Macquarie Park Data Centre

Noise and Vibration Impact Assessment

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Prepared by

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Table of Contents

Executive Summary

This report has been prepared to support the State Significant Development application to construct and operate a data centre ('the Project') at 11-17 Khartoum Road and 33-39 Talavera Road (Lot 1 in DP 633221), Macquarie Park, NSW.

The Project involves the construction of a main building and façade, ancillary offices and staff amenities, car parking, loading dock, security guard house and mechanical and electrical infrastructure, including back up power generators. The Site would be operated on a 24-hour, 7 day a week basis.

Subject to approval, the Project is expected to commence in late 2020/early 2021 and take up to 18 months to construct, with construction undertaken during standard hours only

This Noise and Vibration Impact Assessment (NVIA) provides an assessment of potential noise and vibration impacts from both the construction and operational phases of the Project. Relevant guidelines and assessment procedures have been followed to ensure all applicable requirements have been considered. The Secretary's Environmental Assessment Requirements (SEARs) have been referenced in this assessment to ensure that all potential impacts have been adequately considered.

Background noise levels have been monitored at a total of two locations to identify the existing noise environment throughout the adjacent area. Appropriate construction noise management levels and operational noise trigger levels have been established based on the existing noise levels.

A construction noise assessment has been conducted in accordance with the *Interim Construction Noise Guideline* (DECC, 2009). Three distinct construction stages were used in a computer-based noise model to determine the predicted noise levels generated from the Project. Construction noise impacts were assessed at residential receivers surrounding the Project, as well as non-residential receivers.

The assessment of noise associated with the construction of the Project indicates some exceedances of the noise management levels at the most affected sensitive receivers during certain activities. The magnitude and number of exceedances are detailed in this report.

Measures have been recommended to mitigate the construction noise impact at nearby sensitive receivers. The implemented measures would ultimately be selected by the construction contractor and be largely dependent on the construction strategy and work undertaken. Specific noise management and mitigation measures would be detailed in a Construction Noise and Vibration Management Plan (CNVMP). The recommended mitigation measures that may be implemented include:

- effective community consultation,
- induction and training of construction site workers,
- use of noise barriers,
- noise monitoring,
- appropriate selection and maintenance of equipment, and use of at-source noise mitigation,
- scheduling of work for less sensitive time periods,
- situating plant in less noise sensitive locations,
- construction traffic management, and
- respite periods.

Minimum working distances for vibration intensive construction works have been presented. Equipment size would be selected by the construction contractor and would take into account the minimum working distances and the distance between the area of construction and the nearest sensitive receiver.

Construction traffic is unlikely to increase the road traffic noise levels on surrounding roads by more than 2 dB(A). This is compliant with the traffic noise increase criterion in the *Road Noise Policy* (DECCW, 2011).

Cumulative construction noise impacts may occur as a result of concurrent construction stages of the Project being undertaken or other major projects occurring within proximity to the Project. Consultation would be undertaken with the proponents of other projects to minimise potential impacts where feasible and reasonable.

An operational noise assessment has been completed in accordance with the *Noise Policy for Industry* (EPA, 2017). The primary noise sources would include 19 containerised generators, 16 computer room air conditioning (CRAC) units, 324 relief air fans and 54 air handling units (AHU). The generators are for emergency backup only, and would only be used in emergency situations and periodic testing. Recommendations have been provided for the inclusion of attenuators to control mechanical plant noise. The operation of the proposed data centre with periodic back-up generator testing complies with the relevant *Noise Policy for Industry* criteria and is considered acceptable.

Traffic generation as a result of the operation of the Project is minimal and predicted traffic noise increases would comply with the applicable criteria outlined in the NSW *Road Noise Policy*.

Based upon this assessment, all relevant noise and vibration impacts can be appropriately managed in accordance with the relevant guidelines and standards.

1.0 Introduction

1.1 Project overview

This report has been prepared to support the State Significant Development application to construct and operate a data centre ('the Project') at 11-17 Khartoum Road and 33-39 Talavera Road (Lot 1 in DP 633221), Macquarie Park, NSW. The Project would comprise the following:

- Construction of Road 22 as per the Concept Development consent
- Earthworks, excavation and retaining walls
- Construction of the main building and façade
- Ancillary offices and staff amenities
- Car parking
- Loading dock
- Security guard house
- New vehicular access to Road 22
- Service infrastructure
- Mechanical and electrical infrastructure
- Cooling and air conditioning
- Diesel backup generators
- Landscaping
- Fit out of all data halls in a staged manner based on need.

The data centre would be operated on a 24-hour, 7 day a week basis.

The primary noise sources would include 19 containerised generators, 16 computer room air conditioning (CRAC) units, 324 relief air fans and 54 air handling units (AHU). The generators are for emergency backup only, and would only be used in emergency situations and periodic testing.

Subject to planning approval, construction is anticipated to commence following Project approval in early 2021 and would take approximately 18 months to complete.

This technical report provides an assessment of the potential noise and vibration impacts of the Project and addresses the requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) (the 'Secretary's Environmental Assessment Requirements' or SEARs, 20 June 2020).

1.2 Secretary's Environmental Assessment Requirements

The SEARs relating to Noise and Vibration, and where these requirements are addressed in this technical report, are outlined in Table 1.

Table 1 Secretary's Environmental Assessment Requirements

	Secretary's Environmental Assessment Requirements	Where addressed
General Requirements	*The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (the Regulation). In addition, the EIS must include:* *… a detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment…*	This report
Key Issues	***4. Noise and vibration**– including:* • *a quantitative noise and vibration impact assessment (NVIA) of the development during construction and operation (including testing of the back-up generators). The NVIA must be undertaken by a suitably qualified person in accordance with the relevant Environment Protection Authority guidelines, and include an assessment of potential impacts to nearby sensitive receivers and cumulative impacts of surrounding developments* • *proposed mitigation, management and/or monitoring measures.*	• This report and specifically sections 5.0 and 7.0 • Section 6.0

1.3 Purpose and scope of this technical report

This Noise and Vibration Impact Assessment (NVIA) is one of a number of technical documents that forms part of the Macquarie Park Data Centre EIS. The purpose of this report is to identify potential impacts of the Project and to outline mitigation measures relating to noise and vibration during construction and operation of the Project.

The objectives of the NVIA are to:

- establish the existing background noise levels in the vicinity of the Project
- establish construction noise management levels and vibration limits that would apply to the Project
- predict noise and vibration levels at nearby residential and other sensitive receivers due to the construction of the Project
- predict environmental noise and vibration levels at nearby residential and other sensitive receivers due to operation of the Project
- predict noise levels from additional off-site construction traffic generated by the Project recommend mitigation measures, where necessary, to reduce and manage noise and vibration impacts from the Project to comply with established noise management levels and vibration limits.

1.4 Policies and guidelines

The following policies and guidelines are relevant for this assessment:

- *Assessing Vibration: A Technical Guideline* (AVATG), Department of Environment and Conservation (DEC), 2006
- Construction Noise and Vibration Strategy (CNVS), Transport for NSW, 2019
- *Interim Construction Noise Guideline* (ICNG), Department of Environment and Climate Change (DECC), 2009
- *NSW Road Noise Policy* (RNP), Department of Environment, Climate Change and Water (DECCW), 2011
- *Noise Guide for Local Government* (NGLG), Environment Protection Authority, 2013
- *Noise Policy for Industry* (NPfI), Environment Protection Authority (EPA), 2017
- *State Environment Protection Policy (SEPP) (Infrastructure*), 2007
- Australian Standard AS 1055-2018 – *Acoustics—Description and measurement of environmental noise*, 2018
- Australian Standard AS 2436-2010, *Guide to noise and vibration control on construction, demolition and maintenance sites*, 2010
- Australian Standard AS IEC 61672.1-2019 - *Electroacoustics – Sound level meters Specifications*, 2019
- British Standard 5228: Part 1 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise*, 2009 including Amendment 1, 2014
- British Standard 6472: *Evaluation of human exposure to vibration in buildings (1-80 Hz)*, 1992
- British Standard 7385: Part 2 1993 *Evaluation and Measurement of Vibration in Buildings*, 1993
- DIN Standard 4150: Part 3 2016 *Vibration in Buildings - Effects on Structures*, 1999

Acoustic terminologies used in this assessment are explained in Appendix A.

2.0 Existing acoustic environment

2.1 Site location

The Project is located on land legally designated as Lot 1 in DP 633221, local address 11-17 Khartoum Road and 33-39 Talavera Road, Macquarie Park (the Site). The Site is located within the City of Ryde Local Government Area (LGA).

The area of the Site (by title) is 3.003 ha, with a northwest frontage (181.05 m) facing Khartoum Road, and a northeast frontage (165.96 m) facing Talavera Road. The Project would occupy the south eastern portion of the Site, being around 50% of the total Site area. It is understood that other commercial buildings would occupy the north western portion of the site. These buildings have been assessed as commercial receivers.

The Site is located within the Macquarie Park Corridor and sits adjacent to other existing commercial properties to the southwest and the southeast. The Site is located within a B7 Business Park Zone under the *Ryde Local Environmental Plan 2014* (Ryde LEP). The surrounding areas contain a mix of B4 Mixed Use and B3 Business Park land uses.

More broadly, the Site is located approximately 12 km northwest of the Sydney CBD, approximately 850 m southeast of Macquarie University, and 325 m southeast of Macquarie Shopping Centre, measured along Talavera Road. The Site is also located approximately 490 m northwest of Lane Cove Road and the on-ramp to the M2 motorway, also measured along Talavera.

The surrounding area is characterised by commercial buildings and land uses, consistent with the character of Macquarie Park as a business precinct.

2.2 Assessment receivers

Residential and non-residential receivers potentially affected by the construction and operation of the Project are located in the suburbs of Macquarie Park and Marsfield. To assist in determining noise management levels for the receivers surrounding the Project, two noise catchment areas (NCA) were identified. For the purposes of undertaking a construction noise impact assessment the noise environment at each residential receiver within a NCA is considered to have a similar noise environment, considering the proximity to existing major noise sources.

For the operational noise assessment noise levels are predicted and assessed at representative sensitive receivers. The Project site, NCAs, representative sensitive receivers and surrounding area are presented in Figure 1. The assessment receiver addresses, along with the land usages of each receiver are presented in Table 2.

Table 2 Receiver locations

Assessment receiver	NCA	Address	Usage
Residential receivers			
R1	NCA 1	32 Khartoum Road, Macquarie Park	Residential
R2	NCA 1	33 Khartoum Road, Macquarie Park	Residential
R3	NCA 1	7 Tasman Place, Macquarie Park	Residential
R4	NCA 1	35-39 Fontenoy Road (West), Macquarie Park	Residential
R5	NCA 1	35-39 Fontenoy Road (East), Macquarie Park	Residential
R6	NCA 1	101-107 Waterloo Road (North), Macquarie Park	Residential
R7	NCA 1	101-107 Waterloo Road (South), Macquarie Park	Mixed Use
R8	NCA 2	80 Waterloo Road, Macquarie Park	Mixed Use
R9	NCA 2	82-84 Waterloo Road, Macquarie Park	Mixed Use
R10	NCA 2	16 Cottonwood Crescent, Macquarie Park	Mixed Use
R11	NCA 2	384-386 Lane Cove Road, Macquarie Park	Commercial
R12	NCA 2	112 Talavera Road, Macquarie Park	Mixed Use
Non-residential receivers			
N1	-	11-17 Khartoum Road (North), Macquarie Park	Commercial
N2	-	11-17 Khartoum Road (South), Macquarie Park	Commercial
N3	-	Excelsia College, 63-71 Waterloo Road, Macquarie Park	Educational
N4	-	North Ryde Early Learning Centre, 24 Talavera Road, Macquarie Park	Childcare centre
N5	-	Macquarie University (School of Engineering), 44 Waterloo Road, Macquarie Park	Educational
N6	NCA 1	Marriot Hotel, 7-11 Talavera Road, Macquarie Park	Commercial

Compliance with the relevant criteria at these locations would result in compliance of the appropriate criteria at nearby premises of different land use classifications, such as industrial and commercial premises.

Figure 1 Site map showing NCAs, noise monitoring locations, and representative assessment receiver locations

2.3 Noise Monitoring

Long-term unattended measurements at two locations were undertaken to establish the existing ambient and background noise environment at potentially affected receivers in the vicinity of the data centre site. The noise monitoring was undertaken between Tuesday 10 March 2020 and Friday 20 March 2020.

2.3.1 Instrumentation

The equipment used for site measurements is detailed below in Table 3.

Table 3 Environmental noise monitoring equipment

Location	Equipment	Serial Number
Unit 6, 37 Khartoum Road, Macquarie Park	SVAN 977	45416
7 Booth Street, Marsfield.	SVAN 957	23855

Calibration of the noise loggers was checked on site with a B&K NC74 Sound Calibrator (serial number 34283659) at the beginning and end of the measurement periods. No significant drifts in calibration were observed. All acoustic instrumentation employed during the noise measurements comply with the requirements of AS IEC 61672.1-2019 Electroacoustics - Sound level meters - Specifications and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years). The noise measurements have been conducted in accordance with AS1055.1 – 2018 “Acoustics – Description and measurement of environmental noise”.

In accordance with the EPA’s *Noise Policy for Industry*, noise monitoring data affected by adverse weather conditions or extraneous noise events were excluded. The *Noise Policy for Industry* advises that data may be affected where adverse weather, such as wind speeds higher than five metres per second or rain, occurs. Weather data were acquired from the Bureau of Meteorology’s Sydney Olympic Park weather station (station ID 95765).

2.3.2 Noise monitoring locations

The first noise logger was located north of the site in the front garden of Unit 6, 37 Khartoum Road, Macquarie Park and the second was located to the west of the site in the front garden of 7 Booth Street, Marsfield. The microphones were 1.5 m above ground level.

The loggers were set for sample periods of 15 minutes. The loggers measured the noise levels over the sample period and then determined L_{A10}, L_{A90}, L_{Amax}, and L_{Aeq} levels of the noise environment. The L_{A10} and L_{A90} levels are the levels exceeded for 10% and 90% of the sample period respectively. The L_{Amax} is indicative of the maximum noise levels due to individual noise events such as the pass-by of a heavy vehicle. The L_{A90} is taken as the background noise level. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The background noise level is defined by the EPA as ‘the underlying level of noise present in ambient noise when all unusual extraneous noise is removed’. It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is considered to be represented by the L_{A90} descriptor. The noise levels measured at the proposed development site were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the *Noise Policy for Industry*, for each monitoring location. The ABL is established by determining the lowest ten percentile level of the L_{A90} noise data acquired over each period of interest.

A summary of the measurement data is presented in Table 4. Noise levels are also graphically presented in Appendix B.

Table 4 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

Measurement Date	L_{A90} Background Noise Levels, dB(A)			L_{Aeq} Ambient Noise Levels, dB(A)		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Unit 6, 37 Khartoum Road, Macquarie Park (NCA1)						
Tuesday 10 March 2020	-	46	-	56	58	53
Wednesday 11 March 2020	45	46	37	56	58	50
Thursday 12 March 2020	45	46	38	56	56	52
Friday 13 March 2020	45	43	40	60	54	49
Saturday 14 March 2020	50	46	38	59	57	50
Sunday 15 March 2020	46	44	38	57	57	51
Monday 16 March 2020	48	45	37	59	59	52
Tuesday 17 March 2020	46	43	36	58	66	51
Wednesday 18 March 2020	44	43	39	53	55	50
Thursday 19 March 2020	44	42	38	55	54	50
Friday 20 March 2020	-	-	-	55	-	50
RBL/Log Average	**45**	**45**	**38**	**57**	**59**	**51**
7 Booth Street, Marsfield (NCA2)						
Tuesday 10 March 2020	-	42	-	60	54	52
Wednesday 11 March 2020	42	42	32	55	55	47
Thursday 12 March 2020	-	41	34	53	51	45
Friday 13 March 2020	41	41	33	52	51	51
Saturday 14 March 2020	-	42	34	53	52	47
Sunday 15 March 2020	-	41	32	54	53	45
Monday 16 March 2020	46	44	33	56	52	46
Tuesday 17 March 2020	42	42	29	55	62	45
Wednesday 18 March 2020	42	41	34	55	52	45
Thursday 19 March 2020	-	-	-	-	-	44
RBL/Log Average	**42**	**42**	**33**	**55**	**56**	**47**

Notes:

1. *Day is defined as 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.*
2. *Evening is defined as 6pm to 10pm Monday to Sunday and Public Holidays.*
3. *Night is defined as 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.*

2.4 Attended noise measurements

Attended noise measurements were undertaken to supplement the unattended noise measurements at representative receiver locations. Attended noise measurements were undertaken on Tuesday 10 March 2020 during the setup of the noise loggers. Attended noise measurements were undertaken at the noise logging locations as indicated in Figure 1 above.

Attended noise measurements were undertaken using a Bruel & Kjaer 2250 sound level meter (Serial number: 3009329). The B&K 2250 sound level meter is designated as having Type 1 accuracy. All

equipment used was calibrated before and after measurements with a drift in calibration not exceeding ± 0.5 dB. Additionally, all equipment used for this assessment were in their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. full 1/3 octave band calibration in the last 2 years).

The weather during the attended measurements was fine and did not affect the measurements.

A summary of the attended noise measurement results is presented in Table 5 below.

Table 5 Summary of attended noise measurements

Location	Date/Time	Measured Noise Levels, dB(A)				Comments
		L_{eq}	L_1	L_{10}	L_{90}	
Unit 6, 37 Khartoum road, Macquarie Park	10/03/2020 15:47	54	64	58	45	Noise environment dominated by road traffic noise to west along Khartoum road
7 booth street, Marsfield	10/03/2020 16:32	54	64	55	45	Noise environment dominated by road traffic noise hum to north/north east. Ambient controlled by plane and local traffic pass by and some vehicles along Epping road to the north and Herring road. Overhead plane pass by frequent.

As describe above in Table 5, the acoustic environment in NCA 1 and 2 are generally dominated by local vehicle traffic with receivers also affected by aircraft noise. The receivers in NCA 2 are also affected by commercial activity within the business park and the Macquarie Shopping Centre. Natural sounds are also audible throughout both NCAs. These characteristics are typical of an urban environment.

2.4.1 Traffic noise monitoring

Attended measurements of traffic noise in vicinity of the development site were detailed in a report titled *Macquarie Technology Centre, 11-17 Khartoum road and 33-39 Talavera Road, Macquarie Park Environmental Noise Impact Assessment* by Acoustic Logic, dated 28 November 2017. As the Project site is located within the 33-39 Talavera Road boundary, the measurement results in the report by Acoustic Logic are considered to be applicable to this project. The results of these measurements are presented in Table 6.

Table 6 Traffic noise levels from Khartoum Road and Talavera Road at the Project site

Location	Time of measurement	LAeq level at façade, dB(A)
Road Traffic from Talavera Road at the project site boundary	4.30pm to 5.30pm	68
Road Traffic from Khartoum Road at the project site boundary	4.30pm to 5.30pm	66

3.0 Construction Noise and Vibration Criteria

Construction of the proposed development has the potential to temporarily contribute to the existing external noise environment. This section will establish management levels to address these issues.

3.1 Construction noise

3.1.1 Construction noise management levels

The *Interim Construction Noise Guideline* is the principal guideline for the assessment and management of construction noise in NSW. As the proposed works are expected to continue for a period of more than three weeks and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on representative construction scenarios, has been carried out for the Project.

Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using environmental noise modelling software and compared to the noise management levels (NML), derived in accordance with the *Interim Construction Noise Guideline*.

Where an exceedance of the noise management levels is predicted, the *Interim Construction Noise Guideline* advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise level and duration, as well as provide contact details to facilitate feedback from affected residents during construction.

Where construction noise levels at the receiver reach 75 dB(A), residential receivers are considered to be 'highly noise affected' and the proponent should, in consultation with the community, consider restrictions to the hours of construction to provide respite periods.

3.1.1.1 Residential receivers

Guidance for setting construction noise management levels for residential receivers are summarised in Table 7.

Table 7 Construction noise management levels – residential receivers

Time of Day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to Apply
Recommended standard hours[2]: 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 $L_{Aeq\ (15\ min)}$ 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 dB(A)	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(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 (ICNG).

Notes:

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.*

The *Interim Construction Noise Guideline* defines what is considered to be feasible and reasonable as follows:

- Feasible - a work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

- Reasonable - selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Table 8 presents the NMLs applicable to residential receivers nearby to the Project.

Table 8 Construction noise management levels – Residential receivers

Location of residential receivers	Recommended standard hours RBL	Recommended standard hours noise management levels L_{Aeq} dB(A)	Highly noise affected level L_{Aeq} dB(A)
NCA1 - Residences to the north (Macquarie Park)	45	55	75
NCA2 - Residences to the south (Marsfield)	42	52	75

3.1.1.2 Other sensitive land uses and commercial receiver noise management levels

Table 9 presents the NMLs applicable to other noise sensitive receivers such as educational facilities, places of worship and commercial receivers.

Table 9 Construction noise management levels – other receivers

Land Use	External noise levels, $L_{Aeq,15min}$ (applies when properties are in use)
Classrooms at schools and other educational institutions	65 dB(A)[1]
Childcare centre	65 dB(A)[1]
Active recreation areas	65 dB(A)
Passive recreation areas	60 dB(A)
Industrial premises	75 dB(A)
Commercial premises (including cafes, bars, restaurants, retail stores and hotels)	70 dB(A)

Notes:

1. *This external noise management level is based upon a 45 dB(A) internal noise management level and a 20 dB(A) reduction from outside to inside through a closed window*

3.1.2 Construction traffic noise

To assess noise impacts from construction traffic an initial screening test should be undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A), in line with the *Road Noise Policy*.

Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation should be considered for those receivers affected. The *Road Noise Policy* does not require assessment of noise impact to commercial or industrial receivers.

3.2 Vibration criteria

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities

- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

The relevant standards and guidelines for the assessment of construction vibration are summarised in Table 10.

Table 10 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration)	Assessing Vibration: A Technical Guideline (AVATG)[1]

Notes:

1. *This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. However the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.*

3.2.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration. The German Standard (DIN 4150) provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 11. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage. In this assessment of DIN 4150 structural damage safe limits have been adopted for residential and non-residential structures.

Table 11 Structural damage safe limits (DIN 4150) for building vibration (Peak particle velocity)

Group	Type of structure	At foundation – Less than 10 Hz	At foundation – 10 Hz to 50 Hz	At foundation – 50 Hz to 100 Hz[1]	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed)	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values

3.2.2 Human comfort

The assessment of intermittent vibration outlined in the NSW EPA guideline A*ssessing Vibration: A Technical Guideline* (AVTG) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the daytime and night-time periods.

Maximum and preferred VDVs for intermittent vibration arising from construction activities are listed in Table 12. The VDV criteria are based on the likelihood that a person would comment adversely on the level of vibration over the entire assessment period.

Table 12 Preferred and maximum vibration dose values for intermittent vibration (m/s$^{1.75}$)

Location	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops[2]	0.8	1.6	0.8	1.6

Notes:

1. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. Places where sensitive equipment is stored or delicate tasks are undertaken require more stringent criteria than the residential criteria specified above*

2. *Examples include automotive repair shops, manufacturing or recycling facilities. This includes places where manufacturing, recycling or repair activities are undertaken but do not require sensitive or delicate tasks.*

4.0 Operational Noise Criteria

4.1 Environmental noise emission – *Noise Policy for Industry*

Industrial noise has the potential to affect nearby noise sensitive receivers. The *Noise Policy for Industry* sets out a procedure to determine project noise trigger levels relevant to a development. It if is predicted that the development is likely to cause the project noise trigger level to be exceeded at existing noise sensitive receivers, then management measures need to be considered to reduce the predicted noise level.

The assessment procedure for industrial noise sources has two components that must be considered:

- Controlling intrusiveness noise impacts in the short term for residences, and
- Maintaining noise level amenity for residences and other land uses.

Both components are assessed at the boundary of the noise sensitive receiver site. These criteria apply to environmental noise emissions from any plant installed as part of the Project, and for residential receivers, represent the lower of the intrusive or amenity criteria. This would include the assessment of the testing of the back-up generators, as required by the SEARs.

The primary function of the backup generators is to provide power to the facility during a power outage event (ie short term power back up during an emergency only). Given the rarity of these events the associated noise impacts are considered to be negligible and as such have not been assessed. The generators would however be subject to regular testing and as such this activity has been assessed in this operational noise assessment.

4.1.1 Intrusiveness noise impacts

The *Noise Policy for Industry* states that the intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15 minute period, does not exceed the background noise level measured by more than 5 dB. The Rating Background Levels (RBLs) and resultant project intrusiveness noise levels are presented in Table 13.

Table 13 *Noise Policy for Industry* recommended $L_{Aeq,15\ minute}$ intrusiveness noise levels from industrial noise sources

Location		Period	RBL (L_{A90}), dB(A)	Intrusive Noise Level (RBL+5), dB(A)
Residential Receivers	NCA1	Day[1]	45	50
		Evening[2]	45	50
		Night[3]	38	43
	NCA2	Day[1]	42	47
		Evening[2]	42	47
		Night[3]	33	38

Notes:

1. *Day is defined as 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.*
2. *Evening is defined as 6pm to 10pm Monday to Sunday and Public Holidays.*
3. *Night is defined as 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.*

Intrusiveness noise levels apply only to residential receivers. For other receivers, only the amenity levels apply.

4.1.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the recommended amenity noise levels specified in Table 2.2 of the *Noise Policy for Industry*. Given that the existing acoustic environment is

dominated by traffic and industrial related sources and the receivers are located near a commercial district, the noise amenity area is considered to be 'urban'.

Table 14 *Noise Policy for Industry* recommended L_{Aeq} amenity noise levels from industrial sources

Type of Receiver	Noise Amenity Area	Time of Day	Recommended Noise Level (L_{Aeq}), dB(A)
Residential	Urban	Day	60
		Evening	50
		Night	45
Hotel/motel	Urban	Day	65[1]
		Evening	55[1]
		Night	50[1]
School classroom – internal	All	Noisiest 1-hour	40[2]
School classroom – External	All	Noisiest 1-hour	60[3]
Commercial premises	All	When in use	65

Notes:

1. *According to Noise Policy for Industry Table 2.2, the recommended hotel amenity noise level is 5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day*
2. *The Noise Policy for Industry states "In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$*
3. *Assumes a 20 dB reduction from external to internal through a closed window*

According to Section 2.4 of the *Noise Policy for Industry*, the amenity level applicable to the project is equal to the recommended level minus 5 dB(A). This takes into account the cumulative impacts of other industrial noise sources in the area.

The recommended amenity noise level has therefore been adopted at the proposed new commercial buildings to the noise.

As per the *Noise Policy for Industry*, the project amenity level is converted to a 15 minute period by adding 3 dB(A).

4.1.3 Project noise trigger levels

Table 15 presents the applicable project noise trigger levels.

Table 15 ***Noise Policy for Industry*** **project noise trigger levels**

Type of Receiver		Time of Day	Intrusive noise level (RBL+5) ($L_{Aeq, 15\ minutes}$), dB(A)	Project amenity level ($L_{Aeq, 15\ minutes}$), dB(A)	Project noise trigger level ($L_{Aeq\ 15\ minutes}$), dB(A)
Residential Receivers	NCA1	Day	50	58	50
		Evening	50	48	48
		Night	43	43	43
	NCA2	Day	47	58	47
		Evening	47	48	43
		Night	38	43	38
Hotel/Motel		Day	-	63	63
		Evening	-	53	53
		Night	-	48	48
Commercial Premises		When in Use	-	63	63
School classroom – internal		Noisiest 1-hour		38	38
School classroom – External		Noisiest 1-hour		58	58

Adjustments to the level of noise predicted at the assessment location may be applied in accordance with Fact Sheet C of the *Noise Policy for Industry* to account for the subjective effects of specific noise characteristics including tonality, low frequency content, intermittency and duration.

4.1.4 Sleep disturbance trigger levels

The *Noise Policy for Industry* requires the potential for sleep disturbance to be assessed by considering maximum noise level events during the night-time period.

Where night-time noise levels from the proposed development at a residential location exceed the following screening levels, a detailed maximum noise level event assessment should be undertaken:

- $L_{Aeq, 15\ minute}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is greater; and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is greater.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance trigger levels for the noise sensitive residential receivers are presented in Table 16.

Table 16 Night-time sleep disturbance trigger levels

Type of Receiver	Measured night period RBL ($L_{Aeq, 15\ minute}$), dB(A)	Sleep disturbance screening trigger levels	
		$L_{Aeq, 15\ minutes, dB(A)}$	$L_{AFmax, dB(A)}$
NCA1	38	43	53
NCA2	33	40	52

4.2 Noise from road traffic generation – Road Noise Policy

To assess noise impacts from traffic generated by the operation of the Project an initial screening test should be undertaken by evaluating whether existing road traffic noise levels would increase by more

than 2 dB(A), in line with the Road Noise Policy. Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation should be considered for those receivers affected. The Road Noise Policy does not require assessment of noise impact to commercial or industrial receivers.

5.0 Construction noise impact assessment

An indicative construction noise and vibration impact assessment has been completed for the Project. Whilst the development is likely to be completed in multiple stages the assessment has considered a worst case scenario for the three most noise and vibration intensive stages.

5.1 Construction noise

This construction noise and vibration assessment is based on a typical construction scenario for this type of development.

5.1.1 Construction phases and sources

The construction scenarios that have been assessed are detailed below:

1. Site establishment and enabling works
2. Foundations, and
3. Frame and facade.

The equipment and associated sound powers for the scenarios are shown in Table 17.

Table 17 Construction phases and equipment

Phase	Equipment / Activity	Percentage time on	'A' Weighted SWL dB(A)
Site establishment and enabling works	Large excavator (35T)	100	100
	Vibratory roller	100	108[1]
	Backhoe	100	102
	Grader	100	109
	Water Cart	100	100
	Dump Truck	100	95
	Overall	**-**	**113**
Foundations	Crane	100	106
	Piling Rig – Impact Piling	100	121[1]
	Large excavator (35T)	100	100
	Pneumatic jackhammer	33	111[1]
	Concrete truck	100	106
	Concrete pump	100	106
	Large truck	100	108
	Overall	**-**	**122**
Frame & facade	Concrete truck	100	106
	Concrete pump	100	106
	Crane	100	106
	General hand tools	100	94
	Large truck	100	108
	Overall	**-**	**113**

Notes:

1. *A +5 dB correction has been added to account for annoying characteristics of this source*

Construction is scheduled to be undertaken during recommended standard hours only. As such the impacts of construction activities on sleep disturbance do not need to be assessed. Sound power levels were obtained from published datasets in AS2436:2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*, BS5228: Part 1 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise* and AECOM's database. All equipment is assumed to be modern and in good working order.

5.1.2 Modelling and conditions

Modelling of the proposed construction scenarios was completed using SoundPLAN 8.0. Neutral weather conditions were applied.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment. The acoustic shielding calculated in the model due to localised fixed building structures would also vary as the construction equipment moves around the site.

5.1.3 Results

Table 18 presents the number of residential properties in each NCA where the NMLs are likely to be exceeded. Table 19 presents the number of non-residential properties where the NMLs are likely to be exceeded. Locations of exceedances at residential receivers are presented in Appendix D.

Table 18 Number of residential buildings where noise levels may exceed NMLs

Scenario	Exceedance of NML			Highly Affected >75 dB(A)
	1-10 dB(A)	11-20 dB(A)	>20 dB(A)	
NCA1				
Site establishment and enabling works	1	0	0	0
Foundations - Impact piling	63	0	0	0
Frame and Facades	0	0	0	0
NCA 2				
Site establishment and enabling works	0	0	0	0
Foundations - Impact piling	3	0	0	0
Frame and Facades	0	0	0	0

Table 19 Number of non-residential buildings where noise levels may exceed NMLs

Scenario	Exceedance of NML		
	1-10 dB(A)	11-20 dB(A)	> 20 dB(A)
Site establishment and enabling works	3	3	0
Foundations - Impact piling	8	3	0
Frame and Facades	3	0	0

In general, it can be seen that the construction phases and activities are expected to exceed the noise management levels at various times during the Project's construction. Noise from the impact piling phase is the most noise intensive due to the use of large plant and nature of the activities. Noise from construction activities are less noise intensive and would affect fewer locations.

It is expected that careful selection of well-maintained and quiet plant would result in some noise reduction. Provision of a site-perimeter noise barrier would have minimal effect on construction noise emission due to the relative height of the affected buildings.

None of the construction phases are expected to result in noise levels which exceed the 'highly noise affected' level of 75 dB(A).

There is potential for construction activities in the area to operate concurrently with the project, in particular the commercial development to the north of the site at M Park.

Assuming that the noisiest stages of any other construction project were to coincide with the construction of this Project, the greatest increase in noise levels from either project would be a maximum of 3 dB(A) on the levels presented in this assessment, where this Project is the dominant source of construction noise. Where receivers are impacted to a greater extent by other construction projects, then overall construction noise levels at any receiver could be increased by as much as 3 dB(A) from those projects' noise levels.

Consultation would be undertaken with other contractors where relevant to manage cumulative impacts on sensitive receivers within common areas. Feasible and reasonable mitigation measures would be detailed in the Construction Noise and Vibration Management Plan (refer Section 6.0).

5.2 Construction vibration

Vibration-intensive works may include the use of the following items of equipment:

- Vibratory rollers;
- Piling rigs; and
- Jackhammers.

The minimum working distances of these items of equipment to nearby receivers are shown in Table 20 which is based on recommendations of the TfNSW *Construction Noise and Vibration Strategy* (CNVS) and AECOM's previous project experience. If these minimum working distances are complied with no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage. Equipment size would be selected by the construction contractor and would take into account the minimum working distances and the distance between the area of construction and the nearest sensitive receiver. Based on the indicative construction activities assessed for the proposed development, works are unlikely to occur within the minimum working distances.

Table 20 Recommended minimum working distances for vibration intensive plant

Plant	Rating/Description	Minimum working distance	
		Cosmetic damage	Human response
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	<300 kN (Typically 7-13 tonnes)	15 m	100 m
Piling Rig	≤800 mm	2 m nominal	4 m
Jackhammer	Handheld	1 m nominal	Avoid contact with structure

5.3 Construction traffic

The construction work would be undertaken in stages and would require a number of trucks to deliver materials including concrete to the site, as well as other light vehicles. During early stages of construction workers may be able to park on site, during later stages they would park away from the site and either walk or use public transport to get to the site.

To assess the impact of construction traffic it has been assumed that 90 heavy vehicles and 150 light vehicles would visit the site during a worst case day.

Based on the existing traffic noise levels on the adjacent roads, the construction traffic to the data centre is predicted to be less than 2 dB. Therefore, the traffic impact on access roads would be acceptable.

6.0 Construction noise and vibration mitigation

Given that NMLs are likely to be exceeded, reasonable and feasible noise mitigation measures and work practices would need to be considered. Where receivers are predicted to be 'noise affected' the *interim Construction Noise Guideline* states that all feasible and reasonable works practices should be applied to meet the NMLs. It is recommended that a construction noise and vibration management plan (CNVMP) be prepared for each stage of the data centre construction.

Details of noise and vibration mitigation measures and management practices which should be considered for each CNVMP are detailed below.

The CNVMP would include the following:

- Identification of nearby residences and other sensitive land uses;
- Description of approved hours of work;
- Description and identification of all construction activities, including work areas, equipment and duration;
- Description of what work practices (generic and specific) would be applied to minimise noise and vibration;
- A complaint handling process;
- Noise and vibration monitoring procedures; and
- Overview of community consultation required for identified high impact works.

Noise and vibration mitigation measures which should be considered in the CNVMP are detailed below in Table 21. Details of an indicative monitoring program and complaints handling procedure are provided in Section **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 21 Recommended noise mitigation measures

Action required	Safeguard details
Management measures	
Implement community consultation measures	Periodic notification (monthly letterbox drop or equivalent), website, Project Infoline, Construction Response Line, email distribution list and community and stakeholder meetings.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Monitoring	A noise monitoring program should be considered in accordance with the CNVMP.
Attended vibration measurements	Attended vibration measurements are recommended at the commencement of vibration generating activities to determine site specific minimum working distances. Vibration intensive work should not proceed within the minimum working distances unless a permanent vibration monitoring system is installed approximately a metre from the building footprint, to warn operators (via flashing light, audible alarm, SMS etc.) when vibration levels are approaching the peak particle velocity objective.
Source controls	
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods. Consideration should be given to avoiding examination periods.
Construction respite period	High noise and vibration generating activities (eg rock breaking) may only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block.
Equipment selection and maintenance	Use quieter and less vibration emitting construction methods where feasible and reasonable. Equipment would be regularly inspected and maintained to ensure it is in good working order.
Maximum noise levels	The noise levels of plant and equipment must have operating sound power or sound pressure levels that would meet the predicted noise levels.
Rental plant and equipment	Noise emissions should be considered as part of the selection process.
Use and siting of plant	• Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. • The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. • Plant used intermittently to be throttled down or shut down. • Plant and vehicles to be turned off when not in use. • Noise-emitting plant to be directed away from sensitive receivers.

Action required	Safeguard details
Plan works site and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites	• Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. • Select site access points and roads as far as possible away from sensitive receivers. • Dedicated loading/unloading areas to be shielded if close to sensitive receivers. • Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Construction related traffic	• Schedule and route vehicle movements away from sensitive receivers and during less sensitive times. • Limit the speed of vehicles and avoid the use of engine compression brakes. • Maximise on-site storage capacity to reduce the need for truck movements during sensitive times.
Silencers on Mobile Plant	Where possible reduce noise from mobile plant through additional fittings including: • Residential grade mufflers • Damped hammers such as “City” Model Rammer Hammers • Air parking brake engagement is silenced
Alternative methods	The use of less vibration-intensive methods of construction or equipment is preferred where practical to reduce the potential for cosmetic damage. All equipment should be maintained and operated in an efficient manner, in accordance with manufacturer’s specifications, to reduce the potential for adverse vibration impacts
Site specific minimum working distances	Attended vibration measurements are undertaken when work commences, to determine site-specific minimum working distances. Vibration intensive work should not proceed within the minimum working distances unless a permanent vibration monitoring system is installed around one metre from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective.
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

7.0 Operational noise impact assessment

The sources of noise with the potential to impact adjacent noise sensitive receivers include the air handling units (AHU), relief air fans, computer room air conditioning units (CRAC) and back-up generators.

The data halls and associated mechanical equipment will be fitted out according to customer demand, potentially taking several years to be fully fitted out. Despite this the operational noise assessment has assumed a worst case, based on the facility being fully operational with all floors fitted out from day of opening.

7.1 Equipment

7.1.1 Fan coil units

It is understood that each AHU would consist of 12 fans per unit and that there would be 16 AHUs operating per level, per side, with a total of 64 units serving the building in normal operation. The AHUs would be located within a plant room with intake and discharge via louvres on the northern and southern façades. The AHU fan noise level used in the operational noise assessment is presented in Table 22.

Table 22 AHU fan noise levels

Equipment	dB(A)	Octave band centre frequency, Hz						
		63	125	250	500	1k	2k	4k
Air handling unit fan Sound power level, dB	91	92	102	93	87	84	81	78

The outside air intake louvres would be fitted with an attenuator with an insertion loss equal to or greater than the values presented in Table 23.

Table 23 AHU Outside air attenuator static insertion loss

Description	Octave band centre frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Outside air intake rectangular attenuator, dB (Based on Fantech RT17D)	4	10	20	33	36	27	17	12

It is understood that the outside air take of the AHUs would be fitted with architectural louvres.

7.1.2 Relief air fans

It is understood that relief air would be provided within two electrical rooms on each floor, each with 54 relief air fans. This layout would be repeated on levels 1-3, with air discharging via louvres to the eastern and western facades of the building.

The relief air fan used in the operational noise assessment is presented in Table 24.

Table 24 Relief air fan sound power levels

Equipment	dB(A)	Octave band centre frequency, Hz						
		63	125	250	500	1k	2k	4k
Relief Air Fans Maximum sound power level, dB	80	77	77	77	77	77	72	67

The relief air fans discharge would be fitted with an attenuator with an insertion loss equal to or greater than the values presented in Table 25.

Table 25 relief air fan discharge attenuator static insertion loss

Description	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Relief air fan discharge rectangular attenuator, dB (Based on Fantech RT12C)	4	8	17	27	31	23	14	11

7.1.3 CRAC units

It is understood that 16 CRAC units would be located on the ground floor adjacent to the eastern facade. The sound power level of the CRAC unit used in the operational noise assessment is presented in Table 26.

Table 26 CRAC unit sound power levels

Equipment	Sound power level, dB(A)
CRAC unit maximum sound power level	91

7.1.4 Back-up generators

A series of 2,400 kW back-up generators are proposed to be installed on site within acoustic enclosures. The generators would intake and discharge air through attenuators that are approximately 5.5 metres high and 3.8 metres wide. The back-up generators would be located on the south eastern facade of the building.

Aside from regular testing, the back-up generators would only be used where there is a grid power outage (ie in an emergency and used temporarily). During testing only one back-up generator would be running at any one time.

The manufacturer's sound pressure level at one metre from the back-up generator unit used in the operational noise assessment is presented in Table 27.

Table 27 Back-up generator sound pressure level

Description	Octave band noise levels, dB								
Frequency, Hz	dB(A)	63	125	250	500	1000	2000	4000	8000
Back-up generator with acoustic enclosure, SPL at 1 metre, dB	70	68	70	68	69	65	62	58	50

7.2 Modelling methodology

Operational noise levels from the proposed development have been predicted at nearby noise sensitive receivers using SoundPLAN 8.0 (industry standard) noise modelling software.

The modelling includes:

- ground topography
- buildings and structures
- ground absorption (set at 60%), and
- representative operational noise sources (all sources are assumed to be running for the entire 15 minute period).

7.2.1 Modelling assumptions

The following assumptions have been made:

Normal operations

- all 64 AHUs, 324 Relief air fans, 16 CRAC units operating at full capacity
- during all periods of the day, and
- neutral weather conditions and adverse weather conditions including:
  - 3 m/s wind from source to receiver
  - F class temperature inversion with a 2 m/s drainage wind.

Periodic testing operations

- all 64 AHUs, 324 Relief air fans, 16 CRAC units operating at full capacity
- one back-up generator operating at full capacity (Worst case generator considered ie nearest)
- during daytime only, and
- neutral weather conditions and adverse weather conditions including:
  - 3 m/s wind from source to receiver
  - F class temperature inversion with a 2 m/s drainage wind.

7.3 Predicted noise levels

7.3.1 Residential receivers

Based on the operations described above, the predicted noise levels are provided below in Table 28.

Table 28 Predicted noise levels at residential receivers, dB(A)

Assessment receiver	Weather conditions	Normal operations			Back-up generator testing		
		Predicted level	Criterion[1]	Compliance	Predicted level	Criterion[2]	Compliance
R1	Neutral	40	43	Yes	46	50	Yes
	3m/s wind	41			46		
	Inversion	41			46		
R2	Neutral	41	43	Yes	47	50	Yes
	3m/s wind	43			47		
	Inversion	43			47		
R3	Neutral	43	43	Yes[3]	48	50	Yes
	3m/s wind	44			48		
	Inversion	44			49		
R4	Neutral	41	43	Yes	50	50	Yes
	3m/s wind	42			50		
	Inversion	42			50		
R5	Neutral	41	43	Yes	47	50	Yes
	3m/s wind	42			48		
	Inversion	42			48		
R6	Neutral	38	43	Yes	38	47	Yes
	3m/s wind	39			40		
	Inversion	40			40		

Assessment receiver	Weather conditions	Normal operations			Back-up generator testing		
		Predicted level	Criterion[1]	Compliance	Predicted level	Criterion[2]	Compliance
R7	Neutral	38	43	Yes	40	47	Yes
	3m/s wind	39			41		
	Inversion	39			41		
R8	Neutral	37	38	Yes	44	47	Yes
	3m/s wind	38			45		
	Inversion	38			45		
R9	Neutral	36	38	Yes	43	47	Yes
	3m/s wind	37			43		
	Inversion	37			44		
R10	Neutral	20	38	Yes	24	47	Yes
	3m/s wind	21			24		
	Inversion	21			25		
R11	Neutral	33	38	Yes	40	47	Yes
	3m/s wind	34			41		
	Inversion	34			41		
R12	Neutral	29	43	Yes	30	50	Yes
	3m/s wind	29			31		
	Inversion	29			31		

Notes:

1. *Night-time criterion to represent the worst case scenario*
2. *Daytime criterion as back-up generators would be testing during the daytime only*
3. *Exceedances of up to 2 dB are considered negligible. They would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.*

It can be seen from Table 28 that noise levels at all receivers comply with the criteria under neutral weather conditions. Under adverse weather conditions noise levels at R6 exceeds the night-time criterion by up to 2 dB(A) and noise levels at R3 and R7 exceed the night-time criterion by up to 1 dB(A). The *Noise Policy for Industry* states that exceedances of up to 2 dB are negligible and would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. It is noted that these exceedances occur under worst-case weather conditions only.

7.3.2 Sleep disturbance

The L_{Aeq} levels would comply with the sleep disturbance screening trigger levels presented in Table 16 at residential receivers. Night-time noise emissions from the data centre would generally be associated with relatively constant activities, therefore the L_{Amax} levels would be very similar to the L_{Aeq} levels. The L_{Amax} levels would comply with the sleep disturbance screening trigger levels presented in Table 16 at residential receivers.

7.3.3 Non-residential receivers

Based on the operations described above, the predicted noise levels for non-residential receivers are provided below in Table 29.

Table 29 Predicted noise levels at non-residential receivers, dB(A)

Assessment receiver	Weather conditions	Normal operations			Back-up generator testing		
		Predicted level	Criterion	Compliance	Predicted level	Criterion	Compliance
N1	Neutral	65	63	Yes[1]	65	68	Yes
	3m/s wind	65			65		
	Inversion	65			65		
N2	Neutral	62	63	Yes	63	68	Yes
	3m/s wind	63			63		
	Inversion	63			63		
N3	Neutral	48	58	Yes	57	58	Yes
	3m/s wind	49			57		
	Inversion	49			57		
N4	Neutral	43	58	Yes	52	58	Yes
	3m/s wind	44			53		
	Inversion	44			53		
N5	Neutral	40	58	Yes	47	58	Yes
	3m/s wind	41			48		
	Inversion	41			48		
N6	Neutral	37	48[2]	Yes	41	63[3]	Yes
	3m/s wind	38			41		
	Inversion	38			41		

Notes:

1. *Exceedances of up to 2 dB are considered negligible. They would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.*
2. *Night-time criterion*
3. *Daytime criterion*

It can be seen from Table 29 that noise levels at all non-residential receivers, with the exception of N1 comply with the criteria under all weather conditions. Noise levels at N1 exceed the criteria by up to 2 dB(A). The *Noise Policy for Industry* states that exceedances of up to 2 dB are negligible and would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.

7.4 Traffic movements

The site is expected to generate up to 50 vehicle movements per day. Based on the existing traffic noise levels on the adjacent roads, the operation of the data centre is predicted to be insignificant (less than 1 dB(A)) therefore the traffic impact on access roads would be minimal.

8.0 Conclusion

This report presents the results of a Noise and Vibration Impact Assessment of the proposed data centre located at 11-17 Khartoum Road and 33-39 Talavera Road, Macquarie Park, NSW.

Construction noise has been assessed in accordance with the EPA's *Interim Construction Noise Guideline*. Worst case construction scenarios have been considered. Construction works would be undertaken during standard hours. The level and number of exceedances of the construction noise management levels are provided in Section 5.1.3.

Operational noise emissions from the Project have been assessed with consideration of the project noise trigger levels established in accordance with the *Noise Policy for Industry* and measured noise levels at noise sensitive locations close to the Project site.

The operation of the proposed data centre with periodic back-up generator testing complies with the relevant *Noise Policy for Industry* criteria and is considered acceptable.

Traffic generation as a result of the proposed development is minimal and predicted traffic noise increases would comply with the applicable criteria outlined in the NSW Road Noise Policy.

Based upon this assessment documented above, all environmental noise and vibration impacts can be appropriate managed in accordance with the relevant guidelines and standards.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

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

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [Leq]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Lmax	The maximum sound pressure level measured over the measurement period
Lmin	The minimum sound pressure level measured over the measurement period
L10	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L10.

L90	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L90.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L90 sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The Leq sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the entire length of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 “Acoustics – Glossary of terms and related symbols”, the EPA’s NSW Industrial Noise Policy and the EPA’s NSW Road Noise Policy.

Appendix B

Unattended Noise Monitoring

Appendix B Unattended Noise Monitoring

Noise Logger Report

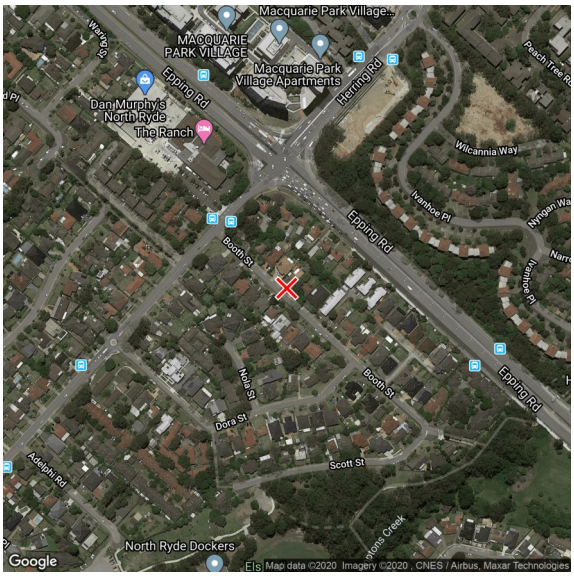
7 Booth Street, Marsfield

Item	Information
Logger Type	Svan 957
Serial number	23855
Address	7 Booth Street, Marsfield
Location	Front yard
Facade / Free Field	Free field
Environment	Dominated by road traffic noise hum to north/north east. Ambient noise controlled by plane and local traffic pass by and some vehicles along Epping road to the north and herring road. Plane pass by frequent. Local car pass by ~ 64 dB(A). Sunny, no to very slight wind, some clouds. Birds calling.

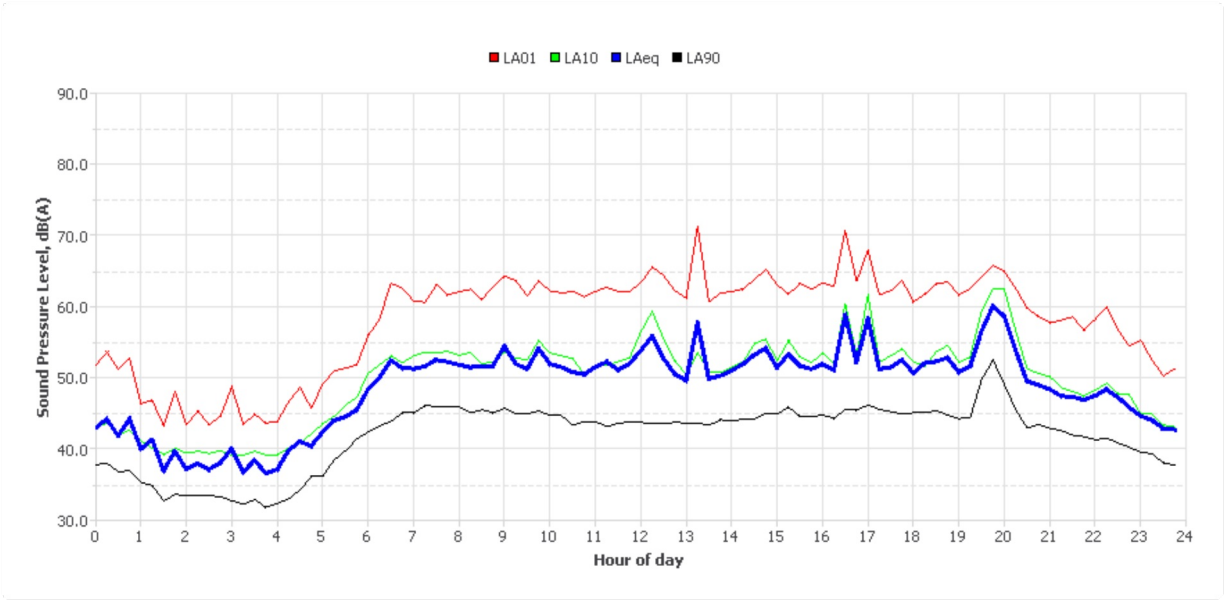
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Tue Mar 10 2020	60	54	52	-	42	-	56	52
Wed Mar 11 2020	55	55	47	42	42	32	55	47
Thu Mar 12 2020	53	51	45	-	41	34	53	45
Fri Mar 13 2020	52	51	51	41	41	33	52	51
Sat Mar 14 2020	53	52	47	-	42	34	53	47
Sun Mar 15 2020	54	53	45	-	41	32	54	45
Mon Mar 16 2020	56	52	46	46	44	33	55	46
Tue Mar 17 2020	55	62	45	42	42	29	58	45
Wed Mar 18 2020	55	52	45	42	41	34	54	45
Thu Mar 19 2020	-	-	44	-	-	-	-	44
Summary	**55**	**56**	**47**	**42**	**42**	**33**	**55**	**47**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

Typical Day



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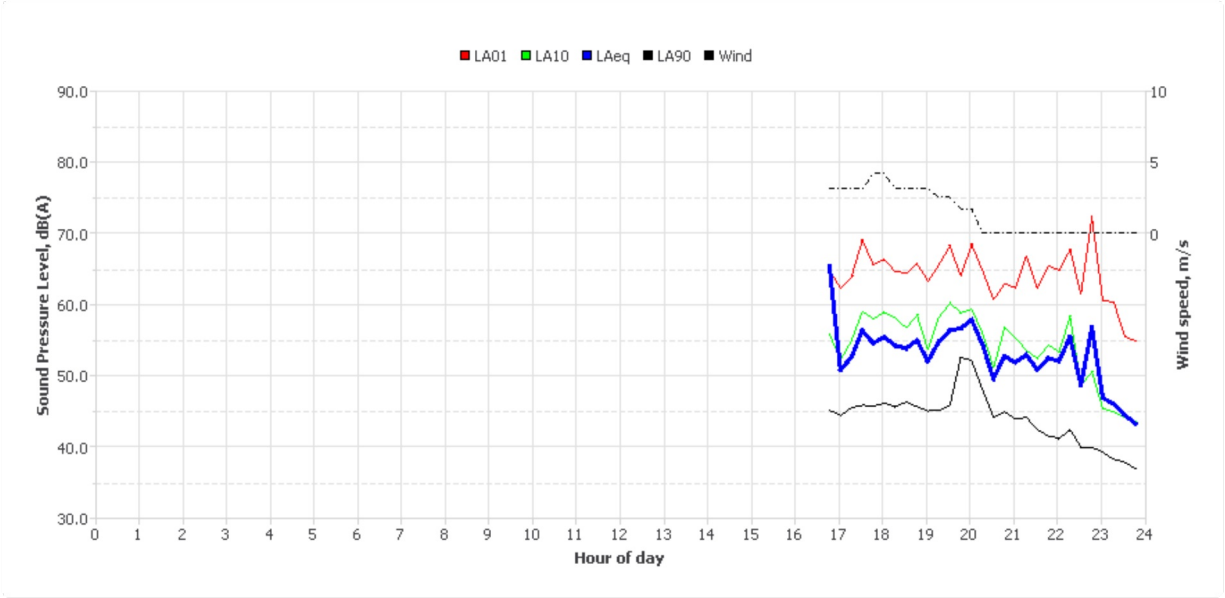

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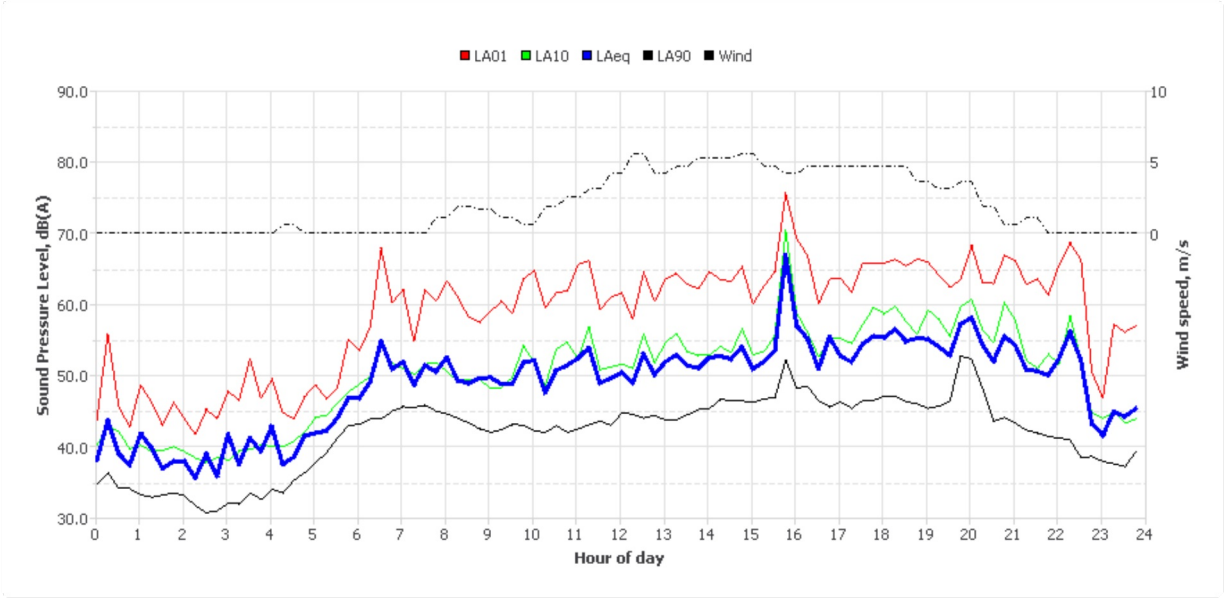

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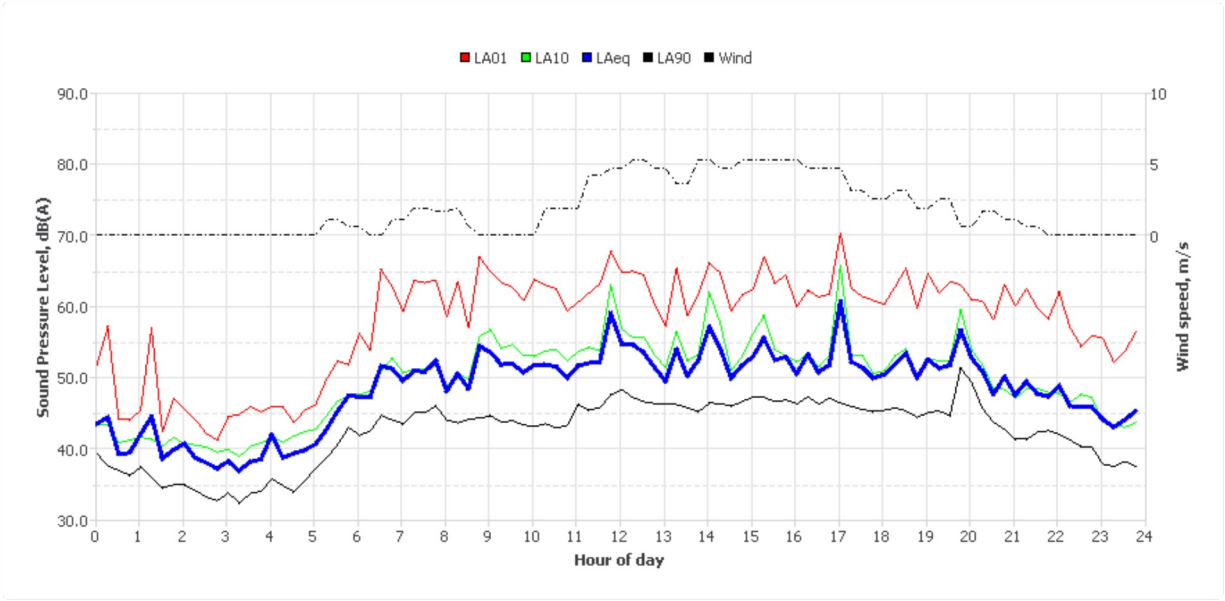

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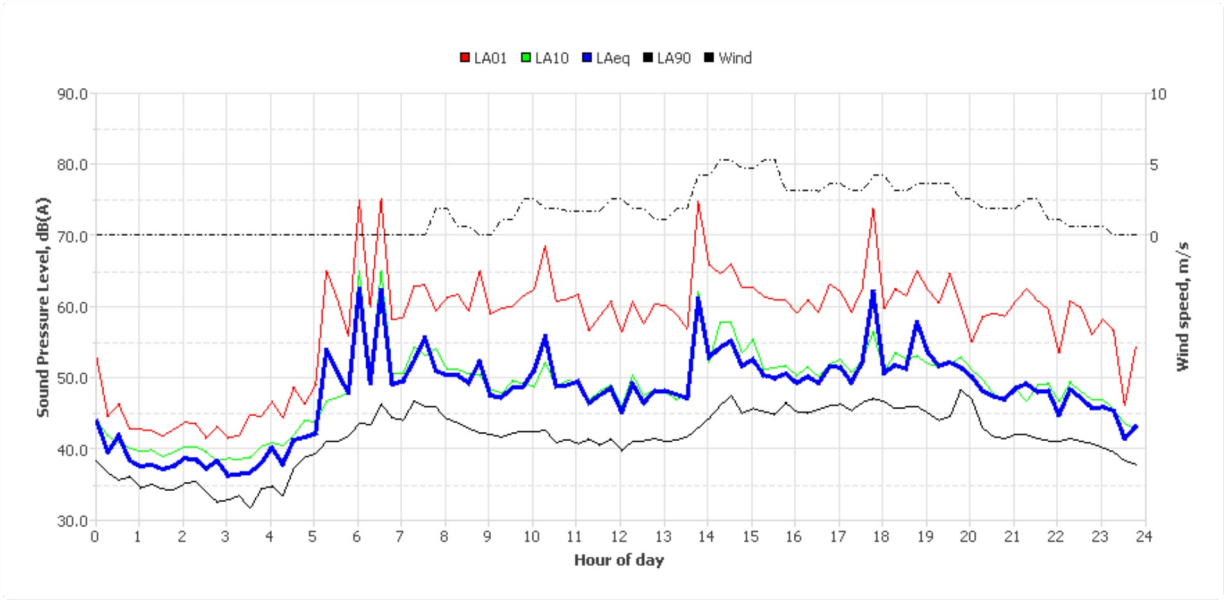

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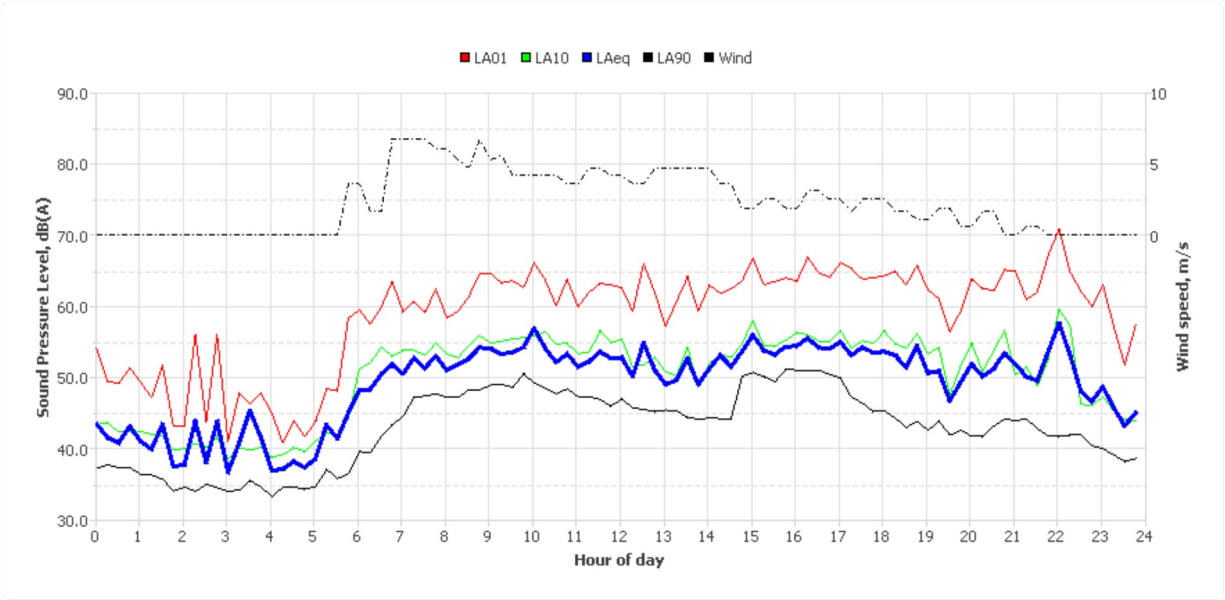

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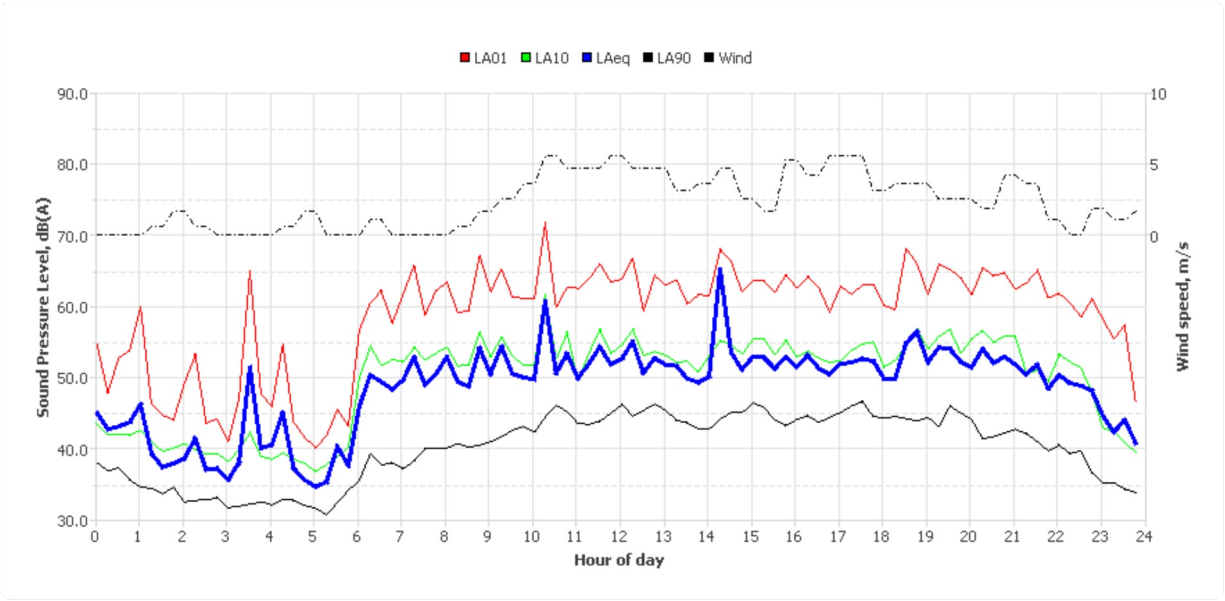

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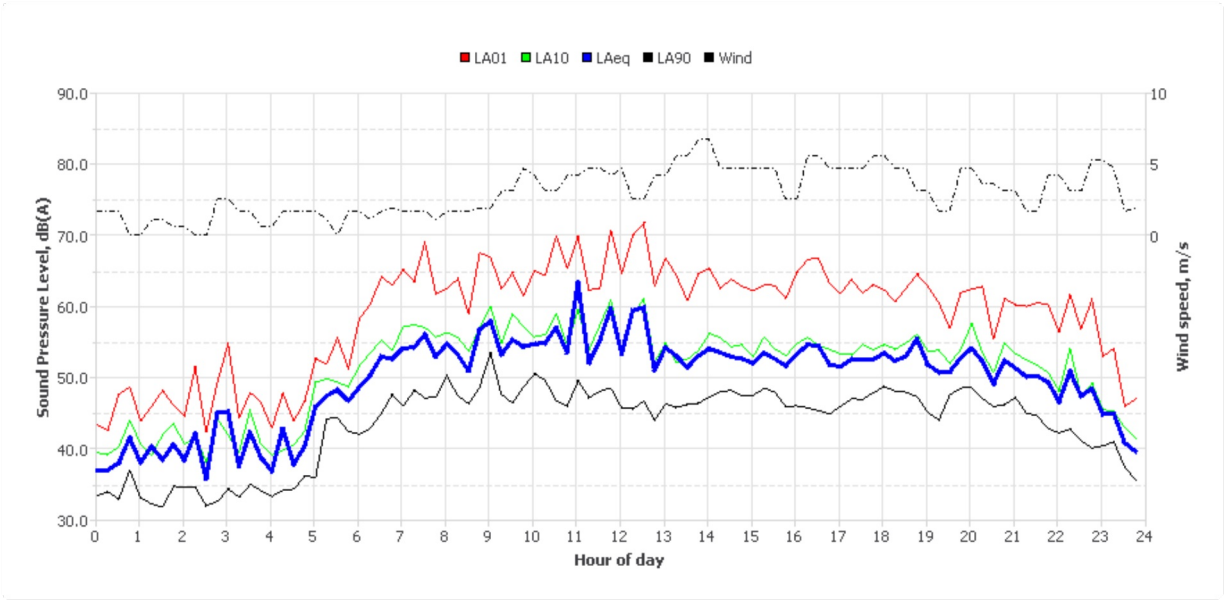

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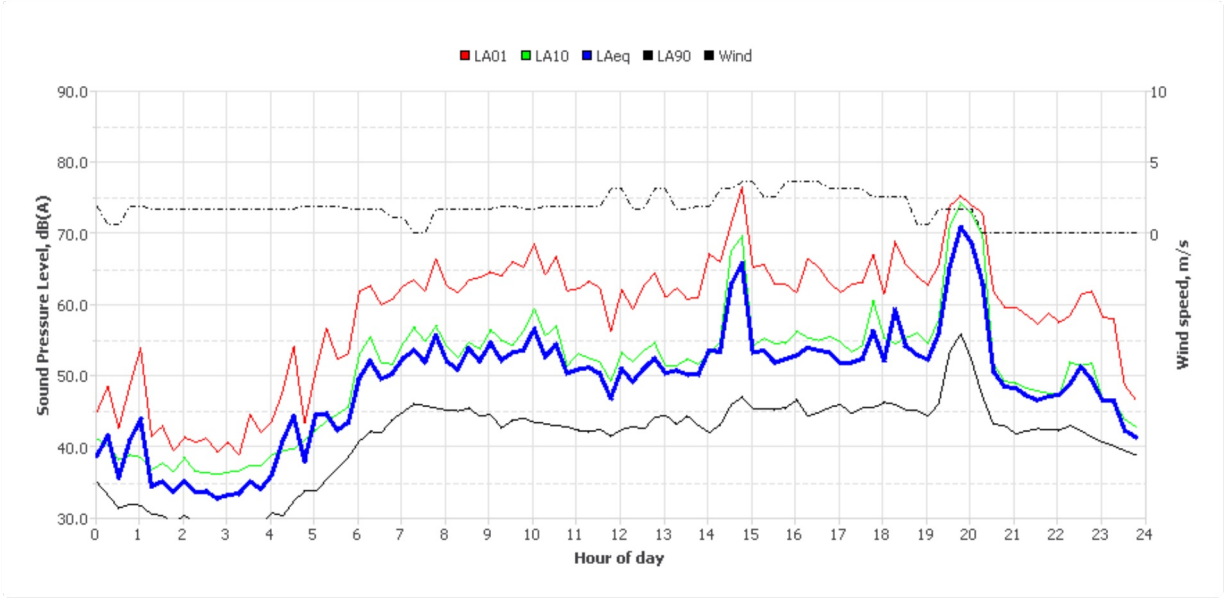

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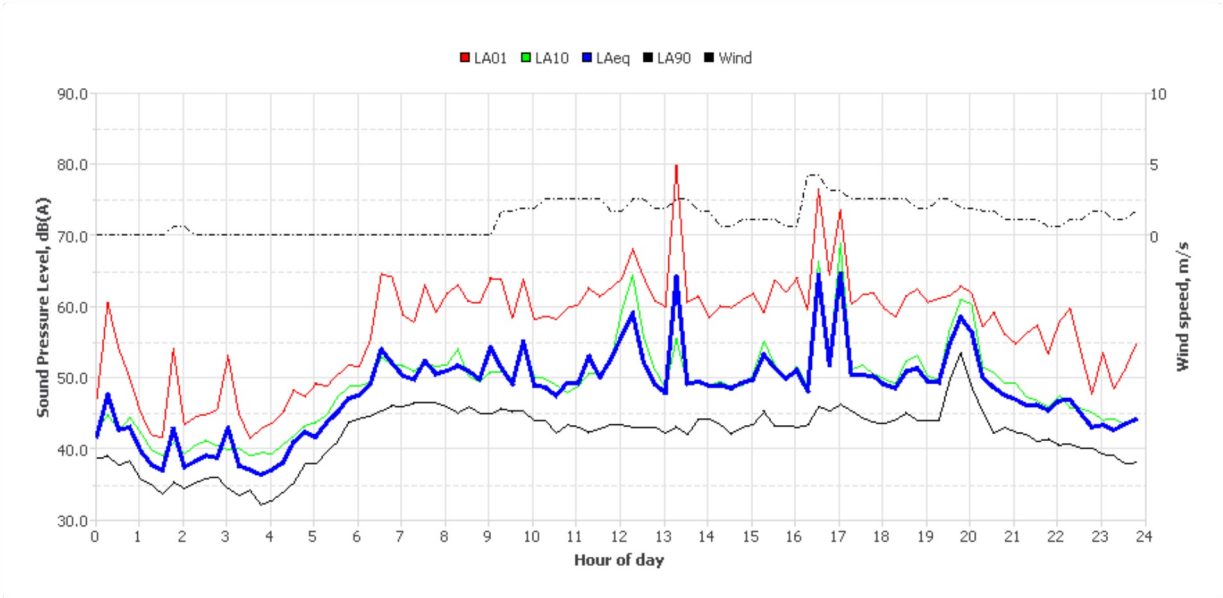

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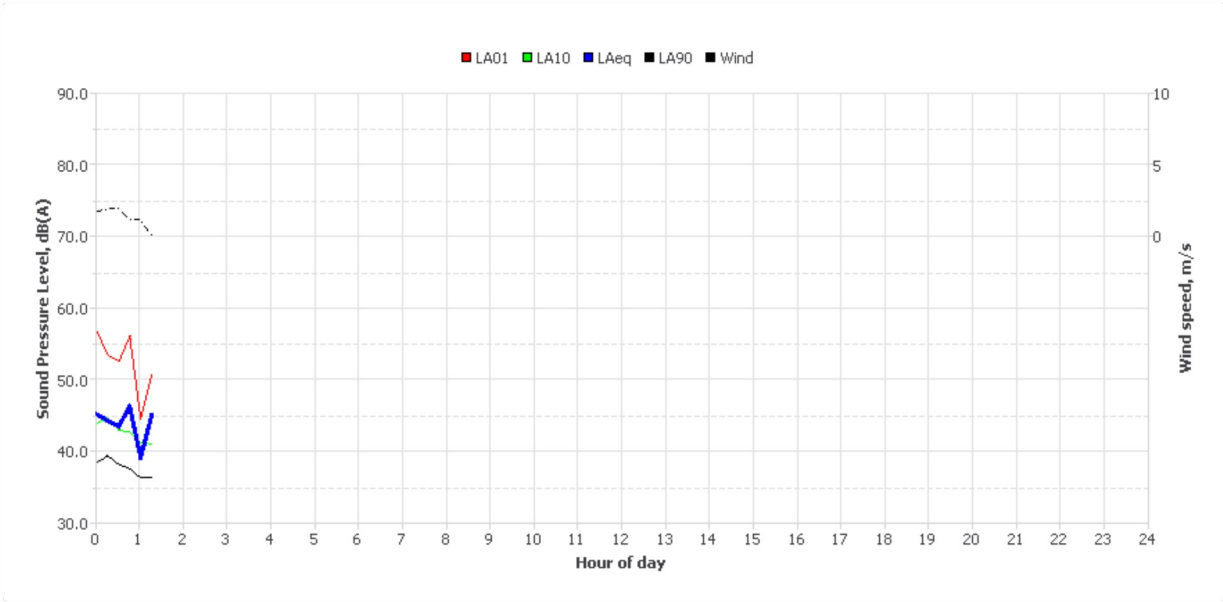


Noise Logger Report

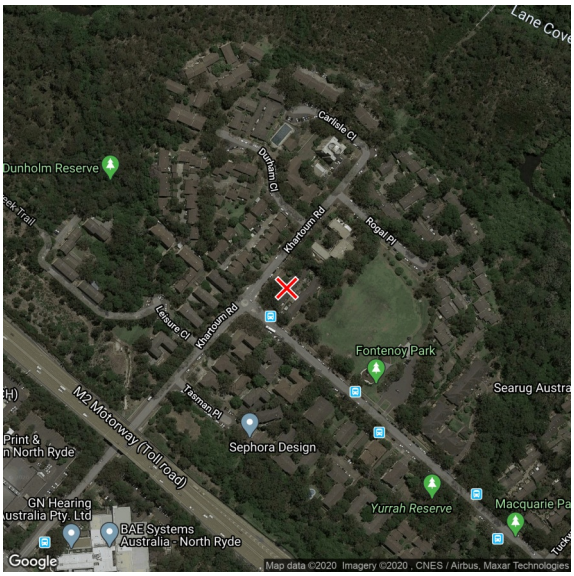
Unit 6, 37 Khartoum Road, Macquarie Park

Item	Information
Logger Type	Svan 977
Serial number	45416
Address	Unit 6, 37 Khartoum Road, Macquarie Park
Location	Front yard
Facade / Free Field	Free Field
Environment	Background controlled by environment. Noise environment dominated by road traffic noise to west along Khartoum road. Car pass by 58-62 dB(A). Minimal to little breeze, sunny, some clouds. Birds calling, trucks can be heard in distance.

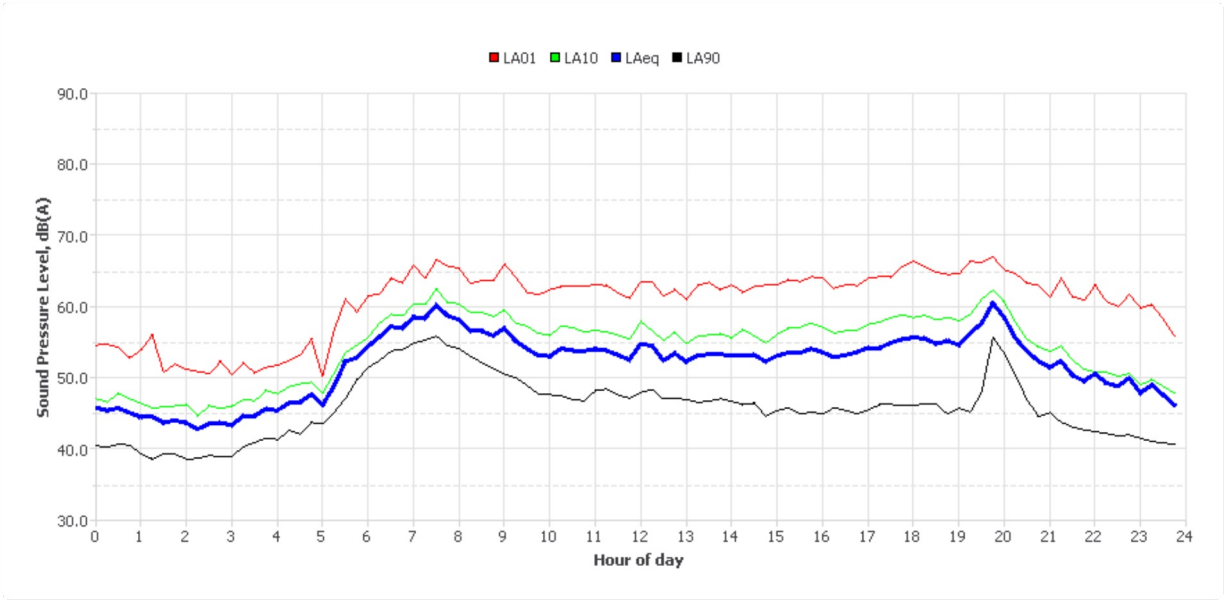
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Tue Mar 10 2020	56	58	53	-	46	-	58	53
Wed Mar 11 2020	56	58	50	45	46	37	57	50
Thu Mar 12 2020	56	56	52	45	46	38	56	52
Fri Mar 13 2020	60	54	49	45	43	40	59	49
Sat Mar 14 2020	59	57	50	50	46	38	59	50
Sun Mar 15 2020	57	57	51	46	44	38	57	51
Mon Mar 16 2020	59	59	52	48	45	37	59	52
Tue Mar 17 2020	58	66	51	46	43	36	62	51
Wed Mar 18 2020	53	55	50	44	43	39	54	50
Thu Mar 19 2020	55	54	50	44	42	38	55	50
Fri Mar 20 2020	55	-	50	-	-	-	55	50
Summary	**57**	**59**	**51**	**45**	**45**	**38**	**58**	**51**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

Typical Day



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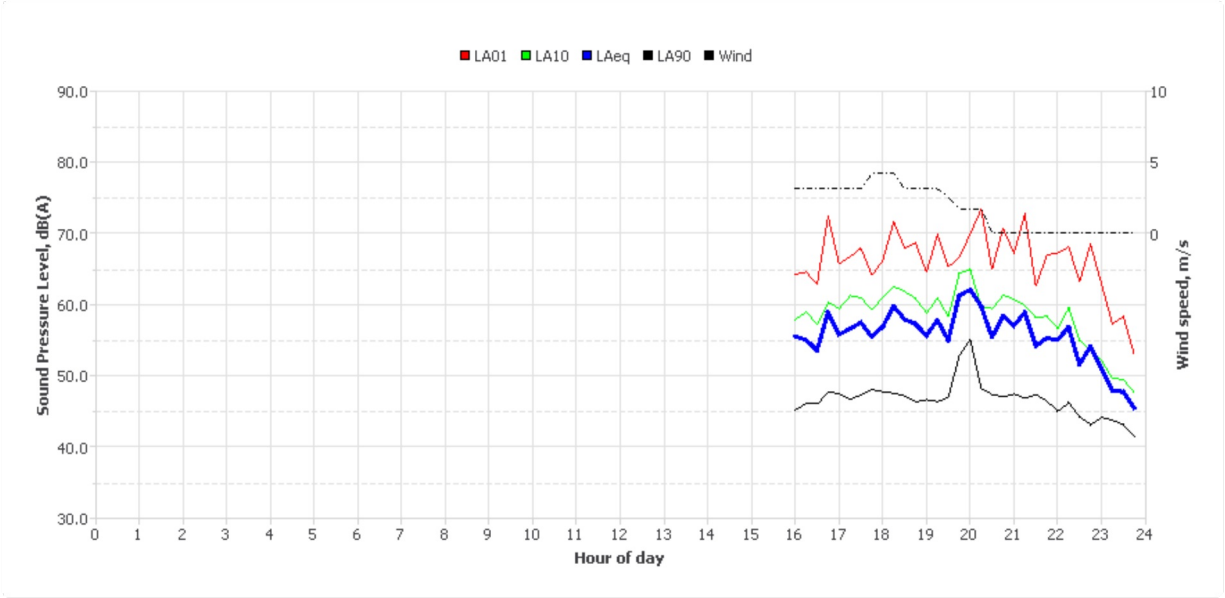

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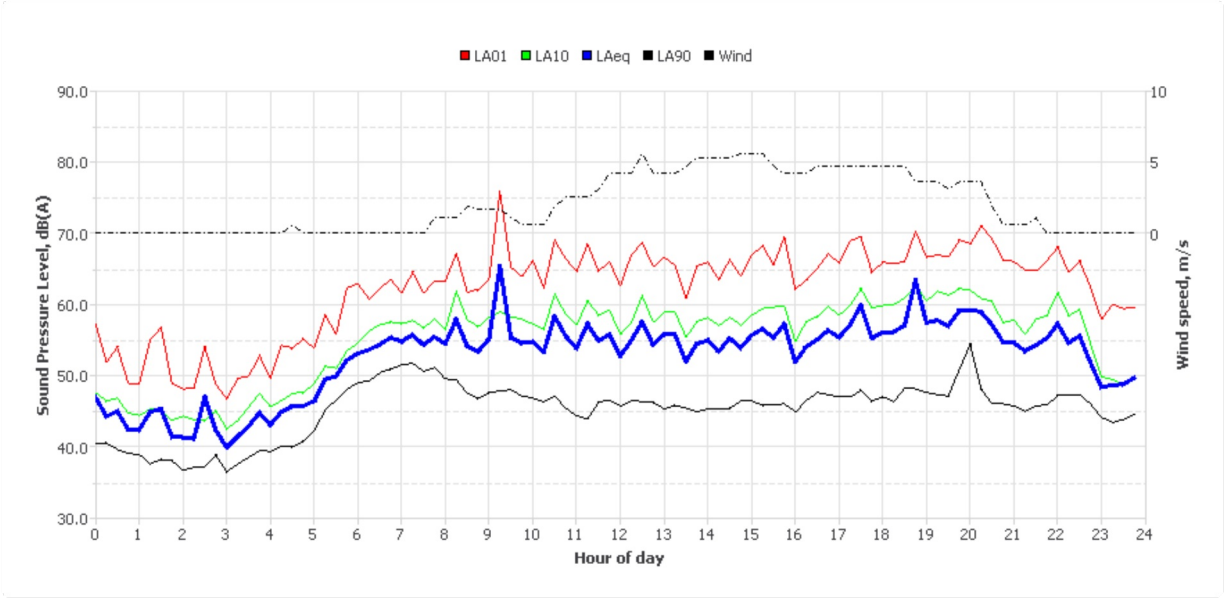

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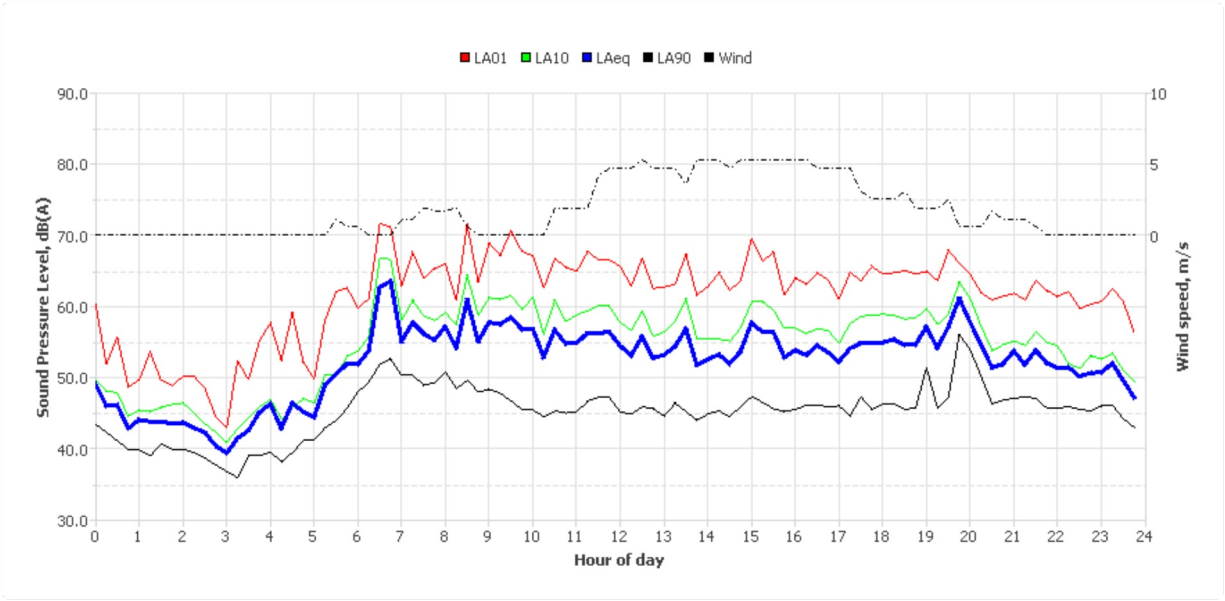

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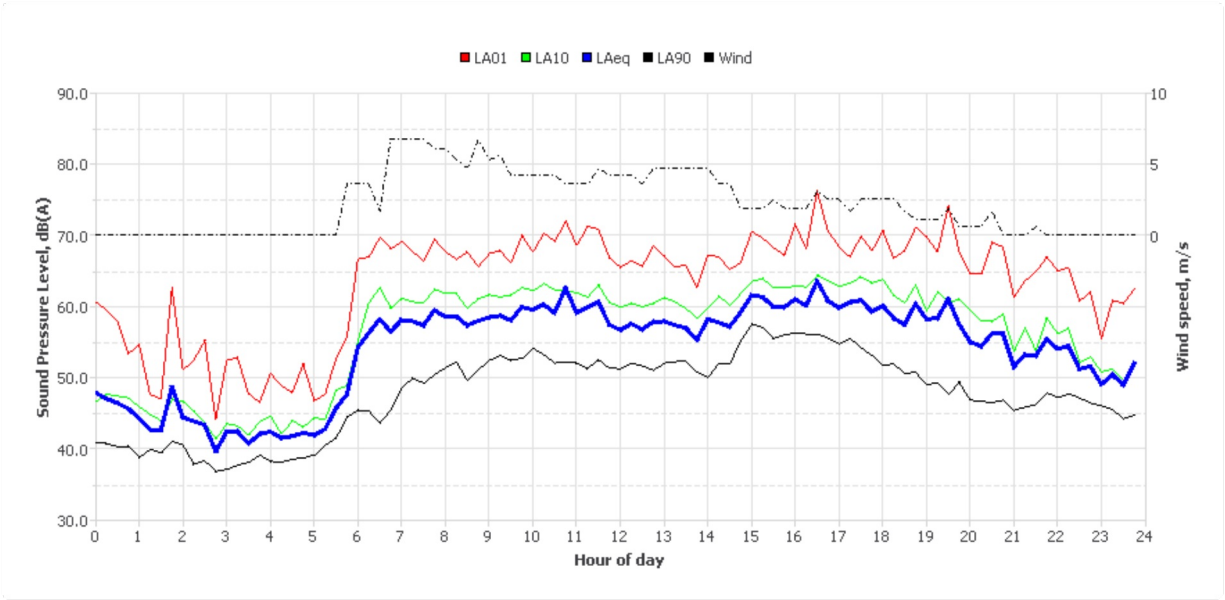

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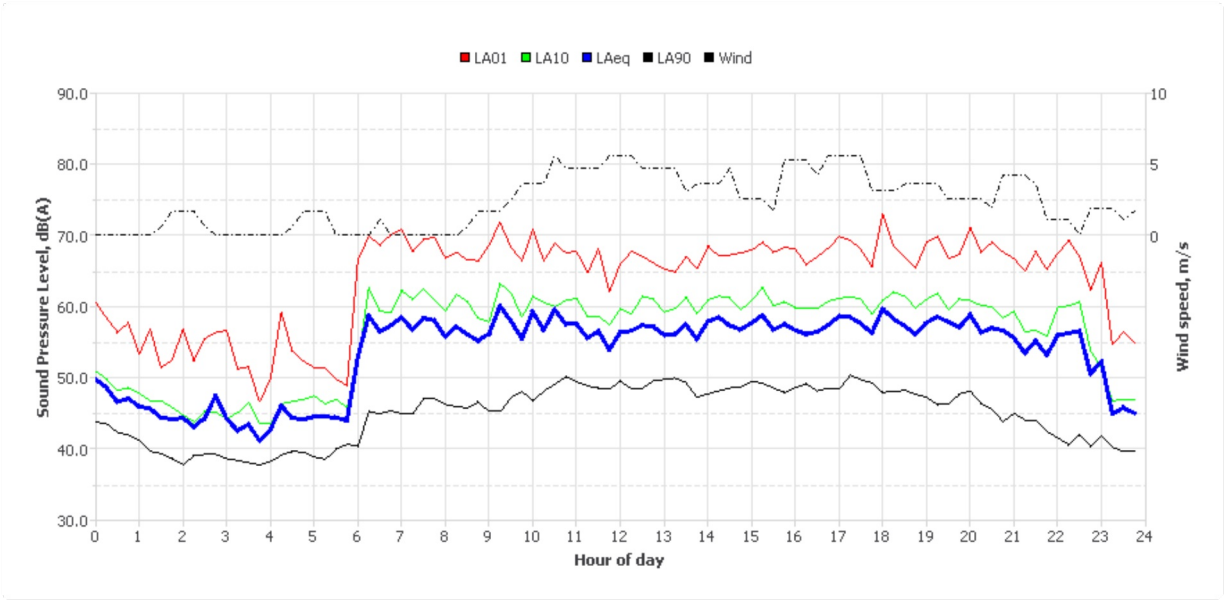
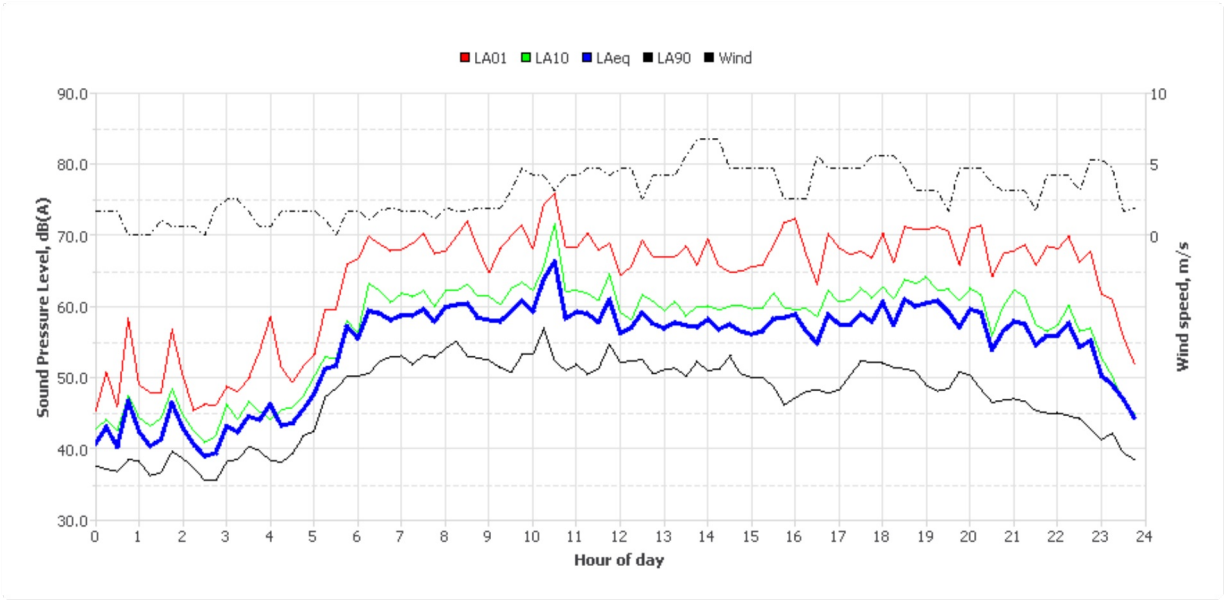


Monday, 16 Mar 2020



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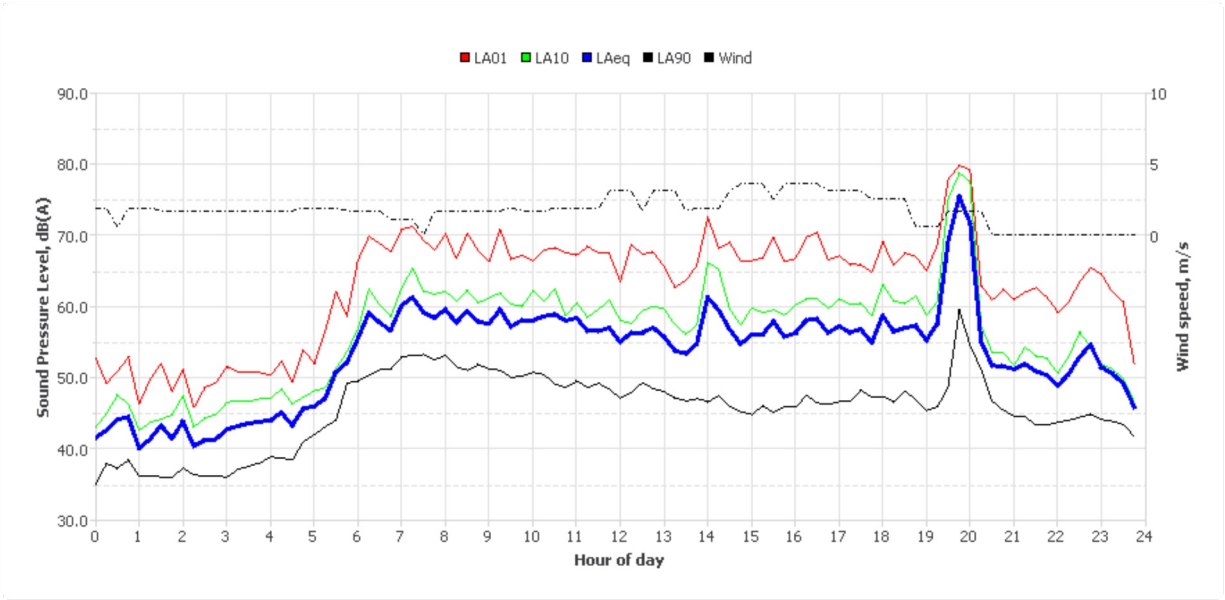

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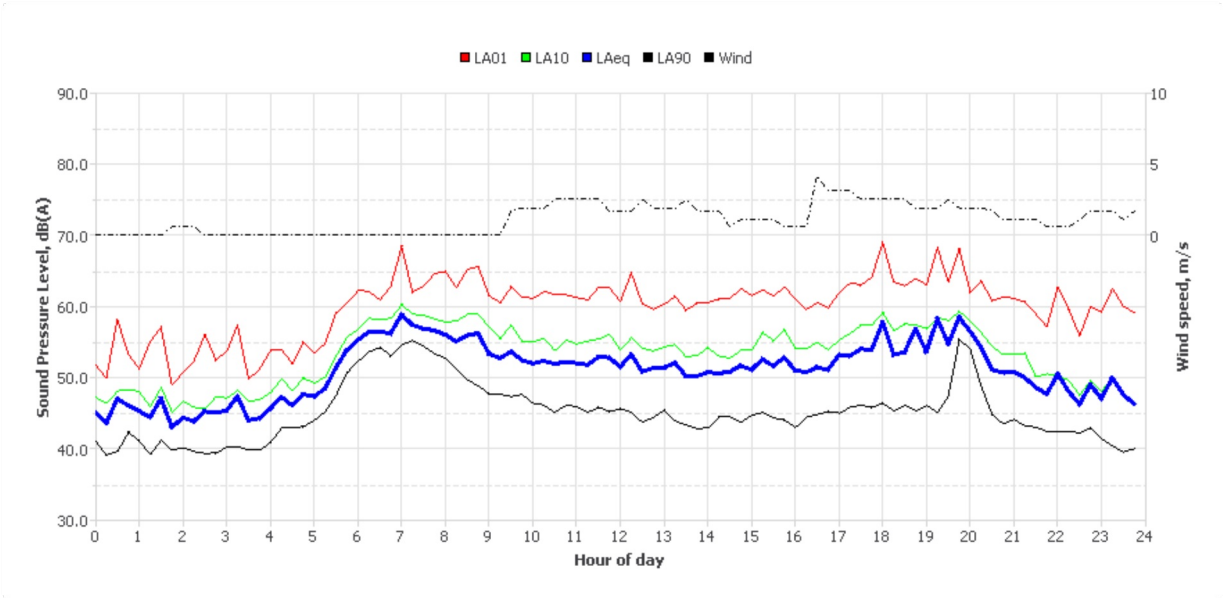

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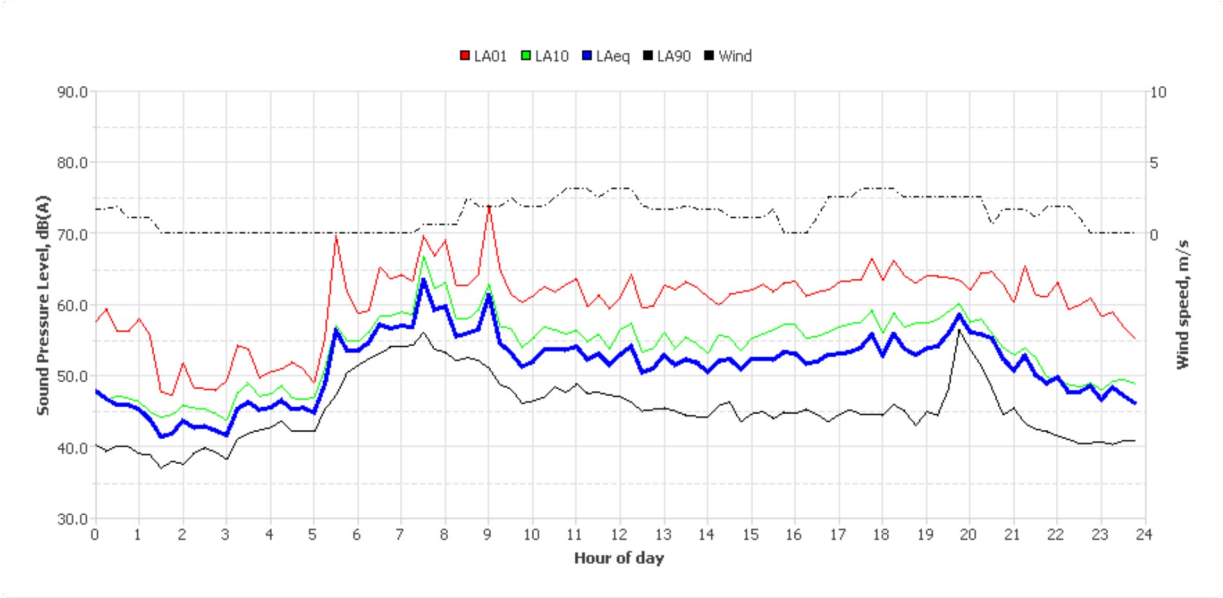

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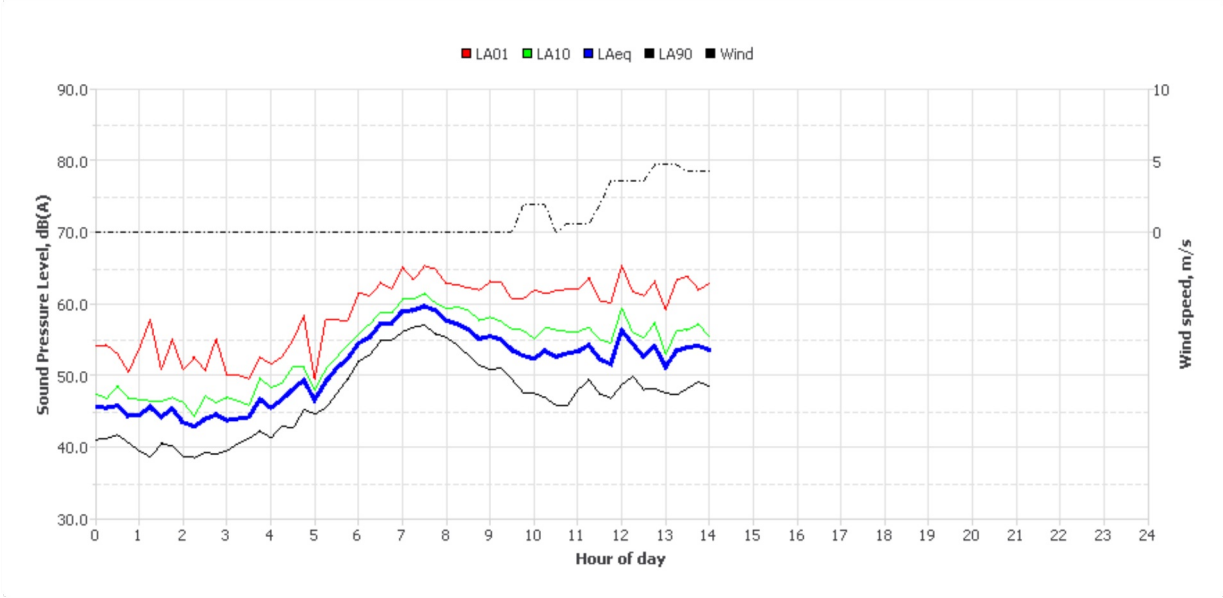
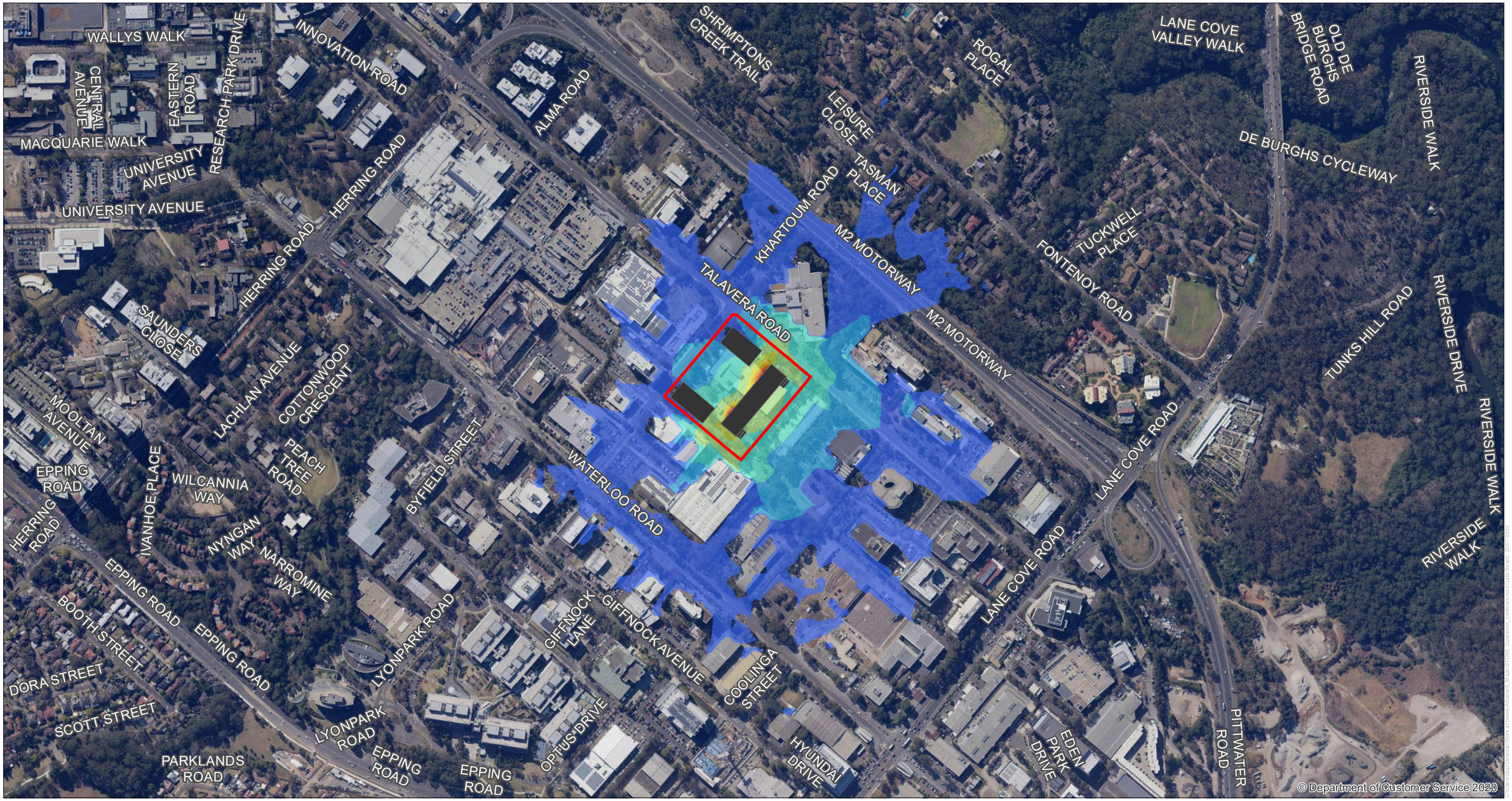


Appendix C

Operational Noise Contour Plots

Appendix C Operational Noise Contour Plots



Macquarie Park Data Centre Predicted operational noise levels - Normal operation

Site

Athena

Sound Pressure Level, $L_{Aeq,15min}$, dB(A)

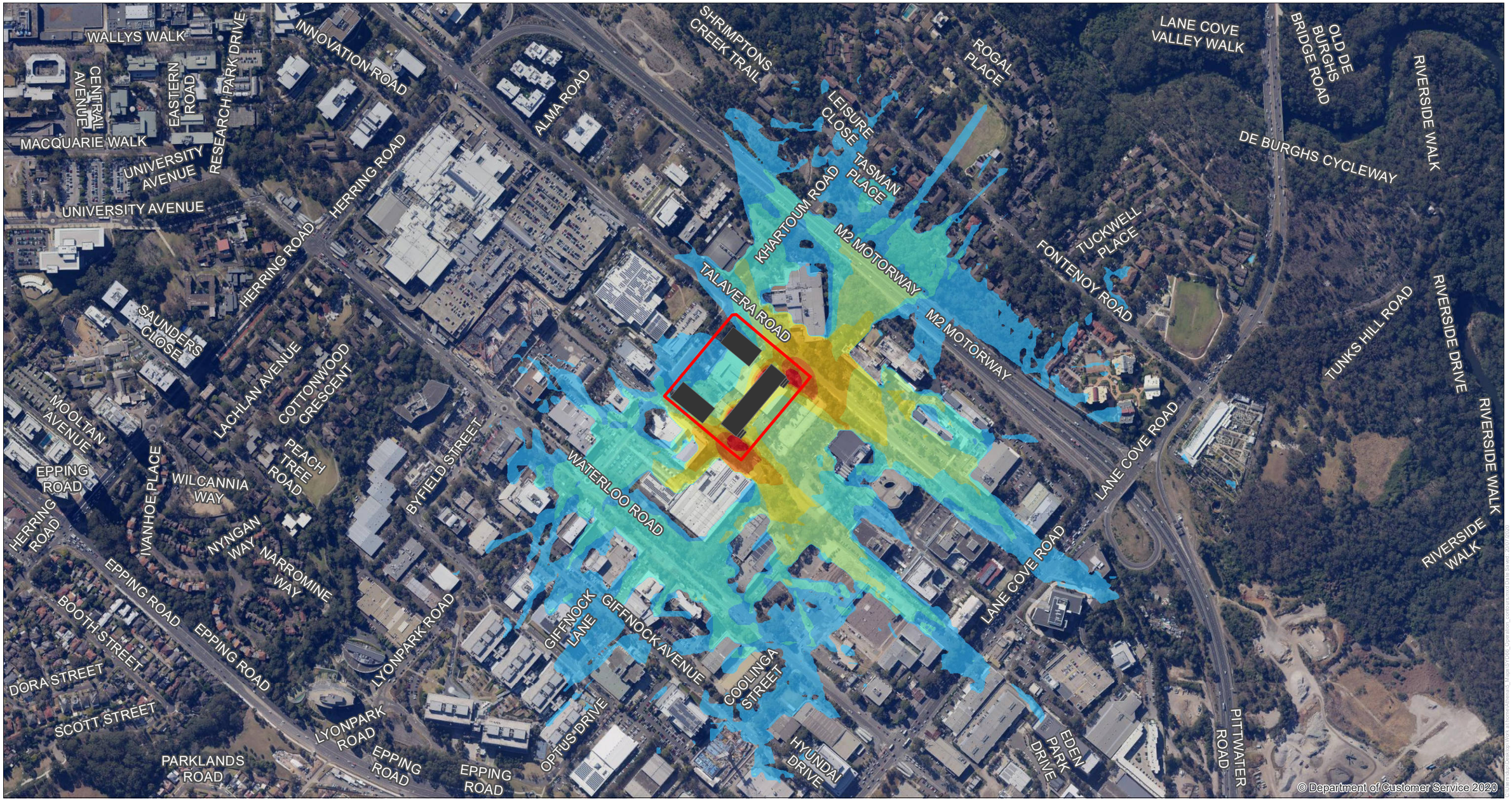
< 35 | 35 - 45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

N

0 0.1 0.2 km

AECOM

Source:



Macquarie Park Data Centre Predicted operational noise levels - Emergency operation

Site

Athena

Sound Pressure Level, $L_{Aeq,15min}$, dB(A)

<45 | 45 - 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

N

0 0.1 0.2 km

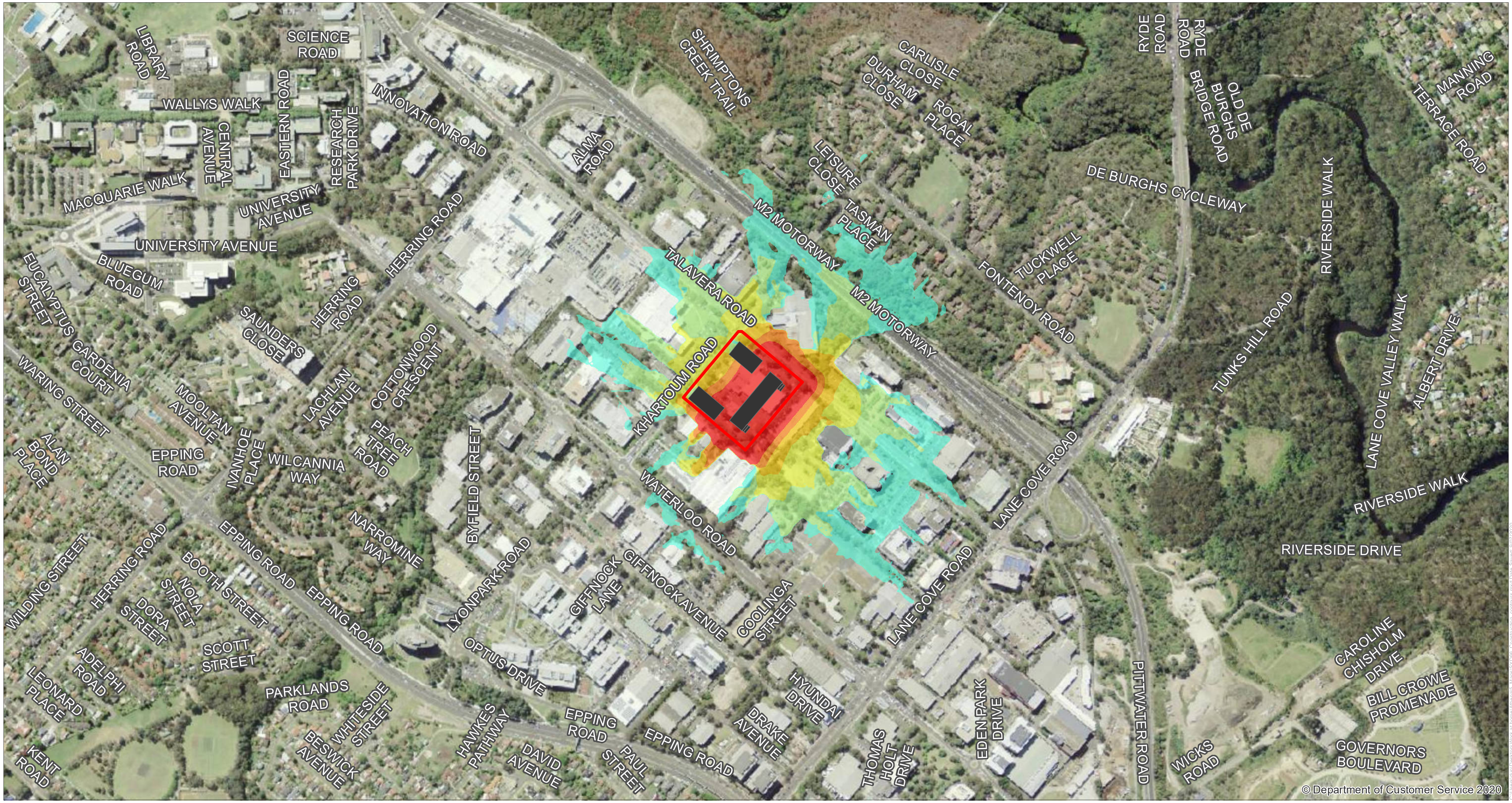
AECOM

Source:

Appendix D

Location of Construction Noise Criteria

Appendix D Construction Noise Contour Plots



Macquarie Park Data Centre Predicted construction noise levels - Site establishment and enabling works

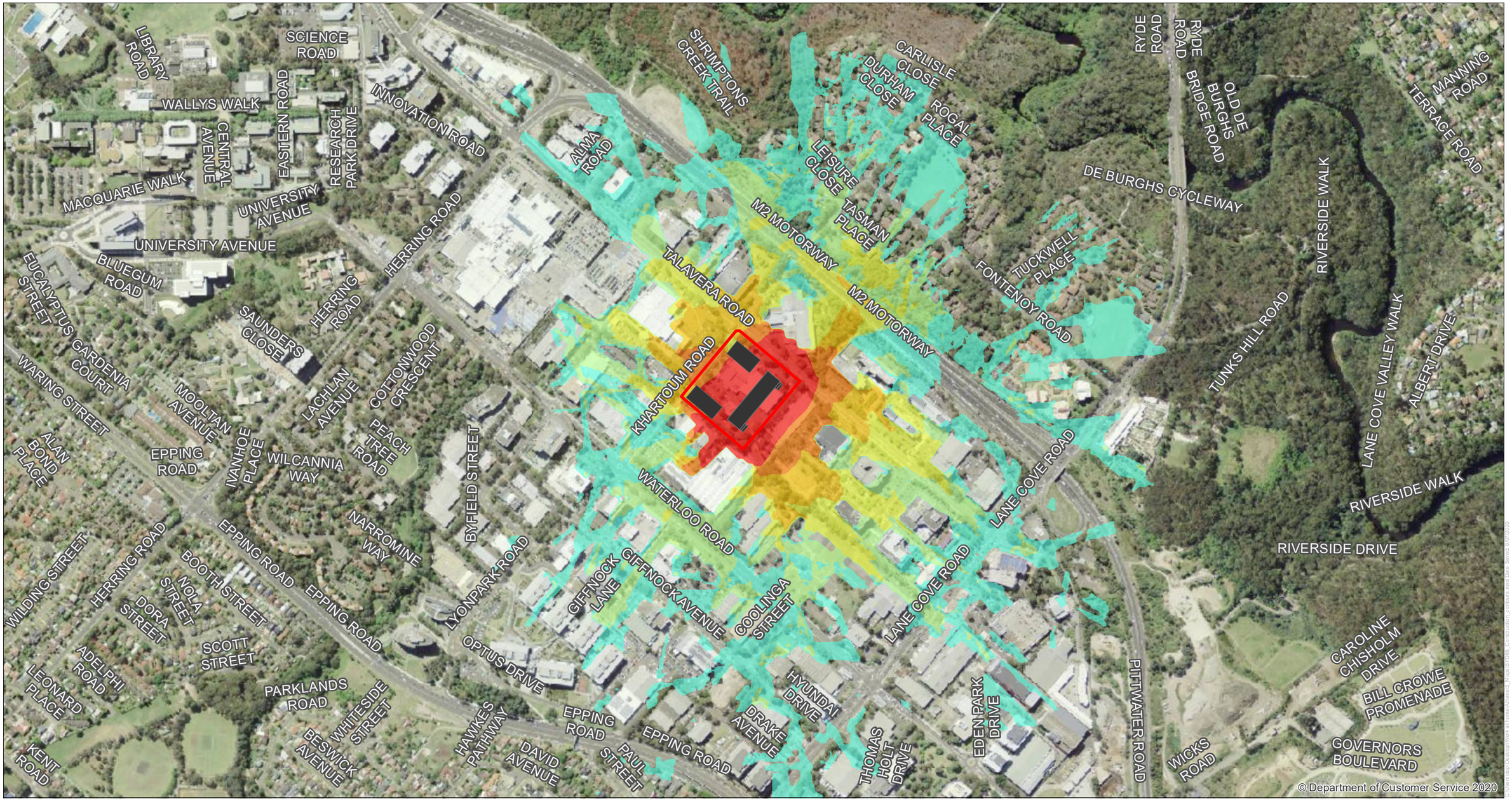
AECOM

Legend	
Site	
Athena	

Sound Pressure Level, $L_{Aeq,15min}$, dB(A)

< 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

Source:



Macquarie Park Data Centre Predicted construction noise levels - Foundations - Impact piling

Site

Athena

Sound Pressure Level, $L_{Aeq,15min}$, dB(A)

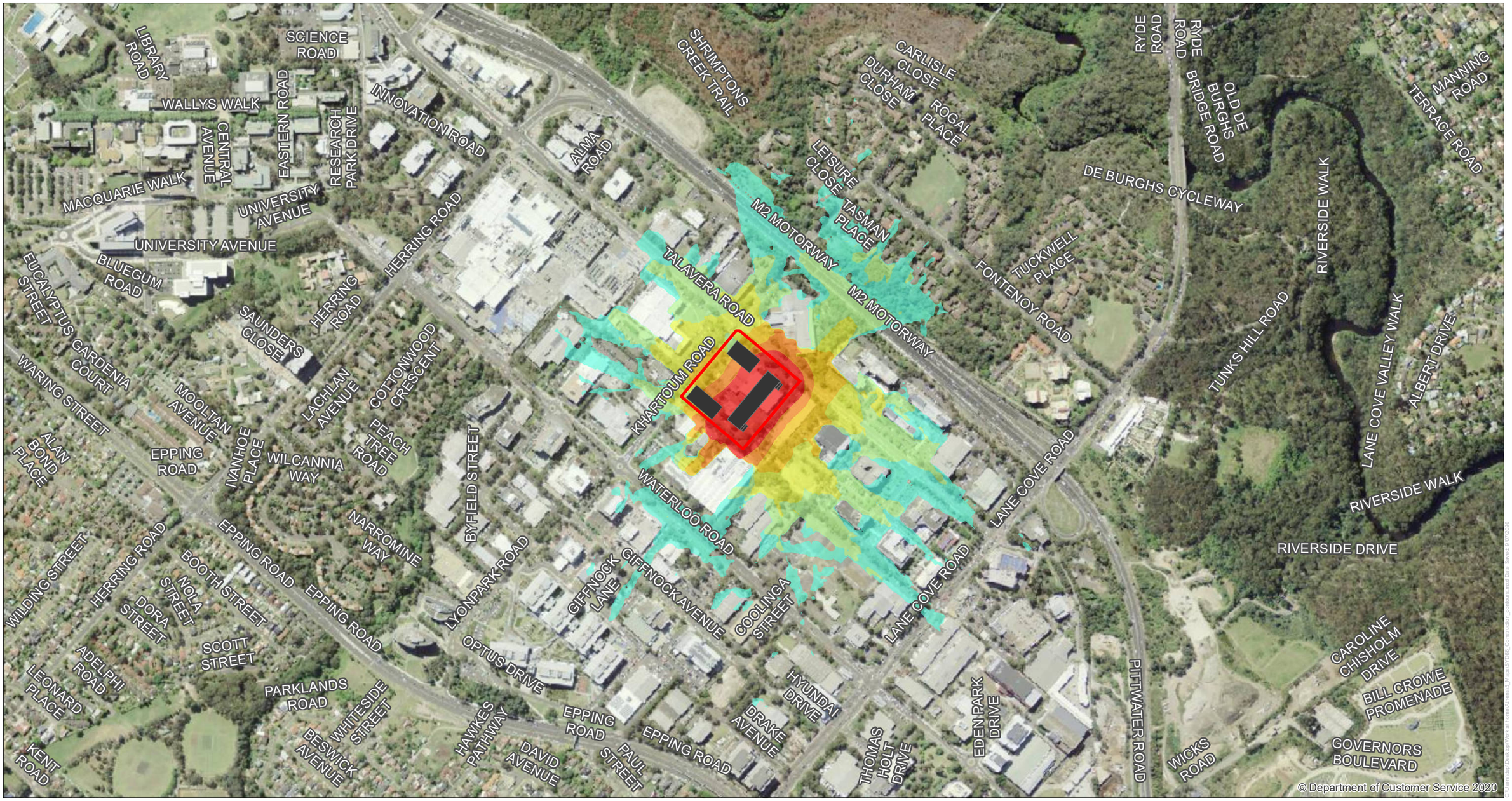
< 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

N

0 0.1 0.2 km

AECOM

Source:



Macquarie Park Data Centre Predicted construction noise levels - Foundations - Bored piling

AECOM

🟥 Site

⬛ Athena

Sound Pressure Level, $L_{Aeq,15min}$, dB(A)

Colour	Level
🟦	< 50
🟩	50 - 55
🟨	55 - 60
🟨	60 - 65
🟧	65 - 70
🟧	70 - 75
🟥	> 75

Source:

Macquarie Park Data Centre Predicted construction noise levels - Frame and Facades

Site

Athena

Sound Pressure Level, $L_{Aeq,15min}$, dB(A)

< 50 | 50 - 55 | 55 - 60 | 60 - 65 | 65 - 70 | 70 - 75 | > 75

N

0 0.1 0.2 km

AECOM

Source: