MEMORANDUM

2019-07-02 AIRTRUNK - AIR COOLED CHILLER OPTION - ONE PAGE SUMMARY.DOCX

TO:	Dino DiPaolo	DATE:	6 September 2019
COMPANY:	A W Edwards Pty Limited		
EMAIL:	ddipaolo@awedwards.com.au		
FROM:	Matthew Harrison		
SUBJECT:	**One Page Summary of Report Changes – Air Cooled Chiller Option 2 Sirius Road, Lane Cove West**		

Pulse Acoustics was engaged by A W Edwards to conduct an acoustic assessment of the proposed Airtrunk Syd 2 Datacentre at 1 Sirius Road, Lane Cove. This document summarises the three conducted acoustic assessments to date and the identifies the acoustic benefits of the current air cooled design option.

This document refers to the following reports:

- *LCWDC – SSDA Acoustic Assessment – Issue 3* (Arup Report, dated 21 February 2019)
- *2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final - Rev2)* (Pulse Acoustics report, dated 19th August 2019)
- *2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final - Rev6)* (Pulse Acoustics report, dated 3rd September 2019)

The Arup report *LCWDC – SSDA Acoustic Assessment – Issue 3* broadly covered the following:

- Identified the nearby receivers and formatted the project criteria using background noise measurements made at 14 Jeanette Street East Ryde (this resulted in an unrealistically low criteria for the closest residents at 150 Epping Road);
- Provided the operational noise predictions for the facility with 24 water-cooled chillers, 24 cooling towers, 34 standby generators and 12 transformers, all located on the roof top plus an additional 14 standby generators externally raised;
- Predicted exceedances of up to 22 dB at receivers when all equipment is operating (including only one generator);
- Recommended mitigation measures including enclosures for water cooled chillers (15-20 dB reduction), 25-30 dB of attenuation for cooling towers, genset selection as not to exceed 72 dB(A) at 1m and transformers achieving a 10-15 dB reduction; and
- These very large recommended noise reductions are unlikely to be achievable using conventional noise reducing techniques such as installing silencers to the cooling tower exhausts.

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The Pulse Acoustics report *2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final - Rev2)* provided an acoustic assessment of the air cooled chiller design option, to determine whether this option was a realistic alternative to the water cooled design option. This assessment involved the following significant differences to Arup assessment:

- The previously specified water cooled chillers have been replaced with air cooled chillers and the assessment has been conducted to calculate the noise from the major noise producing equipment, being the 70 air cooled chillers - TMA 3B 1350A ES EC (1,600kW);
- Additional unattended noise measurements was conducted at the nearest residential receiver, 150 Epping Road with new criteria derived for this receiver in accordance with the Noise Policy for Industry; and
- With 900mm long acoustically lined discharge ducts, attenuated noise levels are predicted to comply with the criteria.

The Pulse Acoustics report *2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final – Rev6)* provided a summary of a more complete acoustic assessment of the air cooled chiller design option and involved the following changes to the previous assessment:

- The report is similar to the *2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final - Rev2)* report, except that the equipment assessed not only considers the 60 air cooled chillers (2,200 kW) but all external noise generating equipment including the 32 transformers on the building roof and generators on the external platforms;
- Compliance with the project criteria is achieved when the air cooled chillers are fitted with attenuation measures, transformers are operational and a single generator with attenuation measures is being tested;
- Noise levels from all generators operating is not considered as Section 1.4 of the Noise Policy for Industry and Schedule 1 of the POEO Act Section 17 (1A), assessment is not required for "the generation of electricity by means of electricity plant that is emergency stand-by plant operating for less than 200 hours per year".

In summary, the latest Pulse Acoustics report *2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final – Rev6)* considers the latest specified equipment and attenuation measures, using noise criteria that has been derived from measurements at the closest residential receiver. Noise levels are predicted to comply with the project criteria when the air cooled chillers are fitted with 900mm long circular lined discharge ducts, transformers are operational and a maximum SWL 95 dBA generator is tested one at a time.

Acoustic Assessment Airtrunk Data Centre Review of Air Cooled Chiller Option 2 Sirius Road, Lane Cove West

Climatech Pty Ltd

100 Queen Street

Beaconsfield NSW 2015

2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option (Final - Rev1)

2 September 2019

Version: Final (Rev 6)

Acoustic Assessment Airtrunk Data Centre Review of Air Cooled Chiller Option 2 Sirius Road, Lane Cove West

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Draft	2nd July 2019	Matthew Harrison	Ollie Conquest	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final	4nd July 2019	Matthew Harrison	Ollie Conquest	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final	4nd July 2019	Matthew Harrison	Ollie Conquest	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final (Rev1)	19th Aug 2019	Matthew Harrison	Ollie Conquest	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final (Rev2)	19th Aug 2019	Matthew Harrison	Ollie Conquest	Matthew Harrison

2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final (Rev3)	2nd Sep 2019	Matthew Harrison	Peter Gangemi	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final (Rev4)	3rd Sep 2019	Matthew Harrison	Peter Gangemi	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final (Rev5)	3rd Sep 2019	Matthew Harrison	Peter Gangemi	Matthew Harrison
2019-07-02 Airtrunk - Acoustic Review of Air Cooled Chiller Option	Final (Rev6)	3rd Sep 2019	Matthew Harrison	Peter Gangemi	Matthew Harrison

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1 INTRODUCTION

Pulse Acoustics Consultancy has been engaged to undertake an acoustic review of a transformer, generator and air cooled chiller option for the Airtrunk Syd 2 Datacentre, to be located at 1 Sirius Road, Lane Cove West.

The currently proposed chiller design involves replacing the original water cooled chiller design scheme with air cooled units. The facility will also externally house transformers and generators. This report includes the result of a previous peer review of the original water cooled design option prepared by Arup Acoustics. The acoustic report that has been reviewed is titled, "*Greenbox Architecture - Lane Cove West Data Centre - Acoustic Assessment - SSD 9741*" and is dated 21 February, 2019.

The air cooled chiller option results in significant cost savings for the development, particularly with respect to the building structure.

The development is described in the Arup report as being comprised of the following major relevant components:

- Basement containing 72 x transformers.
- (2) Data Halls including associated electrical and mechanical plant rooms.
- External raised platform with 14 standby generators.
- External rooftop plant consisting of 30 x water-cooled chillers / cooling towers, 34 x additional standby generators and 12 x transformers.
- Offices and amenities.

The currently proposed air cooled chiller design differs from that reviewed by Arup in that the water-cooled chillers are replaced with air-cooled chillers that do not require cooling towers.

The proposed alternative includes:

- 20 chillers in Building A, 20 chillers in Building B and 20 chillers in Building C
- Each chiller consists of 1 x TMA 4B 1800B ES EC-34 K (2,200kWr) unit (or equivalent)
- 32 transformers located on the building roofs.
- Generators on the external platforms

Figure 2 below indicates the overall site layout and the proposed layout of the currently proposed air cooled chiller design.

Figure 1 Site Layout

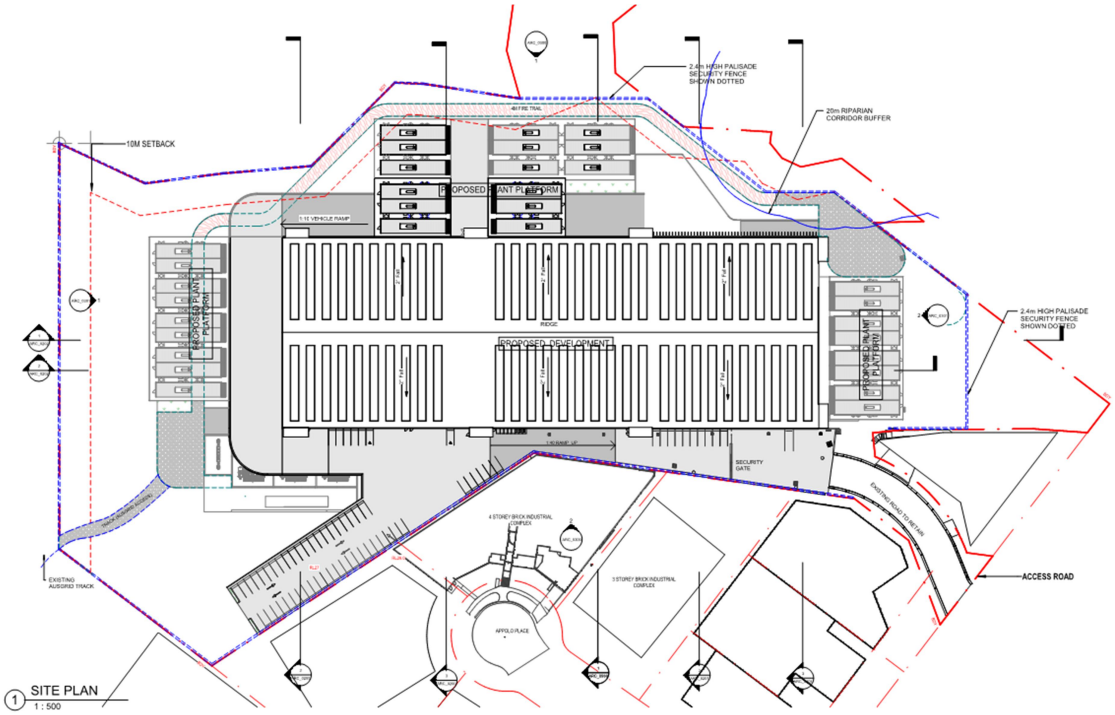
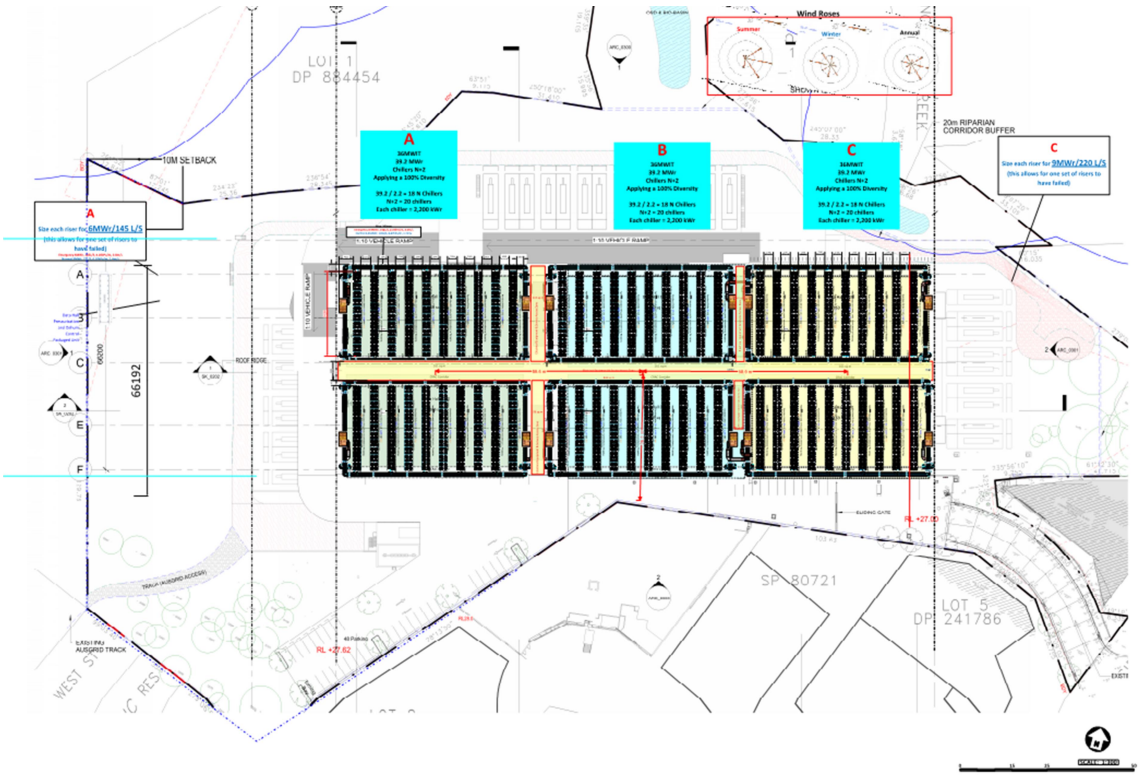


Figure 2 Proposed revised air cooled chiller design option



1.1 Site Description & Operational Conditions

Figure 3 shows the location of the development in relation to noise sensitive receiver locations and adjacent development. In particular, Figure 3 shows the location of residences positioned at 150 Epping Road, located approximately 250 m from the development. This residential development is the closed residential receiver to the development.

Figure 2 has been copied from the Arup report so that there is consistency in the receiver location names.

As well as residential receivers, commercial and passive recreation receiver locations are also identified in this figure.

The Arup report notes that the closest commercial receiver being approximately 10 m away (C1).

Apart from the residential premises to the north, residential premises are also located to the northwest (R2) and west (R3) of the proposed development; approximately 500 m and 600 m distant respectively. The Lane Cove Bushwalk (P1) runs alongside the river and passes the proposed development and is approximately 80 m away (note that these distances will have changed slightly since the release of the Arup report as the building size and equipment configuration has been modified).

The residential receivers have been shaded purple and the commercial receivers are shown as orange in Figure 3 below.

Figure 3 Site layout showing receiver locations (from Arup report)

Type	ID	Address	Description
Residential	R1	150 Epping Road, Lane Cove	Residential apartment complex to the northeast of the subject site
Residential	R2	65 Magdala Road, North Ryde	Residential building to the northwest of the subject site
Residential	R3	14 Jeanette Street, East Ryde	Residential building to the west of the subject site
Commercial	C1	1A Sirius Road	Commercial building to the east of the subject site
Passive Recreation	P1	Lane Cove Bushwalk	River walk to the west-northwest of the subject site

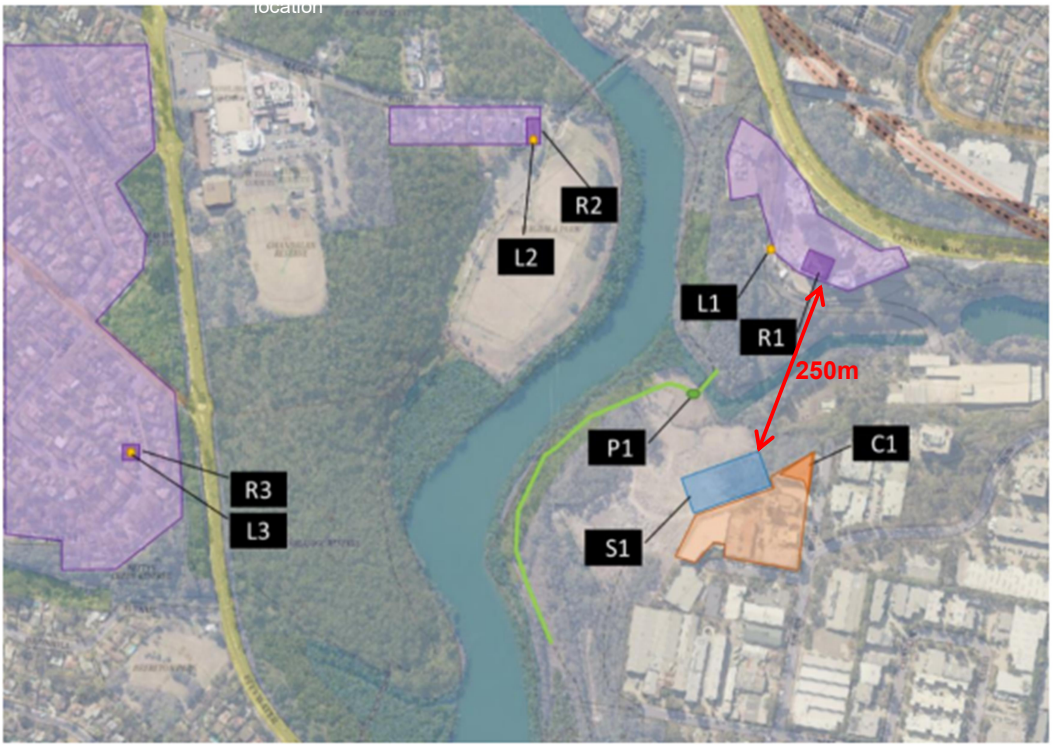
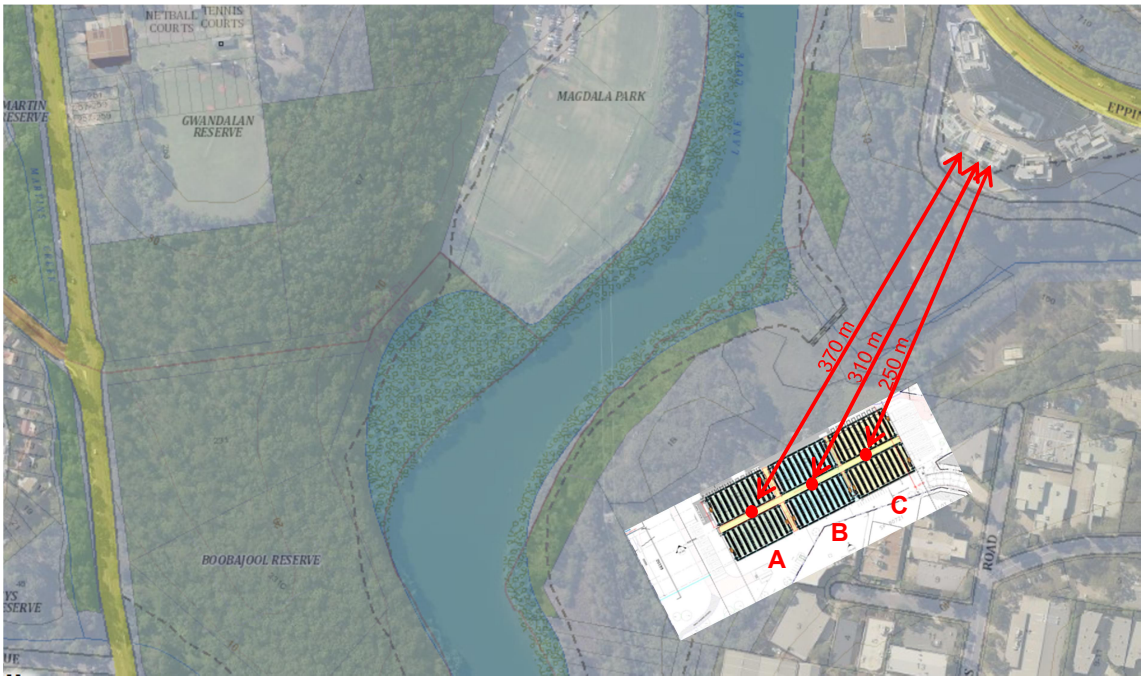


Photo courtesy of Arup (from report dated 21st February, 2019)

The proposed data centre has been re-orientated and modified since the release of the Arup report.

The revised size and orientation is shown in Figure 4 below.

Figure 4 Revised chiller scheme (showing residences at 150 Epping Road)



2 ACOUSTIC SURVEY

2.1 Noise Descriptors and Terminology

Environmental noise constantly varies in level with time. Therefore, it is necessary to measure environmental noise in terms of quantifiable time periods with statistical descriptors. Typically environmental noise is measured over 15 minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dBA, the "A" indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' linear arithmetic does not apply, e.g. adding two sound sources of equal values result in an increase of 3dB (i.e. 60 dBA plus 60 dBA results in 63 dBA). A change of 1 dB or 2 dB in the sound level is difficult for most people to detect, whilst a 3 dB – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the L_{Aeq}, L_{A1}, L_{A10} and L_{A90} noise levels. The L_{Aeq} noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period. It represents the level that the fluctuating noise with the same acoustic energy would be if it were constant over the measured time period.

The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels can be considered as the maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included in Appendix A.

2.2 Arup Noise Survey

An acoustic survey of the existing ambient noise levels around the site were undertaken in order to establish the noise emission criteria for the proposed development. The survey comprised the following measurements:

- Long term measurements over 4 days at location 3 (14 Jeanette Street, East Ryde).
- These measured levels are given Table 3 of the Arup report (copied below for ease of reference).

Table 1 Long term noise monitoring results, dBA

Location	Time Period[1]	Rating Background Level, dBA L_{A90}	Ambient dB L_{Aeq} noise levels
L3 – 14 Jeanette Street	Day	42 dBA	57 dBA
	Evening	42 dBA	57 dBA
	Night	31 dBA	49 dBA

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: As required by the NPI, the external ambient noise levels presented are free-field noise levels

- Additional spot noise measurements were made at 2 other locations over single 15 min periods at each location (see below).

Table 2 Short term noise monitoring results, dBA

Location	Time Period	Rating Background Level, dBA L_{A90}	Ambient dB L_{Aeq} noise levels	Comments
L1 – 150 Epping Road	14:55-15:10	47 dBA	49 dBA	Traffic noise, child crying, occasional aeroplane pass-by
L2 – 65 Magdala Road	16:31-16:46	53 dBA	56 dBA	Traffic noise, car pass-by, children playing sports, birds and insects
L3 – 14 Jeanette Street	17:09-17:25	46 dBA	50 dBA	Traffic noise, birds and insects, car pass-by

In reviewing the daytime background noise levels at around 3 pm at Location 1 (150 Epping Road – the closest residential at 250m) and location 3 (the long term noise monitoring location), it can be seen that that the closest residential location has a daytime noise level that is 5 dBA higher than the level given at the long term noise monitoring location.

On this basis we originally hypothesised that the noise criteria used in the Arup report may be too conservative by approximately 5 dBA the nearest affected residences at 150 Epping Road.

2.3 Pulse Acoustic Noise Monitoring

2.3.1 Monitoring Details

To validate the estimated background noise levels at Location 1, noise monitoring was conducted at the residences located at 150 Epping Road between

- External noise measurements were made between Saturday the 29th June, 2019 and Tuesday 2nd July, 2019.
- Noise levels were made at ground level and are therefore likely to be lower than if the noise monitor was placed on a residential balcony, where traffic noise levels are expected to be higher.
- One noise logger was positioned in the garden area in front of the apartment buildings, with direct line of sight to the Lane Cove West Industrial Park.
- The noise logger recorded noise levels that are thought to be typical of the lower level apartments that face the Industrial Park.
- The noise monitoring results at this location are therefore representative of the background noise levels currently experienced by the potential receivers of noise emissions from the development.

The location of the unattended noise logging survey is shown in Figure 5 below. During the ambient monitoring, the weather was generally fine without any significant windy events.

2.3.2 Monitoring Instrumentation

Instrumentation used for the noise survey comprised a Svantek 971 sound level meter / analysers (serial numbers 39165) fitted with a microphone windshield. Calibration of the logger was checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dBA. 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. These charts, representing each 24 hour period, show the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise levels measured over 15 minute time periods.

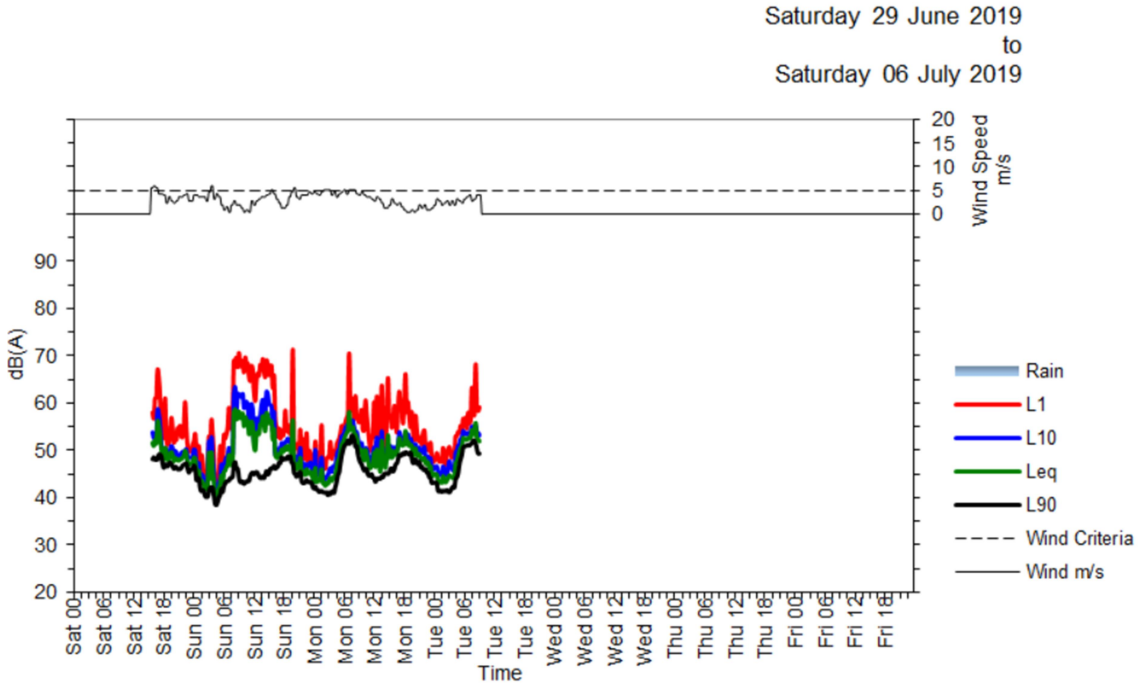
The measurement results have been filtered to remove data affected by adverse weather conditions, such as excessively windy or rainy time periods, as recorded by the Bureau of Meteorology weather station at Darling Harbour. No data was required to be excluded.

The noise monitoring location is shown in the image contained in **Figure 5** below.

Figure 5 Logging Location - front yard of 150 Epping Road development – traffic noise shielded by the buildings

A summary of the monitored levels which are representative of the levels incident on the southern face of the residences located at 150 Epping Road can be seen in **Figure 6** below with the detailed noise logging results shown in **Appendix B**.

Figure 6 Ambient Noise Monitoring Results at 150 Epping Road



2.4 Environmental Noise Monitoring Results

The measured background noise data of the logger was processed in accordance with the recommendations contained in the NSW Environment Protection Authority's (EPA) *Noise Policy for Industry* (NPI).

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. The RBL $L_{A90\ (15minute)}$ and L_{Aeq} noise levels are presented in **Table 3**.

Table 3 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	
	RBL[2]	L_{Aeq}[3]	RBL[2]	L_{Aeq}[3]	RBL[2]	L_{Aeq}[3]
South western noise logger	46 dBA	53 dBA	46 dBA	50 dBA	41 dBA	47 dBA

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 RBL 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.

The results of the measurement survey provide ambient noise levels that are considered to be representative of the levels to be expected at the nearest and most affected residences to the proposed development (i.e. the apartments located at 150 Epping Road).

3 OPERATIONAL NOISE EMISSION CRITERIA

3.1 NSW Noise Policy for Industry

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 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.

3.1.2 Protecting Noise Amenity (All Receivers)

To limit continuing increases 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.

3.1.2.1 Area Classification

The NSW NPI characterises the "Urban Residential" noise environment as an area with an acoustical environment which shows the following:

- It is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable sources, consisting mostly of traffic and/or industrial related sounds
- Has through traffic with characteristically heavy and continuous traffic flows during peak periods

- is near commercial districts or industrial districts
- It has a combination of any of the above

For the residences located at 150 Epping Road, the area might be best described as falling under "Urban" area classification. For other residences located to the west of the proposed development, these areas are better classified as "Suburban" areas.

For residential receivers in either "Urban" or "Suburban" areas as well as non-residential receivers, the recommended amenity criteria are shown in Table 4 below.

Table 4 NSW NPI – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2]
Residence	Urban	Day	60
		Evening	50
		Night	45
	Suburban	Day	55
		Evening	45
		Night	40
Area reserved for passive recreation (e.g. national parks)	All	When in use	50
Commercial	All	When in use	65
Industrial	All	When in use	70

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.

When the existing noise level from industrial noise sources is close to the recommended "Amenity Noise Level" (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area in line with the requirements of the NSW NPI.

It is relevant to note that the Arup report classifies all residential receiver areas as "Suburban".

This is not true for the 150 Epping Road residences. I will adopt the Urban receiver area classification for these residences.

3.1.3 Project Trigger Noise Levels

Generally speaking the noise criteria is determined by both the intrusiveness and amenity criteria. The intrusive and amenity criteria for industrial noise emissions, derived from the measured data, are presented in **Table 5**. These criteria are nominated for the purpose of determining the operational noise limits for mechanical plant associated with the development which can potentially affect noise sensitive receivers.

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 5.**

Table 5 External noise level criteria in accordance with the NSW NPI

Location	Time of Day	Project Amenity Noise Level, $L_{Aeq, period}$ [1] (dBA)	Measured $L_{A90, 15\ min}$ (RBL) [2] (dBA)	Measured $L_{Aeq, period}$ Noise Level (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion [3] for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [4,5]	Noise Criterion (lower of the intrusiveness and amenity criteria[6])
14 Jeanette St East Ryde - Arup data (L3)	Day	50	42	57	**47**	50	47
	Evening	40	42	57	**47**	50	47
	Night	35	31	49	**36**	42	36
65 Magdala Rd - Arup data (L2) at **4:30-4:45pm**	Day	50	53	56			
	Evening	40					
	Night	35					
150 Epping Road - Arup data (L1) at **2:55-3:10pm**	Day	50	47	49			
	Evening	40					
	Night	35					
150 Epping Road – Pulse data from Sat. 29-06-2019 and Tues. 02-07-2019.	Day	55	46	53	**51**	58	51
	Evening	45	46	50	51	**48**	48
	Night	40	41	47	46	**43**	43
Passive recreation	When in use	45	N/A	N/A	N/A	48	48
Commercial	When in use	60	N/A	N/A	N/A	63	63
Industrial	When in use	65	N/A	N/A	N/A	68	68

Note 1: Project Amenity Noise Levels corresponding to "Suburban" areas, equivalent to the Recommended Amenity Noise Levels (from the NPI) minus 5 dBA

Note 2: L_{A90} Background Noise or Rating Background Level (RBL)

Note 3: Intrusive criterion is equal to the RBL + 5 dB

Note 4: Where the project amenity noise levels is 10 dB below the existing industrial LAeq noise level, the amenity criteria can be set at 10 dB below the existing LAeq noise level. Where the project amenity noise levels is 15 dB below the existing traffic noise level, the amenity criteria can be set at 15 dB below the existing L_{Aeq} noise level. This is based on the assumption that the existing noise levels are unlikely to decrease in the future.

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: The lower of the amenity and the intrusiveness level is typically used as the applicable overall noise criterion for the day, evening and nighttime periods.

3.2 Interim Construction Noise Guideline

The Interim Construction Noise Guideline (ICNG) sets out ways to deal with the potential impacts of construction noise on residences and other sensitive land uses. The ICNG presents assessment approaches that are tailored to the scale of construction projects.

A portion of the main objectives from Section 1.3 of the ICNG are presented below:

- 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
- 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, including commercial and industrial premises.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The various NML categories for residential receivers have been reproduced from Table 2 of the Interim Construction Noise Guideline and are presented in Table 6 below. It is understood that no planned construction works are scheduled outside of standard construction hours.

Table 6 Noise Management Levels for Airborne Construction Noise at Residences

Location	Time of Day	Project Trigger Level (dBA)
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 • $L_{Aeq(15minute)}$ 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 recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with 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 Noise Policy for Industry.

3.2.1 Summary of the Noise Construction Criteria

The noise construction criteria (NML) for the receivers affected by the proposed development are outlined in Table 7. It is understood that construction works are proposed to take place during standard hours. Therefore, the construction criteria for standard construction hours are presented in Table 7.

Table 7 Construction Noise Management Levels Criteria

Location	NML, dBA $L_{Aeq(15minute)}$
	Standard Hours, Monday to Friday: 7 am to 6 pm, Saturday: 8 am to 1 pm
R1	57
R2	63
R3	52
C1	70
S1	60

4 PREDICTED MECHANCIAL SERVICES NOISE EMISSION AND ASSESSMENT

4.1 Equipment Noise Levels

In order to ensure compliance with the Project Trigger Noise Levels summarised in 3.1.3, the proposed chiller and transformer plant have been assessed at the nearest residences, located at 150 Epping Road as follows:

- The assessment for the proposed equipment is based on the sound levels listed for the chillers in Table 8 and Table 9, and the transformers and generators in Table 10 below.
- The presented sound power levels in Table 9 are equal to the maximum noise levels minus the correction levels for each period presented in Table 8.
- The chiller sound power levels for the day, evening and night-time periods have been based on the maximum noise levels at 100% IT load and have been provided by Geoclima.
- Corrections made to the maximum chiller levels for the day, evening and night-time periods have been based on the levels provided previously for the TMA 3B 1350A ES EC (1600kW) air cooled chiller units. The corrections for the TMA 4B 1800B ES EC-34 K (2,200kWr) unit are anticipated to be similar.
- **The chiller sound power levels for the Day, evening and Night-time periods are to be confirmed by Geoclima.**
- The sound power levels for the transformers and generators in Table 10 are based on the information contained within the Arup noise report LWCDC – SSDA Acoustic Assessment. The levels include mitigation measures for the transformers and the generators. As per the Arup report, the transformers are to be enclosed to achieve a 10 dB reduction and the gensets are recommended to be specified with a maximum emission of 72 dB(A) at 1m.

Table 8 Max sound power level for Chiller and correction levels without any attenuators and at 100% IT load

Condition	Temp	Unit	SWL (dBA) in Octave Band Centre Frequencies (Hz)								
			63	125	250	500	1000	2000	4000	8000	dBA
Max	44 (100% load)	TMA 4B 1800B ES EC-34 K (2,200kWr)	66.7	80.1	83.9	90.2	94.2	93.0	86.4	79.5	**98.2**
Day	35 (80% speed)	Correction form TMA 3B 1350A ES EC (1600kW)	-6.2	-6.2	-6.3	-6.2	-6.2	-6.3	-6.1	-6.0	**-6**
Evening	30 (80% speed)	Correction form TMA 3B 1350A ES EC (1600kW)	-13.0	-12.1	-12.7	-12.0	-11.8	-12.4	-11.4	-9.7	**-12**
Night	25 (80% speed)	Correction form TMA 3B 1350A ES EC (1600kW)	-19.8	-16.3	-18.6	-15.9	-15.5	-17.2	-14.4	-11.2	**-16**

Table 9 Calculated sound power levels for Chillers without any attenuators and at 100% IT load

Condition	Temp	Unit	SWL (dBA) in Octave Band Centre Frequencies (Hz)								
			63	125	250	500	1000	2000	4000	8000	dBA
Day	35 (80% speed)	TMA 4B 1800B ES EC-34 K (2,200kWr)	61	74	78	84	88	87	80	74	92
Evening	30 (80% speed)	TMA 4B 1800B ES EC-34 K (2,200kWr)	54	68	71	78	82	81	75	70	86
Night	25 (80% speed)	TMA 4B 1800B ES EC-34 K (2,200kWr)	47	64	65	74	79	76	72	68	82

Table 10 Sound power level for transformers and diesel generators

Equipment	No of units	SWL (dBA) in Octave Band Centre Frequencies (Hz)								
		63	125	250	500	1000	2000	4000	8000	dBA
Transformers	12	74	76	71	71	65	60	55	48	**71**
Generators	1	108	104	89	86	88	89	81	77	**95**

The noise levels used for the current assessment for the day, evening and night-time periods are based on the data shown above and are given in Table 11 below.

4.2 Mechanical Services Assessment and Recommendations

4.2.1 Noise Emission Goals

- The noise assessment goal for the closest residences at 150 Epping Road is given below:
  - Daytime 51 dBA Leq
  - Evening 48 dBA Leq
  - Night 43 dBA Leq

4.2.2 Calculation (based on distance loss for actual distances) without any attenuators or additional shielding by adjacent plant items

- The calculated noise levels from the chillers without attenuators and with the transformers at the nearest residents for an assessment that uses real distances of each section of the datacentre development (i.e. Sections A, B & C) is given below:
  - Daytime 52 dBA Leq (+1 dB)
  - Evening 46 dBA Leq
  - Night 43 dBA Leq

The day limits are exceeded by a marginal 1 dB.

4.2.3 Calculation (based on distance loss for actual distances) and 900mm long circular acoustically lined discharge duct (without any additional shielding by adjacent plant items)

- We are informed that circular ducts will be fitted onto the discharge side of the chiller fans to help prevent recirculation of hot air.
- The discharge ducts are 900mm long and 910mm in diameter
- If these ducts are lined internally with 25mm acoustic insulation then the additional acoustic attenuation listed in Table 11 is anticipated.
- No additional attenuation devices are recommended for the transformers

Table 11 Calculated acoustic performance of discharge ducts

Parameter	Octave Band Centre Frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
Attenuator to the discharge side of the fan								
Circular duct 900mm long (910mm diameter with 25mm insulation)	0.0	-0.2	-1.0	-3.0	-2.8	-2.1	-1.8	-1.9
Note 1: These attenuators must have Mylar facing over the insulation to minimise the level of water absorption during rain insulation								

- The calculated noise levels from the transformers and the chillers with the 900mm long discharge ducts (910mm diameter lined with 25mm acoustic insulation) at the nearest residents for an assessment that uses real distances of each section of the datacentre development (i.e. Sections A, B & C) is given below:
  - Daytime 50 dBA Leq
  - Evening 44 dBA Leq

- Night 40 dBA L_{eq}

This results in compliance with the noise criteria for all time periods (with a marginal of 1 dB, 4 dB and 3 dB for the daytime, evening and night-time periods respectively).

It is noted that the noise levels from the transformers and chillers will be approximately 6 dBA lower at the closest residences located to the west of the site at a distance of approximately 600m. The criterion here is also lower, particularly for the night-time period when the noise criterion is 35 dBA. The calculated noise level for this time period is 35 dBA and therefore meets the noise criterion.

The noise criteria for the national park and the nearest commercial receivers are 48 dBA and 63 dBA respectively. Both of these receiver locations will be significantly affected by acoustic shielding provided by the edge of the building structure and adjacent mechanical plant items. Noise emission during the daytime period will be calculated to these receiver locations during the detailed design stage of the project.

4.2.4 Calculation of Generator Testing

It is understood that a number of generators are proposed to be located on external platforms. The generators are proposed to be used in the event of a power blackout. Additionally, the generators are proposed to be tested periodically, one at a time during the day period.

Section 1.4 of the Noise Policy for Industry states that the NPI applies to activities listed in Schedule 1 of the Protection of the Environment Operations (POEO) Act. In Schedule 1 of the POEO Act, Section 17 (1A), it states that

"this clause does not apply to the generation of electricity by means of electricity plant that is emergency stand-by plant operating for less than 200 hours per year".

Testing of generators one by one will tally over 200 hours per year, while use of all generators in a power outage will not exceed 200 hours per year. Therefore, use of all generators at once is outside the Noise Policy for Industry. In this section, the testing of one generator at a time is analysed.

The calculated noise levels from the transformers and the chillers with the 900mm long discharge ducts (910mm diameter lined with 25mm acoustic insulation), as well as the testing of a single generator is given below. At the nearest residents for an assessment that uses real distances of each section of the datacentre development (i.e. Sections A, B & C), predicted noise levels are:

- Daytime (Section A Generator) 50 dBA L_{eq}
- Daytime (Section B Generator) 50 dBA L_{eq}
- Daytime (Section C Generator) 50 dBA L_{eq}

This results in compliance with the noise criteria for the day time period by 1 dB.

5 CONCLUSIONS

Using the maximum sound power data for the TMA 4B 1800B ES EC-34 K (2,200kWr) chiller unit provided by Geoclima, as well as sound power data for the transformers and generators, sound power levels for the day, evening and night-time period have been calculated. The assessed scheme includes chillers and transformers on the roofs of buildings A, B and C as well as generators on external platforms.

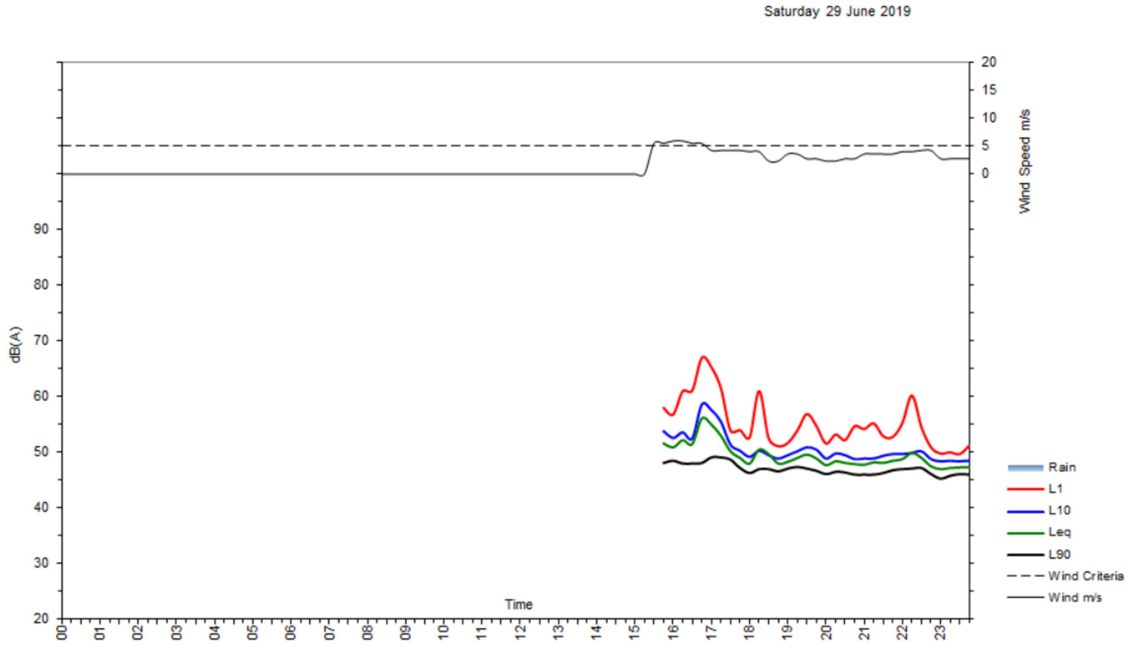
The total noise emission for the proposed datacentre for the currently selected transformer, generator and air cooled chiller scheme has subsequently been calculated to the nearest residential receiver locations. The predicted noise levels are in compliance with the relevant noise criteria for these residential receiver locations during chiller, transformer and a single generation operation.

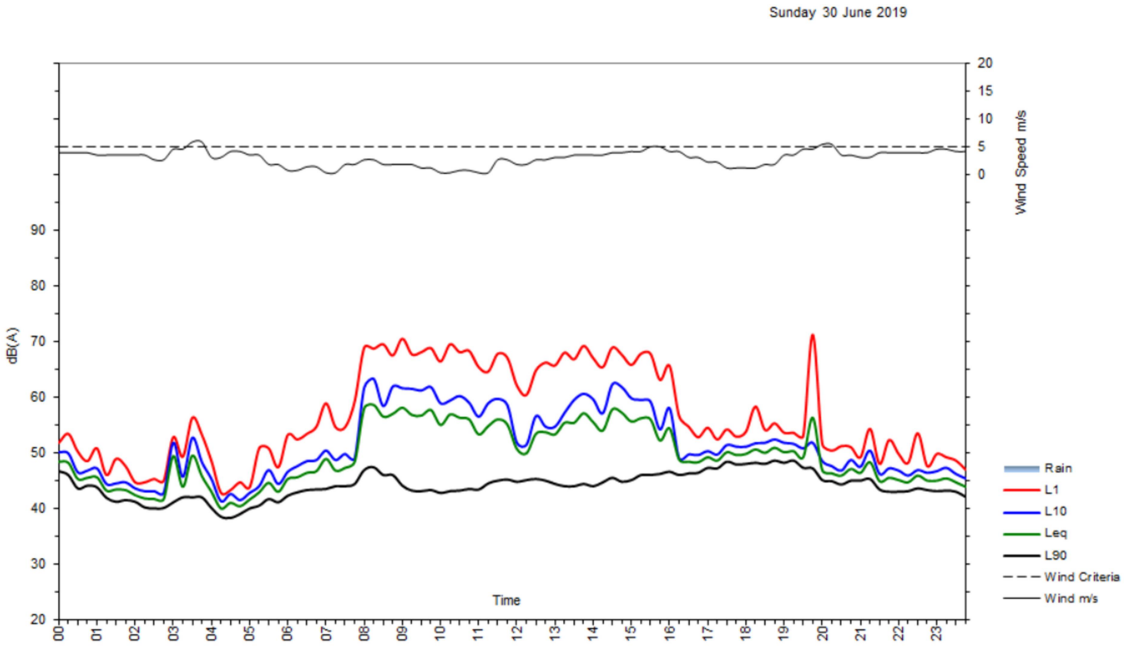
Noise levels have not as yet been calculated to other receiver locations such as the adjacent commercial and passive recreational areas. The predicted noise levels to these locations will be significantly affected by shielding proved by the edge of the building structure and adjacent plant items and will therefore be provided during the detailed design stage when this detailed information can be more accurately determined.

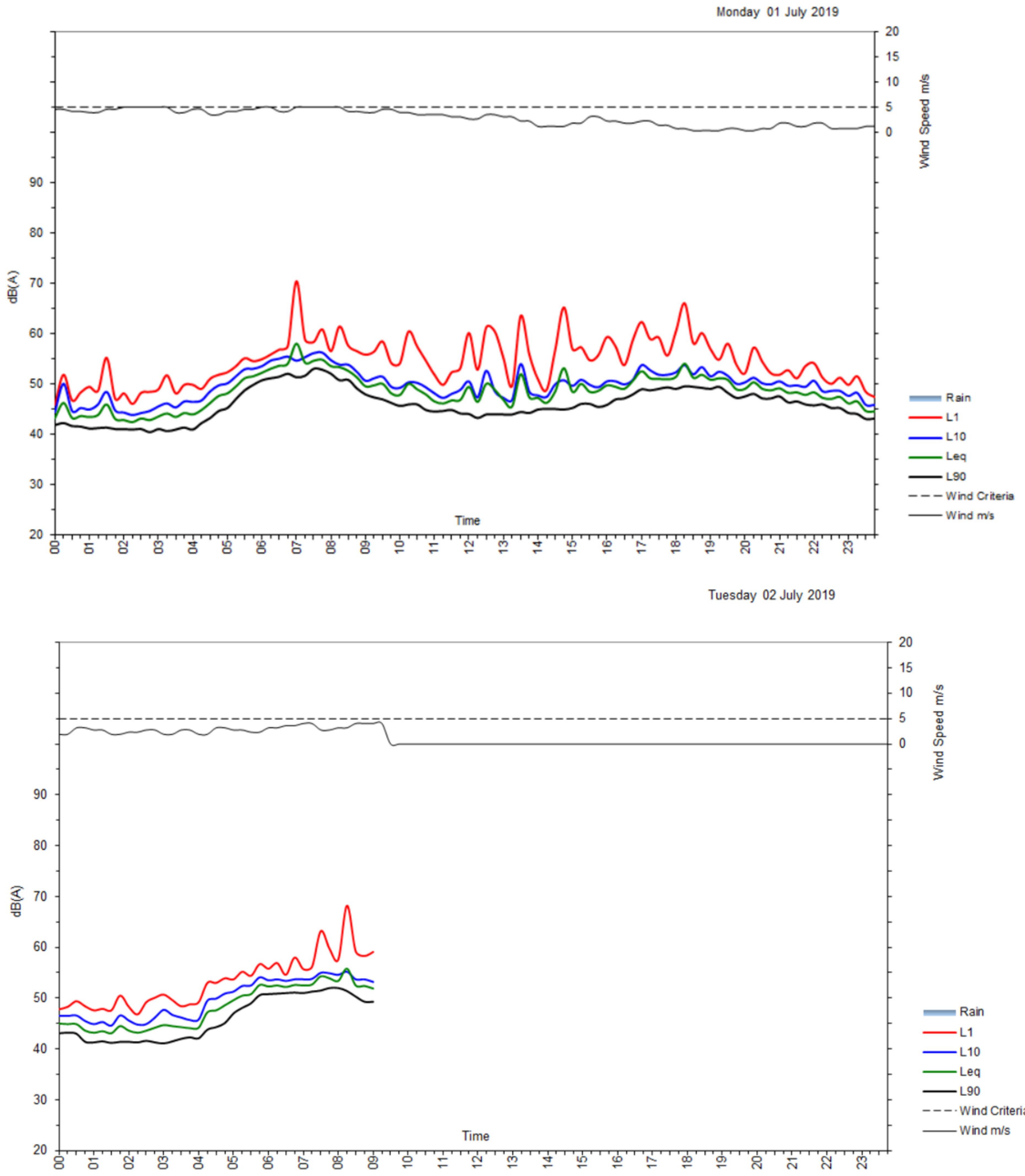
APPENDIX A: ACOUSTIC GLOSSARY

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; 0dBA the faintest sound we can hear 30dBA a quiet library or in a quiet location in the country 45dBA typical office space. Ambience in the city at night 60dBA Martin Place at lunch time 70dBA the sound of a car passing on the street 80dBA loud music played at home 90dBA the sound of a truck passing on the street 100dBA the sound of a rock band 115dBA limit of sound permitted in industry 120dBA 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.
Background Sound Level	The average of the lowest levels of the sound levels measured in an affected area in the absence of noise from occupants and from unwanted, external ambient noise sources. Usually taken to mean the LA90 value
Sound Isolation	A reference to the degree of acoustical separation between any two areas. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term "sound isolation" does not specify any grade or performance quality and requires the units to be specified for any contractual condition
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: NOISE MONITORING RESULTS






Monday 01 July 2019
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
Tuesday 02 July 2019
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s