we provide the following acoustic design advice which is recommended to be incorporated during the design phase:

- Noise levels at surrounding residents should not exceed the RBL + 10dBA criteria established above. This would equate to the following sound pressure level @ 5m:
    - To the southern external areas are the building: 59 dB(A) @ 5m
    - To the eastern and western external areas are the building: 61 dB(A) @ 5m
    - Other areas of the building externally: 67 dB(A) @ 5m
- As a design principle, to minimise noise spill on surrounding receivers, more speakers operating a lower noise level is an effective way of controlling noise spill.
- Directional speakers located in the correct locations angled away from the residential residence to the south of the project will also reduce noise spill.

6 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

A preliminary acoustic assessment of the noise and vibrations impact during the construction of the proposed development has been undertaken below.

6.1 Construction Activities Sound Power Levels (Lw)

Sound power levels have been predicted for the construction tasks identified in the project program. The equipment anticipated for use in each task is based on previous project experience. The sound power levels for the equipment likely to be used for each of the listed tasks are provided in Table 6-1 below.

Table 6-1 Summary of predicted sound power levels

Tasks	Equipment	Sound Power Levels (dBA re 1pW)	Aggregate Sound Power Level per Task (dBA re 1pW)
Site Establishment Works	Mobile crane	110	113
	Power hand tools	109	
	Semi Rigid Vehicle [1]	105	
Ground Works and Demolition	Excavator	112	119
	Hand held jack hammer [1]	111	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Skid steer	110	
	Power hand tools	109	
Structure	Hand held jack hammer [1]	106	117
	Concrete saw [1]	114	
	Power hand tools	109	
	Welder	101	
	Concrete pump truck	110	
	Concrete agitator truck	108	
Internal Works	Power hand tools	109	109
Common and External Works	Concrete agitator truck	108	117
	Saw cutter [1]	104	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Power hand tools	109	

Note 1: An assumed time correction has been applied, this being 5 minutes of operation in any 15-minute interval.

6.2 Predicted Construction Noise Levels

Predicted construction noise levels are presented below for each of the surrounding receivers in accordance with the NSW EPA ICNG.

Table 6-2 Receiver 1 – Summary of preliminary predicted construction noise levels – Residential Receivers to the south of the site

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	54 to 72	57 to 76	**Monday to Friday** 07.00-18.00 41 + 10 = 51 **Saturday** 08.00-13.00 41 + 10 = 51 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to have the potential to exceed the internal noise management level when working near a receiver. Management of construction noise including community engagement it required as detailed in this section of the report
	Power hand tools		53 to 71			
	Semi Rigid Vehicle		49 to 68			
Ground Works and Demolition	Excavator	119	56 to 74	62 to 81		
	Handheld jack hammer		50 to 69			
	Dump truck		48 to 67			
	Concrete saw		58 to 77			
	Skid steer		54 to 72			
	Power hand tools		53 to 71			
Structure	Handheld jack hammer	117	50 to 69	62 to 80		
	Concrete saw		58 to 77			
	Power hand tools		53 to 71			
	Welder		45 to 63			
	Concrete pump truck		54 to 72			
	Concrete agitator truck		52 to 70			
Internal Works	Power hand tools	109	53 to 71	53 to 71		
Common and External Works	Concrete agitator truck	117	52 to 70	61 to 79		
	Saw cutter		48 to 67			
	Dump truck		48 to 67			
	Concrete saw		58 to 77			
	Power hand tools		53 to 71			

6.3 Construction Traffic Noise Assessment

Construction traffic required to access the site as part of the works to be undertaken on the site will be management in accordance with a *Construction Management Plan* which will be developed once a building contractor has been appointed.

6.4 Vibration Assessment

In order to maintain compliance with the human comfort vibration criteria discussed in Section 3.4.2, it is recommended that the indicative safe distances listed in Table 6-3 should be maintained. These indicative safe distances should be validated prior to the start of construction works by undertaking measurements of vibration levels generated by construction and demolition equipment to be used on site.

Since the criteria for scientific or medical equipment (should any of these exist close to the site) can be more stringent than those required for human comfort, vibration validating measurements should be conducted at each site to determine the vibration level and potential impact onto this sensitive equipment.

Additionally, any vibration levels should be assessed in accordance with the criteria discussed in Section 3.4.2. This information should also be included as part of a *Construction Noise Vibration Management Plan* (CNVMP) to be developed by the building contractor once appointed.

Table 6-3 Recommended indicative safe working distances for vibration intensive Plant

Plant	Rating / Description	Safe Working Distances (m)	
		Cosmetic Damage (BS 7385: Part 2 DIN 4150: Part 3)	Human Comfort (AVTG)
Vibratory roller	< 50 kN (Typically 1 – 2 tonnes)	5	15 – 20
	< 100 kN (Typically 2 – 4 tonnes)	6	20
	< 200 kN (Typically 4 – 6 tonnes)	12	40
	< 300 kN (Typically 7 – 13 tonnes)	15	100
	> 300 kN (Typically more than 13 tonnes)	20	100
Small hydraulic hammer	300 kg, typically 5 – 12 tonnes excavator	2	7
Medium hydraulic hammer	900 kg, typically 12 – 18 tonnes excavator	7	23
Large hydraulic hammer	1600 kg, typically 18 – 34 tonnes excavator	22	73
Vibratory pile driver	Sheet piles	2 – 20	20
Jackhammer	Hand held	1	Avoid contact with structure and steel reinforcements

6.5 Acoustic Management Procedures

6.5.1 Summary of Management Procedures

Table 6-4 below summarises the management procedures recommended for airborne noise and vibration impact. These procedures are also further discussed in the report.

Table 6-4 Summary of mitigation procedures

Procedure	Abbreviation	Description
General Management Measures	GMM	Introduce best-practice general mitigation measures in the workplace which are aimed at reducing the acoustic impact onto the nearest affected receivers.
Project Notification	PN	Issue project updates to stakeholders, discussing overviews of current and upcoming works. Advanced warning of potential disruptions can be included. Content and length to be determined on a project-by-project basis.
Verification Monitoring	V	Monitoring to comprise attended or unattended acoustic surveys. The purpose of the monitoring is to confirm measured levels are consistent with the predictions in the acoustic assessment, and to verify that the mitigation procedures are appropriate for the affected receivers. If the measured levels are higher than those predicted, then the measures will need to be reviewed and the management plan will need to be amended.
Complaints Management System	CMS	Implement a management system which includes procedures for receiving and addressing complaints from affected stakeholders
Specific Notification	SN	Individual letters or phone calls to notify stakeholders that noise levels are likely to exceed noise objectives. Alternatively, contractor could visit stakeholders individually in order to brief them in regards to the noise impact and the mitigation measures that will be implemented.
Respite Offer	RO	Offer provided to stakeholders subjected to an ongoing impact. The offer could include movie tickets, meal vouchers, gift cards or equivalent measures.
Alternative Construction Methodology	AC	Contractor to consider alternative construction options that achieve compliance with relevant criteria. Alternative option to be determined on a case-by-case basis. It is recommended that the selection of the alternative option should also be determined by considering the assessment of on-site measurements (refer to Verification Monitoring above).

The application of these procedures is in relation to the exceedances over the relevant criteria. For airborne noise, the criteria are based on NMLs. The allocation of these procedures is discussed in Section 6.5.2

For vibration, the criteria either correspond to human comfort, building damage or scientific and medical equipment. The application of these procedures is discussed in Section 6.5.3.

6.5.2 Allocation of Noise Management Procedures

For residences, the management procedures have been allocated based on noise level exceedances at the affected properties, which occur over the designated NMLs (refer to Section 3.4.1 for list of NMLs used in the acoustic assessment). The allocation of these procedures is summarised in Table 6-5 below.

Table 6-5 Allocation of noise management procedures – residential receivers

Construction Hours	Exceedance over NML (dB)	Management Procedures (see definition above)
Standard Hours Mon – Fri: 7:00 am to 6:00 pm Sat: 8:00 am – 1:00 pm	0 - 3	GMM
	4 - 10	GMM, PN, V [1], CMS, AC
	> 10	GMM, PN, V, CMS, SN, AC
Outside Standard Hours Sat: 1:00 pm – 5:00 pm	0 - 10	GMM, AC
	11 - 20	GMM, PN, V [1], CMS, AC
	> 20	GMM, PN, V, CMS, SN, RO, AC

Notes
1. Verification monitoring to be undertaken upon complaints received from affected receivers

6.5.3 Allocation of Vibration Management Procedures

Table 6-6 below summarises the vibration management procedures to be adopted based on exceedance scenarios (i.e., whether the exceedance occurs over human comfort criteria, building damage criteria, or criteria for scientific and medical equipment). Please note these management procedures apply for any type of affected receiver (i.e., for residences as well as non-residential receivers).

Table 6-6 Allocation of vibration management procedures

Construction Hours	Exceedance Scenario	Management Procedures
Standard Hours Mon – Fri: 7:00 am to 6:00 pm Sat: 8:00 am – 1:00 pm	Over human comfort criteria (refer to Section 0)	GMM, PN, V, RO
	Over building damage criteria (refer to Section 0)	GMM, V, AC
Outside Standard Hours Sat: 1:00 pm – 5:00 pm	Over human comfort criteria (refer to Section 0)	GMM, SN, V, RO, CMS
	Over building damage criteria (refer to Section 0)	GMM, V, AC

6.6 Site Specific Noise Mitigation Measures

6.6.1 General Comments

The contractor will, where reasonable and feasible, apply best practice noise mitigation measures. These measures shall include the following:

- Maximising the offset distance between plant items and nearby noise sensitive receivers.
- Preventing noisy plant working simultaneously and adjacent to sensitive receivers.
- Minimising consecutive works in the same site area.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

In order to minimise noise impacts during the works, the contractor will take all reasonable and feasible measures to mitigate noise effects.

The contractor will also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

The contractor should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

6.6.2 Noise Monitoring

Noise monitoring, if required, will be performed by an acoustical consultant directly engaged by the contractor.

Noise monitoring for the excavation, compaction and construction works could be undertaken using statistical noise loggers. The statistical parameters to be measured should include the following noise descriptors: L_{Amin}, L_{A90}, L_{A10}, L_{A1}, L_{Amax} and L_{Aeq}. Unattended noise measurements should be conducted over consecutive 15 minute periods.

This monitoring should also be complemented by undertaking attended noise measurements in order to:

- Differentiate between construction noise sources and other extraneous noise events (such as road traffic and aircraft noise)
- Note and identify any excessive noise emitting machinery or operation.

In the event of any complaints, the noise impact at the affected location should be confirmed by conducting attended noise measurements.

The survey methodology and any equipment should comply with the requirements discussed in Standard AS 1055.1-1997.

6.6.3 Alternate Equipment or Process

Exceedance of the site's NMLs should result in an investigation as to whether alternate equipment could be used, or a difference process could be undertaken.

In some cases, the investigation may conclude that no possible other equipment can be used, however, a different process could be undertaken.

6.6.4 Acoustic Enclosures/Screening

Typically, on a construction site there are three different types of plant that will be used: mobile plant (i.e., excavators, skid steers, etc.), semi mobile plant (i.e., hand tools generally) or static plant (i.e., diesel generators).

For plant items which are static it is recommended that, in the event exceedances are being measured due to operation of the plant item, an acoustic enclosure/screen is constructed to reduce impacts. These systems can be constructed from Fibre Cement (FC) sheeting or, if airflow is required, acoustic attenuators or louvres.

For semi mobile plant, relocation of plant should be investigated to either be operated in an enclosed space or at locations away from a receiver.

With mobile plant it is generally not possible to treat these sources. However, investigations into the machine itself may result in a reduction of noise (i.e., mufflers/attenuators etc).

6.7 Vibration Mitigation Measures

6.7.1 General Comments

As part of the CNVMP, the following vibration mitigation measures should be implemented:

- Any vibration generating plant and equipment is to be in areas within the site in order to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Use lower vibration generating items of construction plant and equipment; that is, smaller capacity plant.
- Minimise conducting vibration generating works consecutively in the same area (if applicable).
- Schedule a minimum respite period of at least 30 minutes before activities commence which are to be undertaken for a continuous 4-hour period.
- Use only dampened rock breakers and/or "city" rock breakers to minimise the impacts associated with rock breaking works.
- Conduct attended measurements of vibration generating plant at commencement of works in order to validate the indicative safe working distances advised in Table 6-3 and, consequently, to establish safe working distances suitable to the project. Measurements should be conducted at the nearest affected property boundary. These safe working distances should be defined by considering the vibration criteria discussed in Section 0 (i.e., criteria for structural damage, human comfort and impact to scientific or medical equipment).

6.7.2 Vibration Monitoring

Vibration monitoring, if required, should be undertaken continuously at the nearest most affected structures.

The monitoring location would be on a stiff part of the structure (at the foundation) on the side of the structure adjacent to the subject demolition and construction works.

The vibration monitoring system will be configured to record the peak vibration levels and to trigger an audible/visual alarm when predetermined vibration thresholds are exceeded. The thresholds correspond to an "Operator Warning Level" and an "Operator Halt Level", where the Warning Level is 75% of the Halt Level. The Halt Level should be determined based on the vibration criteria for building contents and structure (refer to Section 0).

Exceedance of the "Operator Warning Level" would not require excavation or demolition work to cease, but rather, alerts the site manager to proceed with caution at a reduced force or load.

An exceedance of the "Operator Halt Level" would require the contractor to implement an alternative excavation technique pending further analysis of the vibration frequency content in order to determine any potential exceedance of the criteria.

The vibration monitoring equipment would be downloaded and analysed by the acoustical consultant.

Reports of the measured vibration levels and their likely impacts would be prepared by the acoustical consultant and issued to the contractor.

Based on the location of the proposed building to the residential receivers vibration measurements could be undertaken to conform compliance with construction vibration criteria as exceedances are not expected based on the proximity of construction to be undertaken to receivers.

6.8 Community Consultation

6.8.1 Stakeholder Engagement

The overarching Communications and Stakeholder Engagement Strategy for the project, as well as the Communications and Engagement plans to support each stage of the development, including the Project, have been developed in line with Schools Infrastructure guiding principles for capital projects, which centre on:

- Proactive stakeholder engagement
- Proactive and transparent communications
- Coordinated information
- Collaboration

6.8.2 Stakeholders

The Project's stakeholder environment is complex and extensive. The Project team has developed a deep understanding of stakeholders and the engagement environment which has informed the timing, method and level of engagement across all stages of the redevelopment. Key engagement methods include:

- Formal and information briefings and meetings
- Workshops
- Door Knocks
- Letterbox Drops
- Email Notifications

6.9 Complaints Management System

The Contractor is to establish a communication register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

All complaints should be investigated by the Contractor in accordance with the procedures outlined in Australia Standard 2436-2010. In addition, the following procedures are an example of the procedures that are to be specifically adopted for complaints relating to noise.

Upon receipt of a complaint the Contractor is to:

- Try to ascertain from the complaint which appliance is causing the problem i.e., inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.
- The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.
- The Project Manager is to provide a report on the incident to the relevant stakeholders.
- The Contractor is to provide a 24-hour telephone contact number and this number is to be prominently displayed on the site.

6.10 Contingency Plans

Contingency plans are required to address noise or vibration problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans could include:

- Stop the onsite works.
- Identify the source of the main equipment within specific areas of the site which is producing the most construction noise and vibration at the sensitive receivers; and
- Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered.
- In the event an alternate piece of equipment or process can be used, works can re-commence.
- In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant.

6.11 General Mitigation Measures (Australia Standard 2436-2010)

As well as the above project specific noise mitigation controls, AS 2436-2010 "*Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*" sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below, including the typical noise reduction achieved, where applicable.

6.11.1 Adoption of Universal Work Practices

- Regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
- Regular identification of noisy activities and adoption of improvement techniques.
- Avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby sensitive receivers.
- Where possible, avoiding the use of equipment that generates impulsive noise.
- Minimising the need for vehicle reversing for example (particularly at night), by arranging for one-way site traffic routes.
- Use of broadband audible alarms on vehicles and elevated work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

6.11.2 Plant and Equipment

- Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Selecting plant and equipment with low vibration generation characteristics.
- Operating plant and equipment in the quietest and most efficient manner.

6.11.3 On Site Noise Mitigation

- Maximising the distance between noise activities and noise sensitive land uses.
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

6.11.4 Work Scheduling

- Providing respite periods which could include restricting very noisy activities to time periods that least affect the nearby noise sensitive locations, restricting the number of nights that after-hours work is conducted near residences or by determining any specific requirements.
- Scheduling work to coincide with non-sensitive periods.
- Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers.
- Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
- Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

6.11.5 Source Noise Control Strategies

Some ways of controlling noise at the source are:

- Where reasonably practical, noisy plant or processes should be replaced by less noisy alternatives.
- Modify existing equipment: Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, trucks, etc. In order to minimise noise emissions, residential grade mufflers should be fitted on all mobile plant utilised on site.
- Siting of equipment: locating noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Regular and effective maintenance.

7 CONCLUSION

Pulse White Noise Acoustics Pty Ltd (PWNA) has undertaken a detailed acoustic assessment for the Pymble Ladies College, Grey house Precinct project and results are included in this report.

A review of existing onsite noise at the site have been assessed and recommended acoustic treatments to the future buildings facades to ensure internal noise levels are within permissible limits. These recommendations also assist with the control of noise emissions from high noise spaces such as the community and dance studios will comply with relevant guidelines at nearby receivers.

Analysis of noise from internal areas such of the proposed development as well as noise associated with external play areas and the use of the public address system have been assessed and suitable acoustic building constructions and operational controls to mitigate noise emissions resulting from the development are detailed in this report.

Noise emissions from the use of the school play areas during periods where maximum capacities are achieved (i.e. recess and lunch) is likely to exceed the formulated criteria outlined above. However as cited above, *"All noise that emanates from the normal activities at a school is not offensive"* and therefore is deemed acceptable.

If you have any additional questions, please contact us should you have any further queries.

Regards

Ben White
Director
Pulse White Noise Acoustics

APPENDIX A: ACOUSTIC GLOSSARY

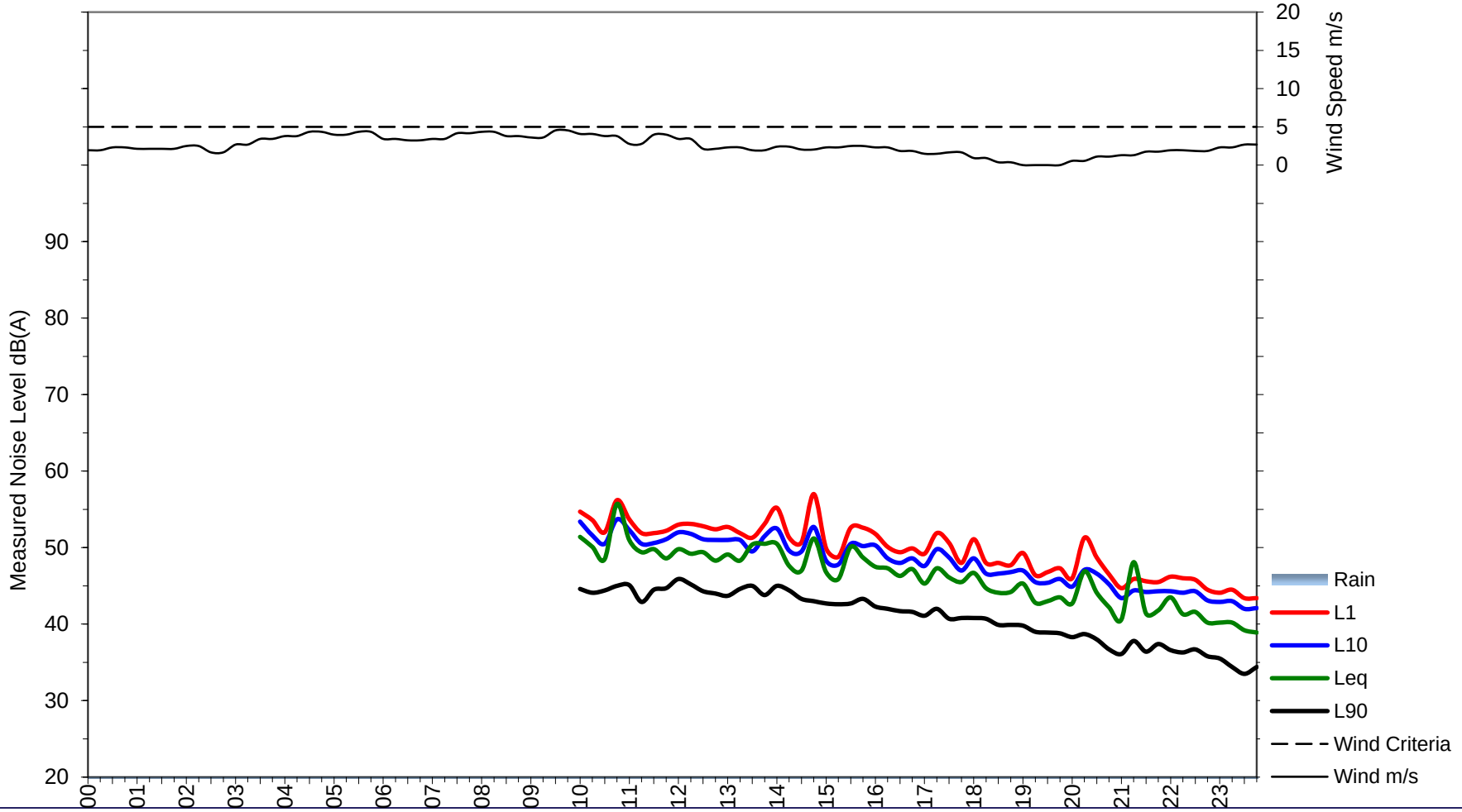
The following is a brief description of the acoustic terminology used in this report:

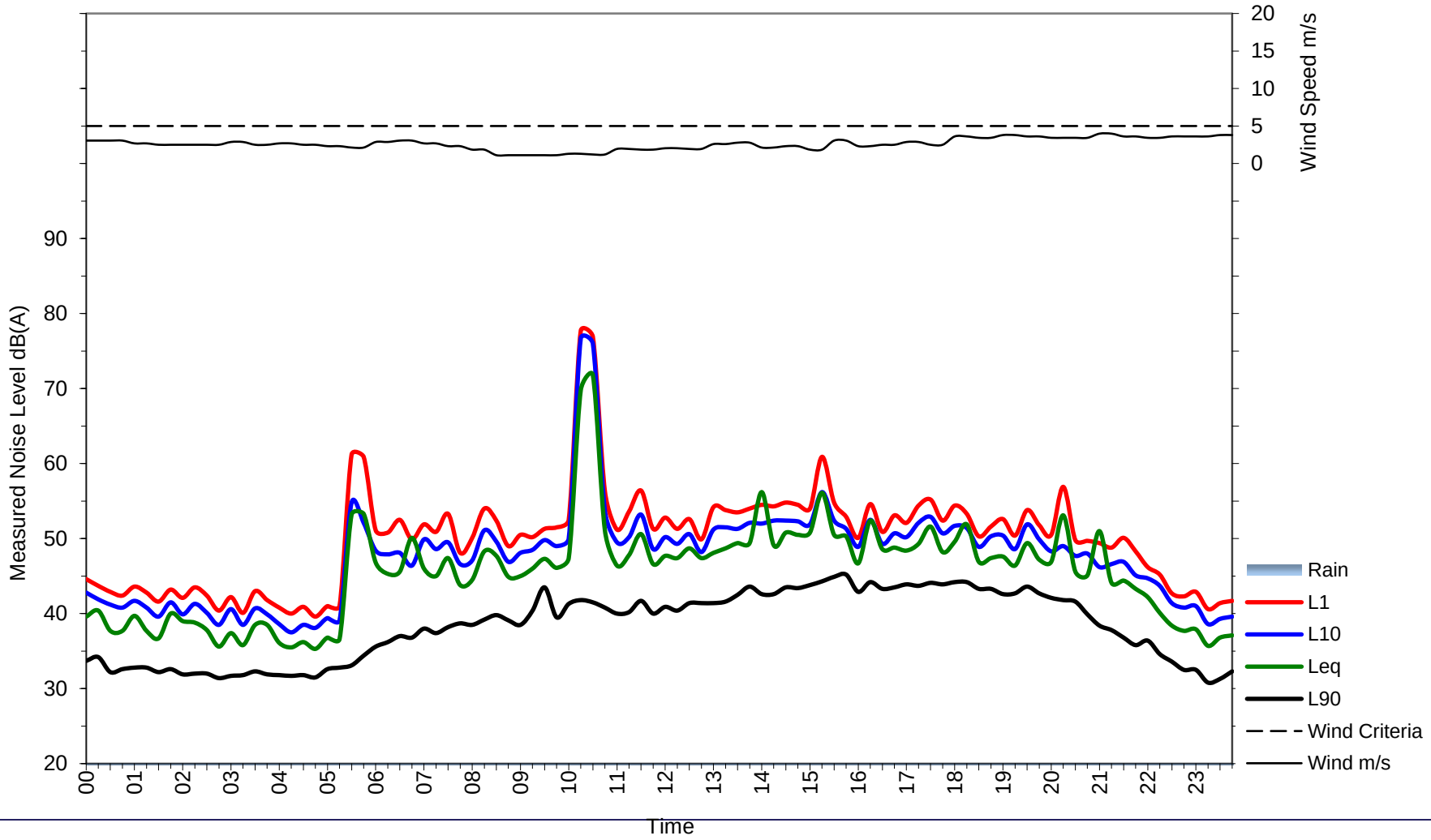
Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
LMax	The maximum sound pressure level measured over a given period.
LMin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
dB (A)	'A' Weighted overall sound pressure level
Sound Pressure Level, LP dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.
Sound Power Level, Lw dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt

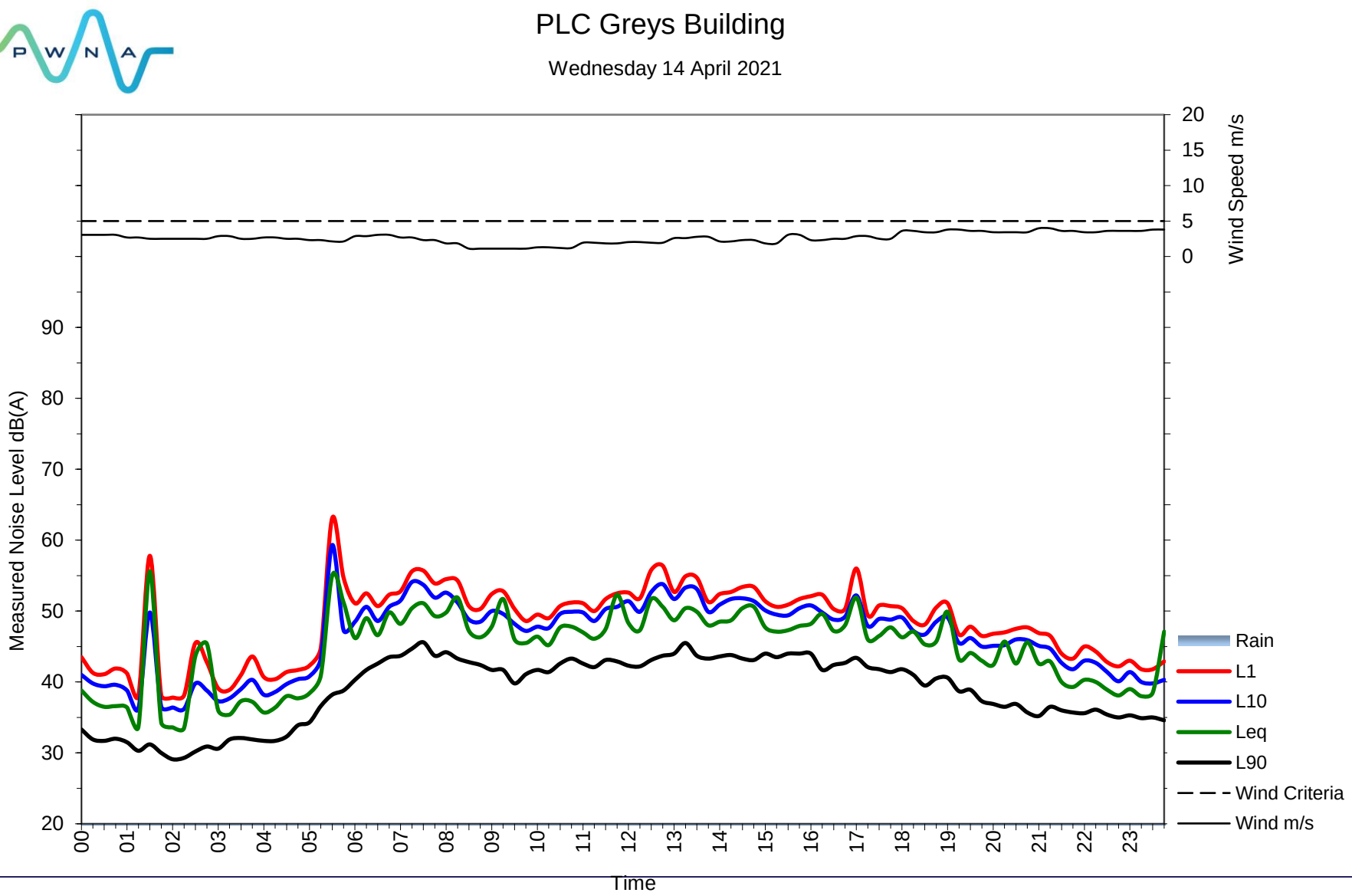
APPENDIX B: UNATTENDED NOISE MONITORING RAW DATA

PLC Greys Building

Monday 12 April 2021




PLC Greys Building
Tuesday 13 April 2021
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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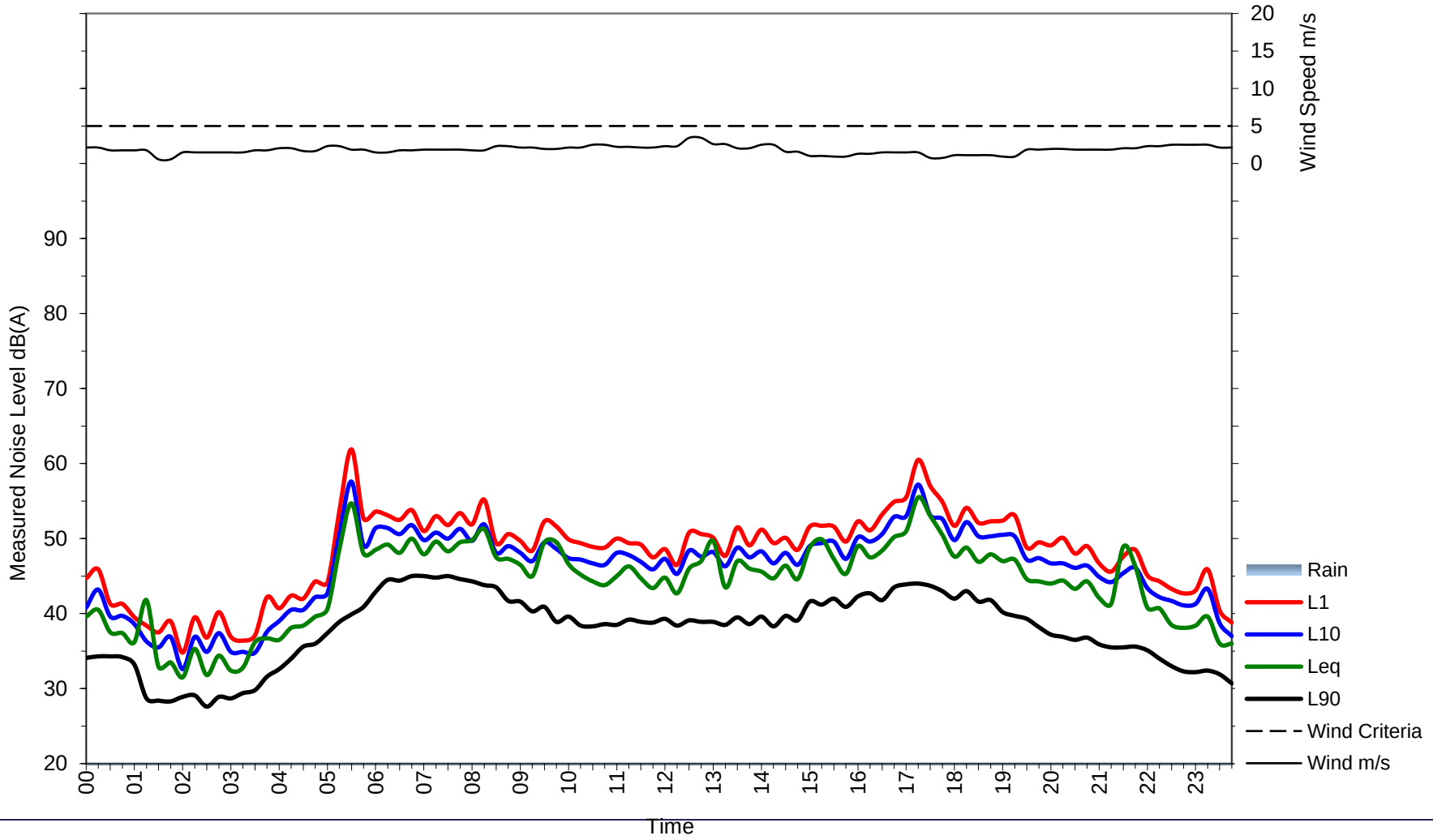
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s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Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
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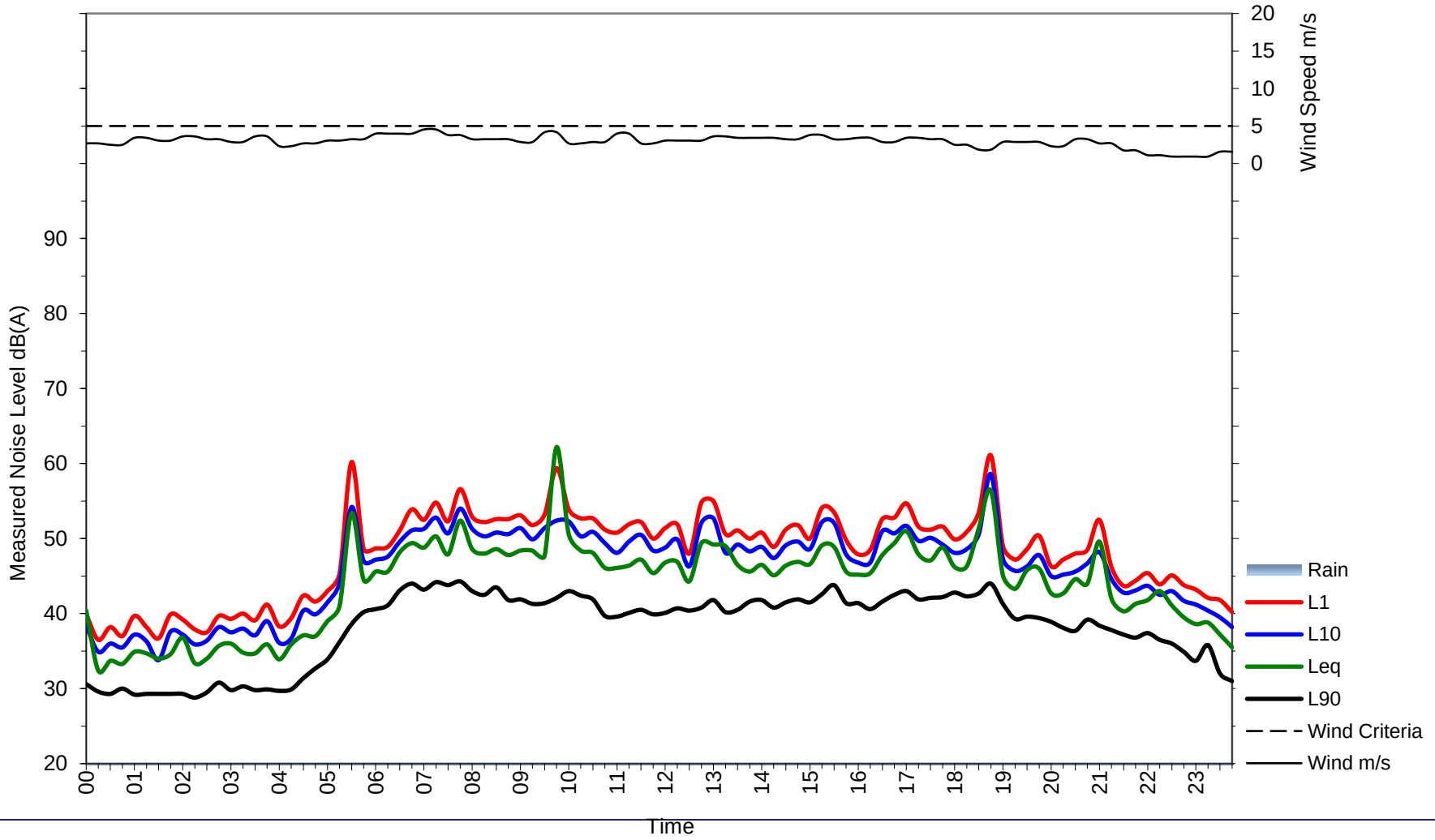
PLC Greys Building
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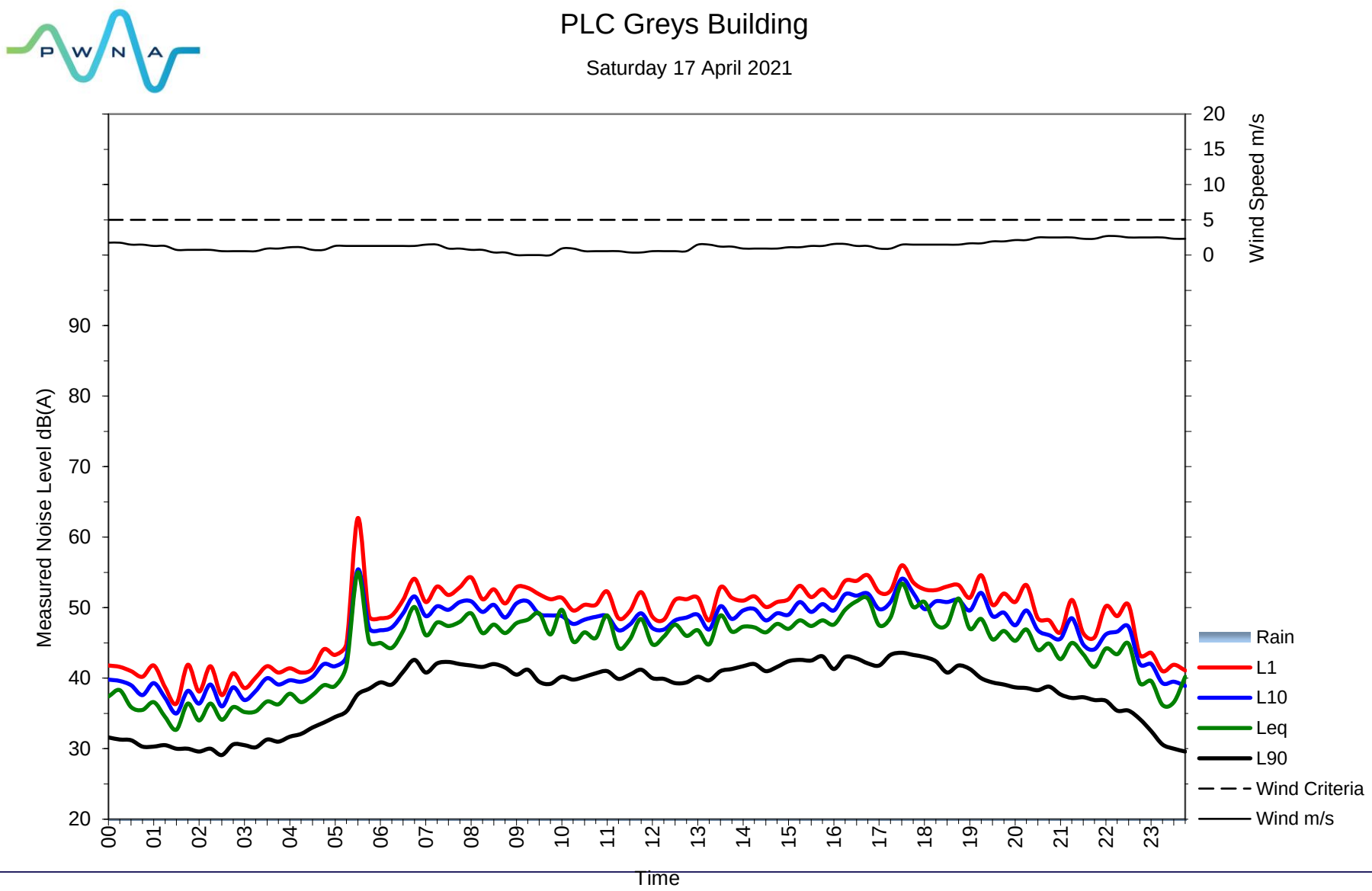
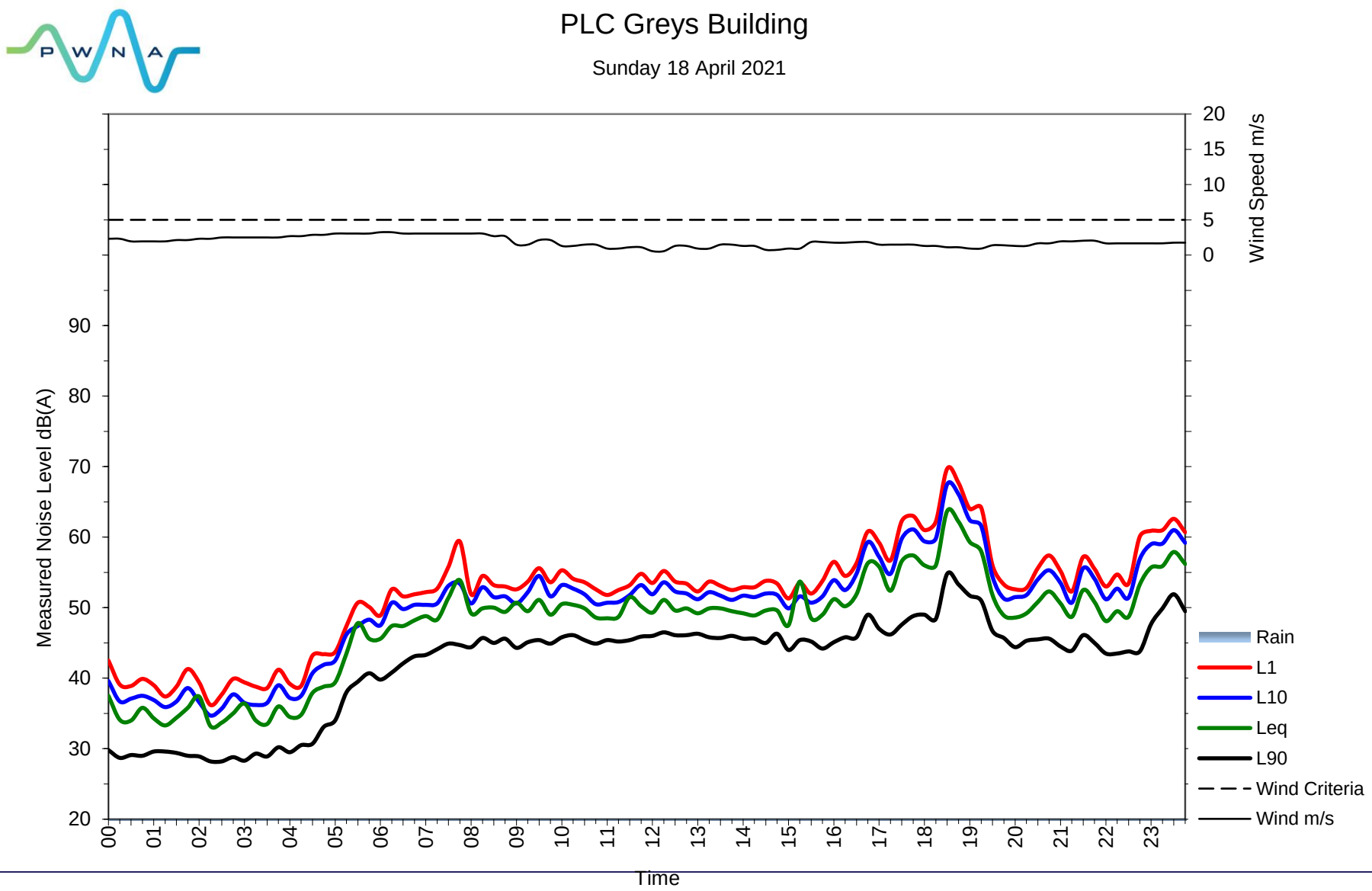
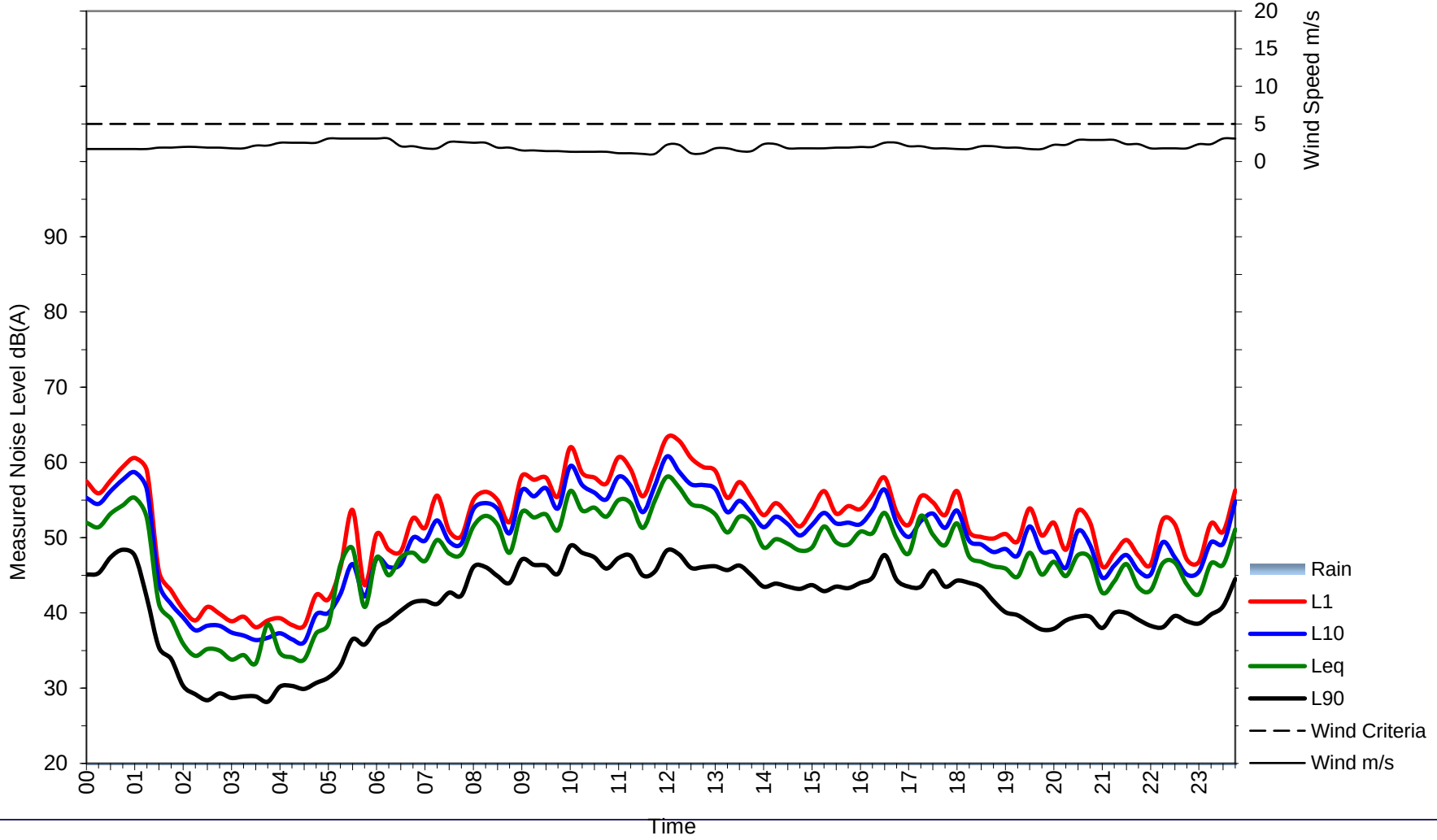
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


PLC Greys Building
Saturday 17 April 2021
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


PLC Greys Building
Sunday 18 April 2021
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

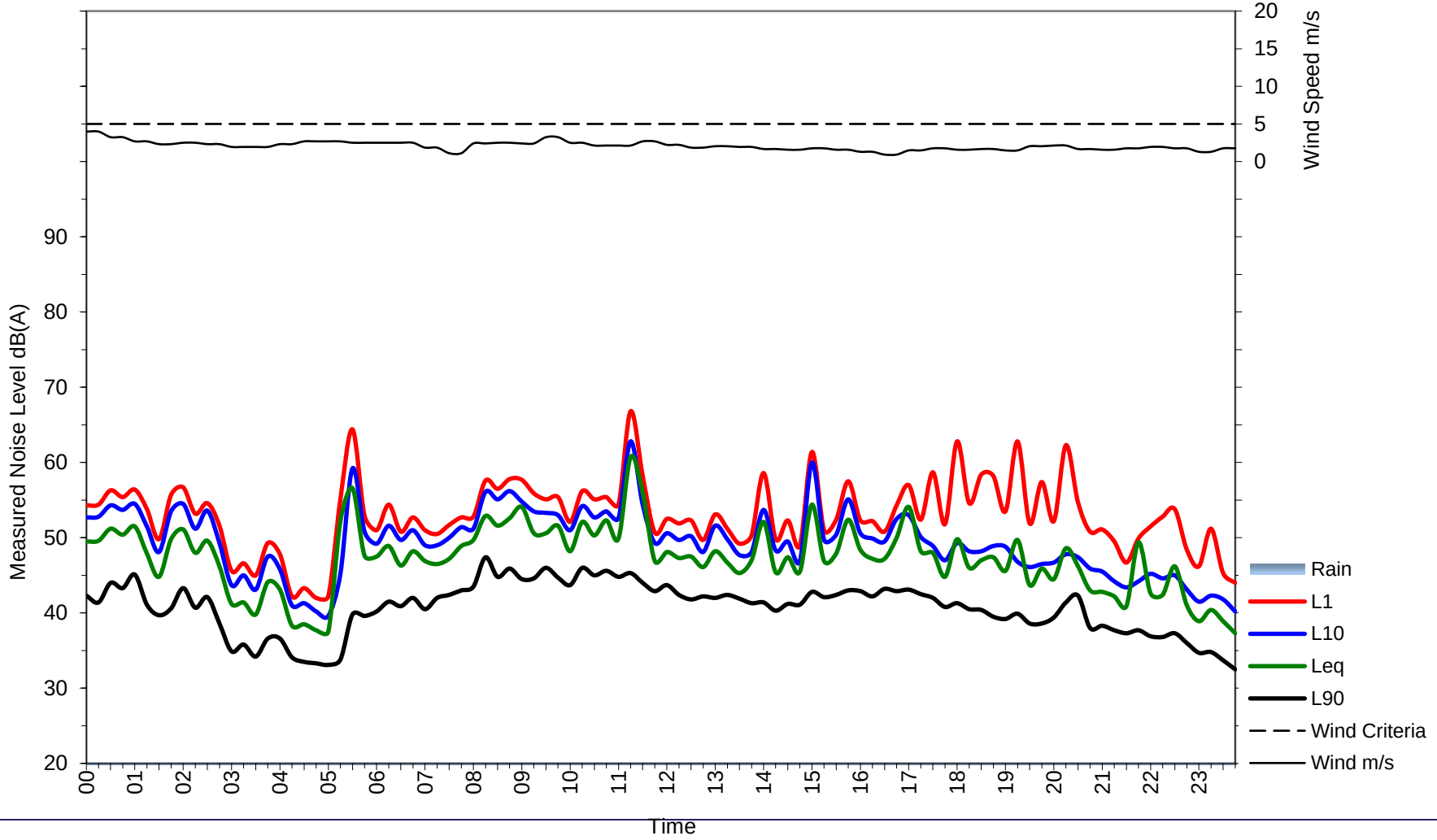
PLC Greys Building

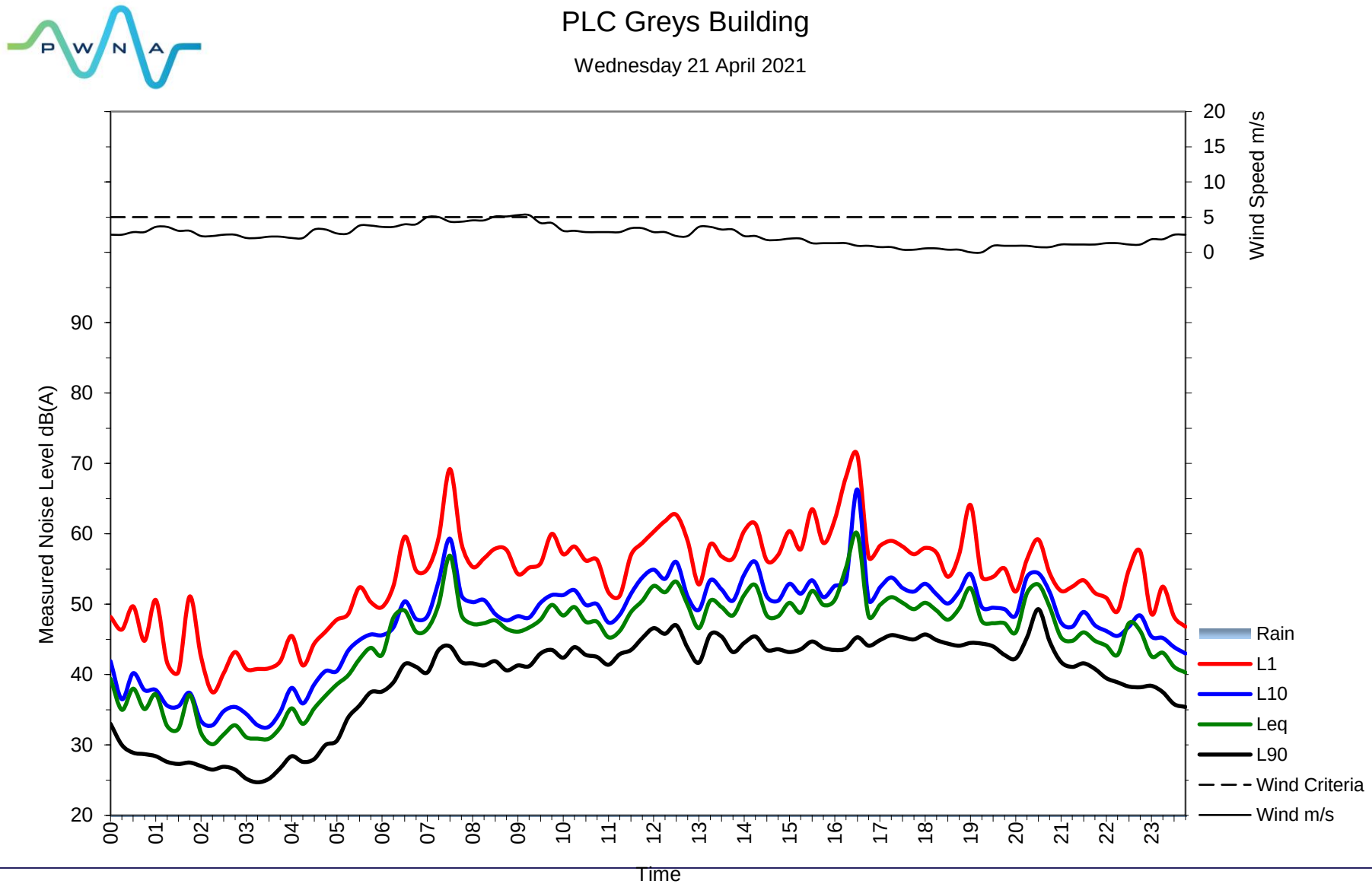
Monday 19 April 2021



PLC Greys Building

Tuesday 20 April 2021




PLC Greys Building
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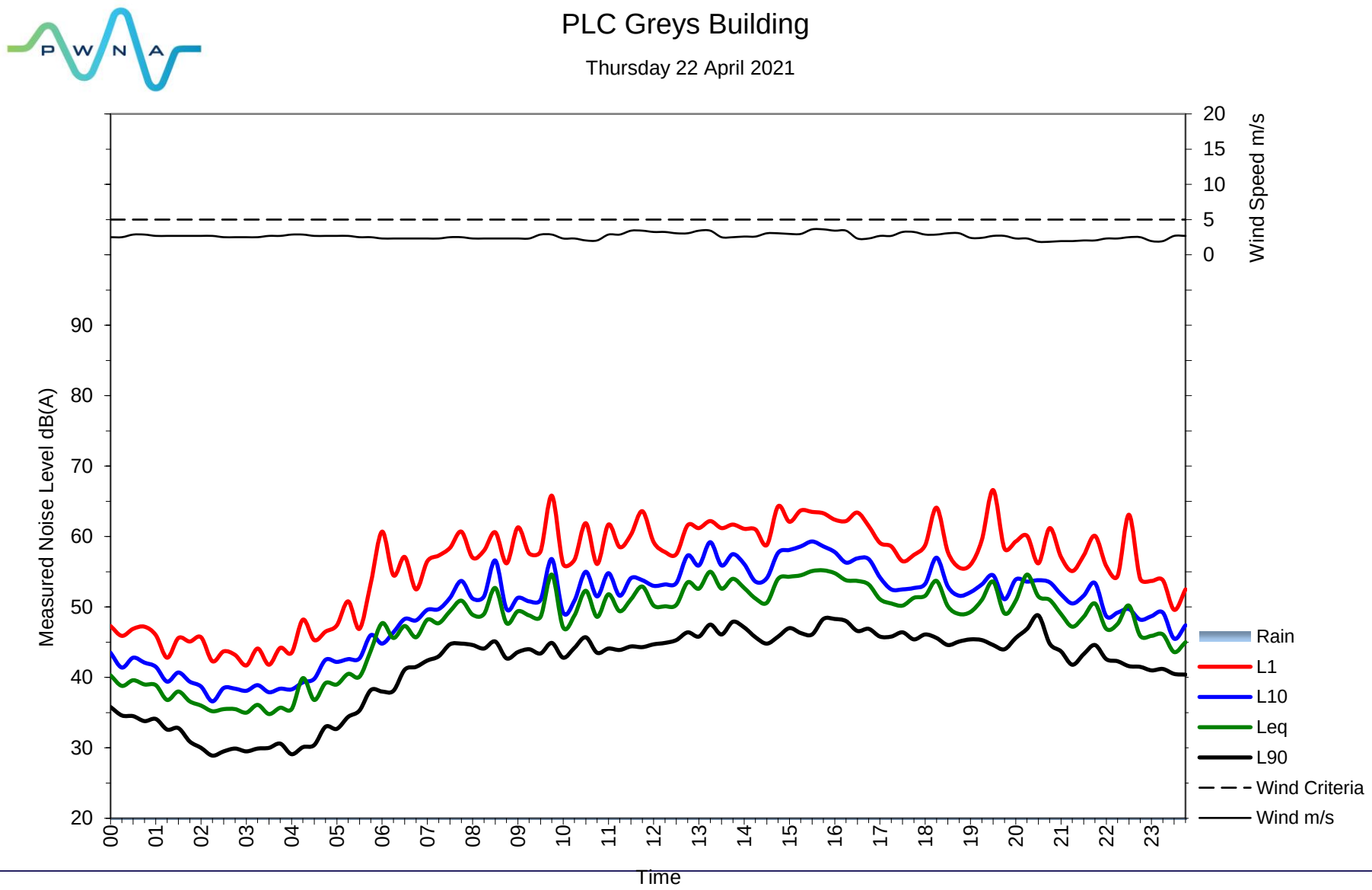
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


PLC Greys Building
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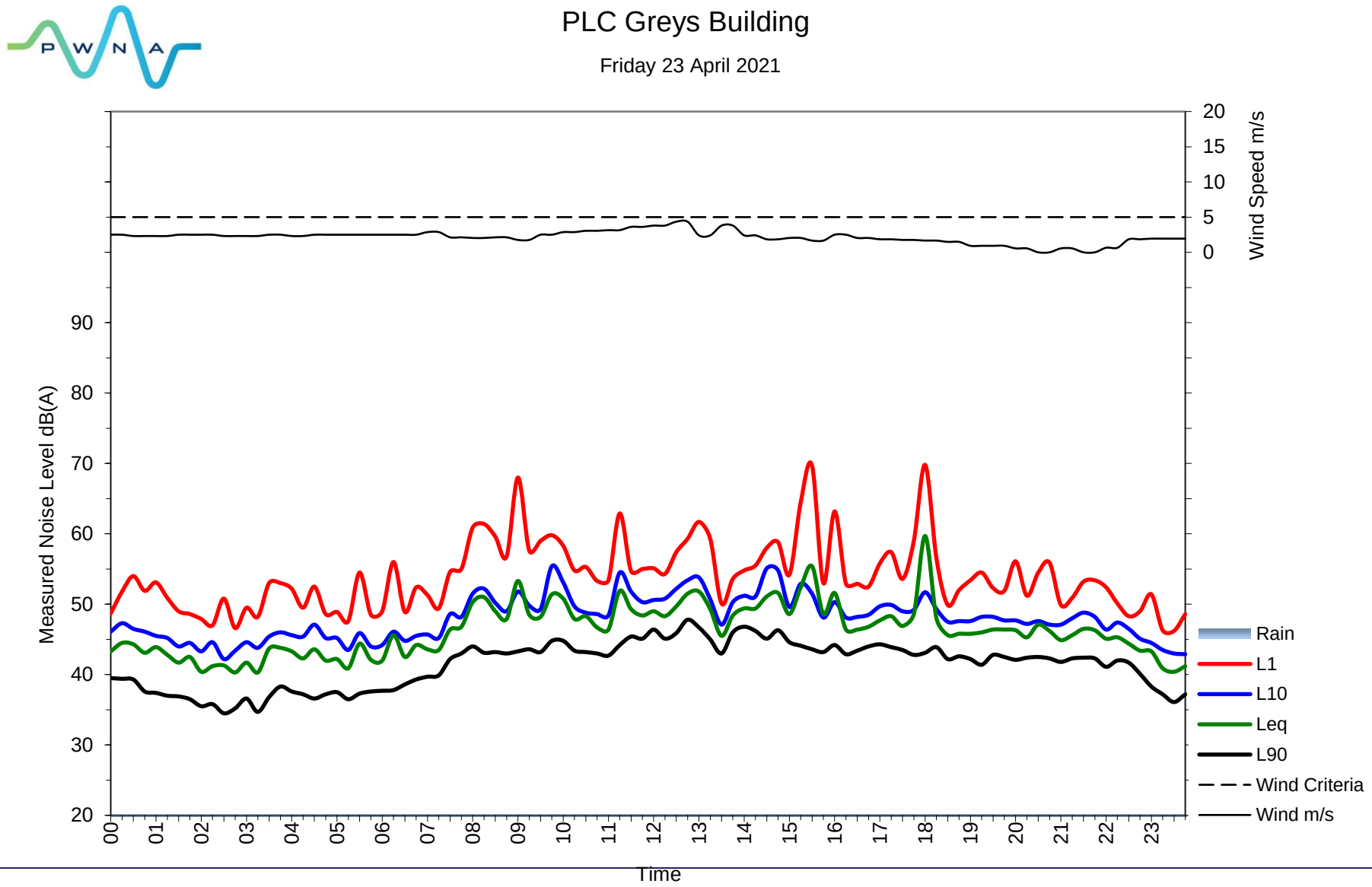
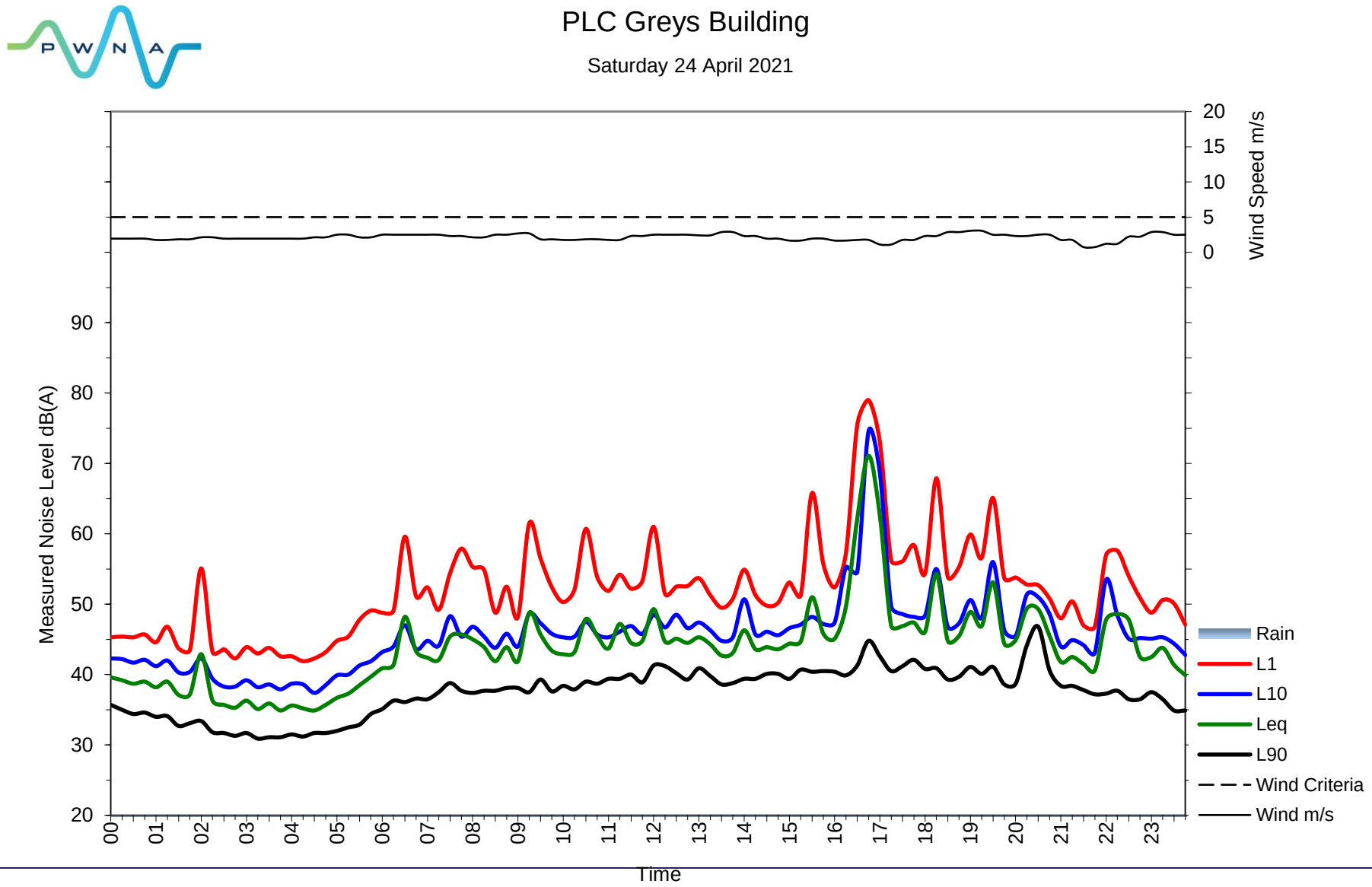
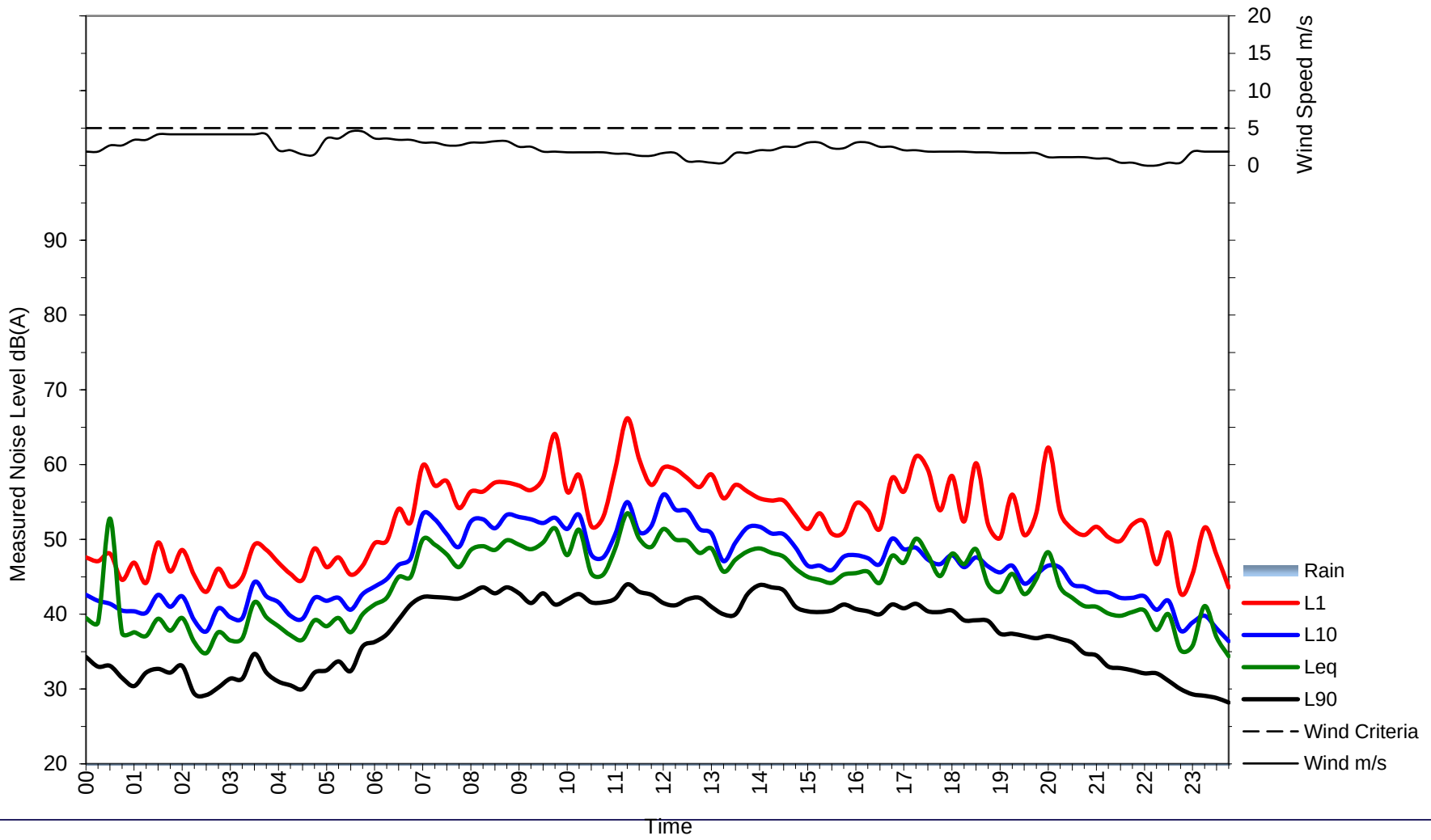
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


PLC Greys Building
Friday 23 April 2021
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


PLC Greys Building
Saturday 24 April 2021
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


PLC Greys Building
Sunday 25 April 2021
Measured Noise Level dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s

PLC Greys Building

Monday 26 April 2021