Confidential

Kemps Creek Data Centre

Noise and Vibration Impact Assessment

SYD05-06-07_Y-R-0000

Revision 3 | 23 July 2021

Job number 277863-00

Arup Australia Pty Ltd ABN 76 625 912 665

Arup
Level 5
151 Clarence Street
Sydney NSW 2000
Australia
www.arup.com

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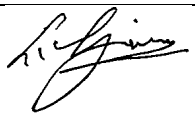
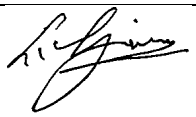
		Signature			
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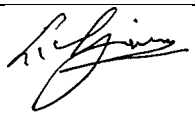
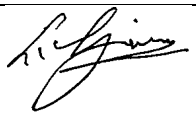
		Name	Chris Nugroho	Mathew Simon	Mathew Simon
		Signature			

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		Name	Mathew Simon	Chris Nugroho	Mathew Simon
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		Name			
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Executive summary

An acoustic assessment has been carried out for the proposed data centre in accordance with the requirements of the NSW Department of Planning, Industry and Environment (DPIE), which has included consideration of the operational and construction phases of the development. Consideration to the Mamre Road Draft DCP [1] has been given.

The operational noise assessment established project noise goals and carried out noise predictions in accordance with the NSW *Noise Policy for Industry* [2]. Both standard operations, including maintenance testing of generators during the daytime period, as well as critical power failure scenario noise emissions have been predicted.

Indicative noise mitigation measures are provided in Section 7. Detailed acoustic design will be required during the design development phase to confirm the detailed specification of equipment and mitigation measures. Provided mitigation measures are implemented, operational noise emissions are predicted to comply with established criteria for all periods.

Regarding construction, while specific activities and work schedules are not yet known, criteria has been established in accordance with the NSW ICNG [3] and *Assessing Vibration: a technical guideline* [4]. Exceedances of Noise Management Levels are predicted at nearest residential and non-residential receivers. Recommendations with regard to mitigation and management measures are also outlined and are expected to be developed further in a formal Construction Noise and Vibration Management Plan, to be prepared prior to commencement of works.

No significant acoustic impacts due to the traffic generated by service vehicles are predicted.

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1 Introduction

1.1 Purpose of this report

The purpose of this report is to respond to the Secretary's Environmental Assessment Requirements (SEARs) by providing an assessment of the noise and vibration impacts of the proposal and all reasonable and feasible measures that will be implemented to minimise potential impacts. The report provides an assessment of noise and vibration sources and impacts during the construction and operation of the proposal, and outlines how these impacts will be minimised or mitigated.

1.2 Proposal overview

1.2.1 Site context

The identified site address that is the subject of this technical report is legally defined as 757-769 Mamre Road, Kemps Creek. The entire Site comprises a total area of approximately 17.38 hectares (ha) and is subject to the applicable provisions outlined within SEPP (WSEA) 2009. Access to the Site is currently obtained via the proposed Estate Access Roads (SSD 9522), which are accessed from Mamre Road. Access into the Site is made possible via Mamre Road, which is subject to future road widening as part of the Mamre Road Widening Project (Transport for NSW).

The Site is situated approximately 40.26 km west of the Sydney CBD, 22.11 km west of Parramatta and 11.97 km southeast of Penrith. It is within close proximity to transport infrastructure routes (predominantly the bus network), as well as sharing direct links with the wider regional road network, including Mamre Road and both the M4 & M7 Motorways. All of which provide enhanced connectivity to the Subject Site and immediate vicinity, as well as the wider locality.

Additionally, the Subject Site is located within close proximity to active transport links, such as bicycle routes, providing an additional mode of accessible transport available to the Subject Site. In its existing state, the Subject Site comprises an undeveloped land portion; however, is subject to bulk earthworks and infrastructure works under a concurrent State Significant Development (SSD) Application - SSD 9522.

The Proponent is proposing to construct and operate a Data Centre on the Subject Site. The Site is located within the Penrith Local Government Area (LGA) and is zoned IN1 General Industrial under the provisions of State Environmental Planning Policy (Western Sydney Employment Area) 2009 (SEPP (WSEA) 2009). Development for the purpose of a Data Centre is permissible with consent within the IN1 General Industrial zone pursuant to the provisions outlined with Part 3, Division 3, Clause 27 of State Environmental Planning Policy (Infrastructure) 2007 (ISEPP).

The site and surrounding context are illustrated below in Figure 1.

Lot 34
DP1118173

Lot 1
DP1018318

Lot X
DP421633

Lot Y
DP421633

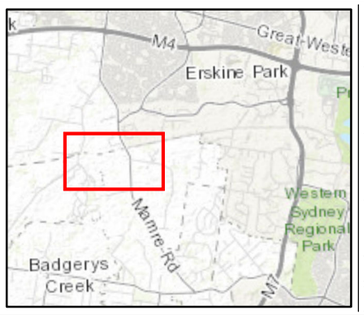
Lot 22
DP258414

Subject Site

COMMERCIAL IN CONFIDENCE

Legend

- Proposed Site
- Lot
- SSDA 9522



Client

Job Title
Kemps Creek Data Centre

Figure Title
Site Context and Surrounding Area

Meters
0 100 200 300 400

Issue	Date	By	Chkd	Appd
D2	2021-03-03	ICD	LS	

ARUP
Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point,
Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Scale at A3	Figure Status
1:10,000	Draft

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863-00	Figure 01

Aerial Imagery: DFSI, 2020

1.3 Architectural drawings

The acoustic assessment has been based on the following architectural drawings prepared by Greenbox Architecture Pty Ltd, as outlined in Table 1.

Table 1: Architectural drawings

Drawing Number	Revision	Revision Date	Sheet Name
CRD001	2	18/12/2020	GA FLOOR PLANS_1-1000
CRD010	2	18/12/2020	GA FLOOR PLAN - L1 - WEST_1-500
CRD011	2	18/12/2020	GA FLOOR PLAN - L1 - EAST_1-500
CRD020	2	18/12/2020	GA FLOOR PLANS-L2_1-500
CRD050	2	18/12/2020	GA SECTIONS_1-500
CRD051	2	18/12/2020	GA SECTIONS_1-500

1.4 Qualification

This report was prepared by Mathew Simon and reviewed by Glenn Wheatley, both suitably qualified and experienced acousticians from the Arup Acoustics team, who hold good working knowledge of the relevant standards, specifications and conditions applicable to this project.

Mathew and Glenn hold over 10 years' experience as acoustic consultants and are qualified and operating members of the Australian Acoustical Society (AAS). Arup are a member firm of the Association of Australasian Acoustical Consultants (AAAC).

1.5 SEARs and DCP requirements relevant to this report

Table 2 identifies the SEARs and DCP requirements which are relevant to this technical assessment.

Table 2: SEARs and DCP requirements for acoustics

Requirements relevant to this technical report	Where addressed in this technical report
SEARS Key Issue - Noise and Vibration	
The EIS must include an assessment of the potential impacts of the proposal (including cumulative impacts) and develop appropriate measures to avoid, mitigate, manage and/or offset these impacts. The EIS must address the following specific matters:	
a quantitative noise and vibration impact assessment (NVIA) of the development during construction and operation (including testing of the back-up generators). The NVIA is to be undertaken by a suitably qualified person in accordance with the relevant Environment Protection Authority guidelines and include an assessment of nearby sensitive receivers	Construction – Section 5 Operation – Section 6 Nearby sensitive receivers - Section 4

Requirements relevant to this technical report	Where addressed in this technical report
cumulative impacts of other developments	Cumulative noise impacts - Section 6.5
details of proposed mitigation, management and monitoring measures	Environmental management measures - Section 7
Mamre Road Precinct Draft DCP November 2020 **Section 4.3.1 – Noise and Vibration**	
Objectives a) Establish design criteria for noise emissions from industrial or other employment generating development. b) Establish acoustic environmental goals for existing and future adjacent residential areas Establish noise contributions for individual allotments within the employment zones when related to residential boundaries	
Control 1: Any machinery or activity considered to produce noise emissions from a premise shall be adequately sound-proofed so that noise emissions are in accordance with the provisions of the Protection of the Environment Operations Act 1997.	Operation – Section 6
Control 2: The use of mechanical plant and equipment may be restricted in areas close to sensitive receivers, such as adjoining rural residential development. Developers in all areas should ensure through design of their development that no offensive noise is emitted	Operation – Section 6
Control 4: All development shall comply with the requirements of relevant Australian Standards and State Government policies and guidelines relating to noise.	Operation – Section 6
Control 5: An acoustic report shall be required for developments that are likely to generate high noise levels and for development within 500m of residential areas and other sensitive noise receivers, including seniors housing, places of public worship and educational establishments. The acoustic design report should refer to the relevant Australian Standards and State Government policies and guidelines relating to noise	Operation – Section 6
Control 7: It is essential that potential developers investigate noise amelioration features to be included in building design, which will assist in achieving compliance with Council's acoustic criteria. Having regard to the surrounding topography, it is critical that the roof element of all buildings be acoustically capable of controlling potential breakout noise.	Operation – Section 6
An Acoustic Report in accordance with Section 4.3.1 of this DCP must be prepared by a suitably qualified acoustic consultant who possesses the qualifications to render them eligible for membership of the Australian Acoustical Society or employed by an Association of Australasian Acoustical Consultants (AAAC) member firm. The report should refer to the relevant Australian Standards and State Government policies and guidelines relating to noise.	Qualifications – Section 1.3

2 Policy and planning context

The following Acts, Plans, Guidelines and Policies have been considered in accordance with the SEARs:

- NSW DEC *Assessing Vibration: A Technical Guide* [4]
- NSW EPA *Noise Policy for Industry*
- NSW EPA Environmental Criteria for Road Traffic Noise ('ECRTN') [5]

  Note: the ECRTN has been superseded by the NSW Road Noise Policy. Road traffic assessments have been conducted in accordance with this current policy.
- NSW EPA *Noise Guide for Local Government* [6]
- NSW DECC Interim Construction Noise Guideline [3]

In addition, the following documents have been considered as part of this assessment:

- British Standard 7385 Part 2 [7]
- TfNSW Construction Noise Strategy [8]
- NSW Road Noise Policy [9]
- Draft Mamre Road Precinct Development Control Plan 2020 (DCP) [1]
- German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure'* [10]

Regarding aircraft noise, the site location does not require an assessment in accordance with the draft ANEF noise contours for Badgerys Creek Airport. (https://www.westernsydneyairport.gov.au/about/flight-paths/noise-tool)

3 Methodology

This Chapter outlines the methodology used to undertake the environmental assessment of potential acoustic impacts of the proposal, including definition of the study area used as the basis of the assessment.

The scope of work for this project is as follows:

- Review the Master SSD-9522 Acoustic Report (Master SSDA) [11] , site plans and proposed development details.
- Conduct noise monitoring is proposed to ensure the current ambient acoustic environment is captured. Monitoring results are presented in the Master SSDA, however additional monitoring has been conducted to establish current background noise levels.
- Establish construction and operational acoustic criteria based on monitoring data.
- Predict construction noise and vibration impacts based on a preliminary construction equipment selection.
- Predict operational noise emissions based on a preliminary plant equipment selection. Operational scenarios include:
    - Normal operations
    - Power failure operations

  A testing and commissioning period is anticipated following commencement of operations. Noise impacts throughout this period are anticipated to be equal or lower than during operations, therefore are deemed to comply following demonstration of compliance during normal operations
- Assessment of the net change in traffic noise levels on the local road network due to the operation of the development.
- Conduct a preliminary assessment to determine potential (in-principle) noise mitigation treatment for primary operational noise sources, and to inform design that is to be documented for the Development Application.

3.1 Study area

The proposed study area will extend across all nearest receivers to the site, including residences in Luddenham to the west, isolated rural residences to the south and east, and residential and commercial / industrial premises to the north, shown in Figure 2.

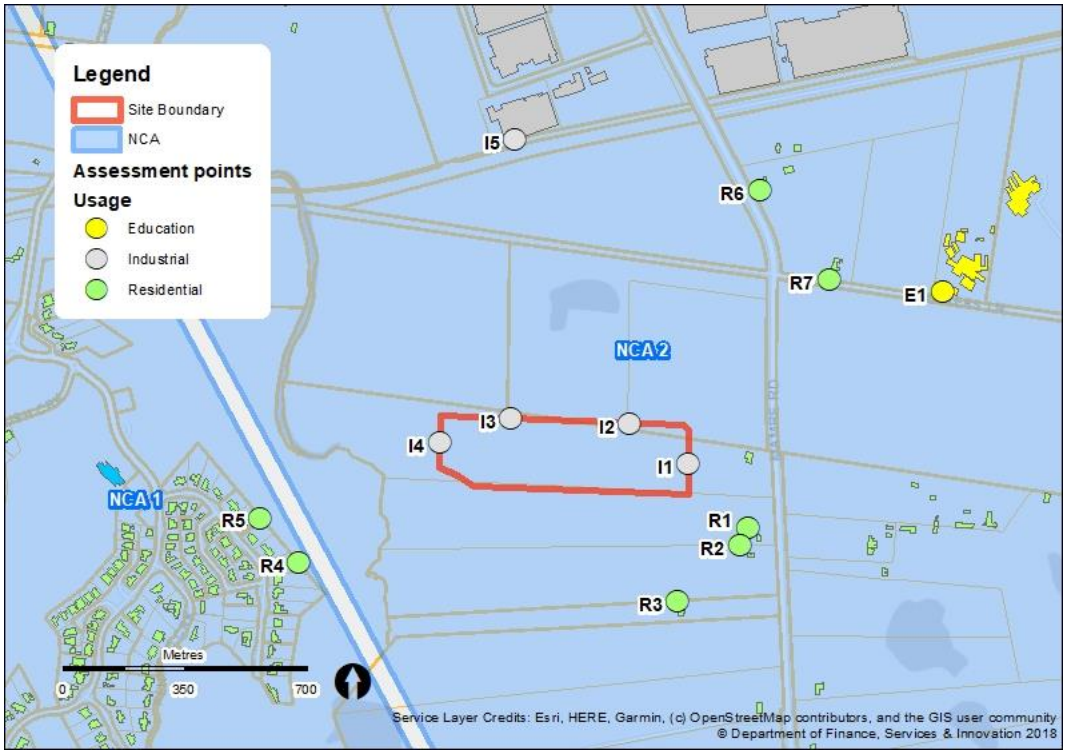


Figure 2: Site, surrounding sensitive receivers and NCAs

4 Existing environment

Noise monitoring was undertaken for the purpose of deriving of noise criteria and qualifying the noise environment at nearby receivers.

Long-term unattended and short-term attended monitoring was conducted at locations presented in Table 3 and shown in Figure 3.

Table 3: Monitoring locations

Type	Purpose	ID	Location	Description
Both long-term unattended and short-term attended	Establish criteria	L1	Residential 1 Medinah Avenue, Luddenham	Backyard of 1 Medinah Avenue, near the overhead power line.
		L2	Residential Bakers Lane West, Kemps Creek	Adjacent to Bakers Lane West, a private access road.
Short-term attended only	Quantify and qualify noise levels surrounding site	S1	On Master site	Along northern boundary of site
		S2	Adjacent to Mamre Road	South of intersection of Mamre Road and Bakers Lane

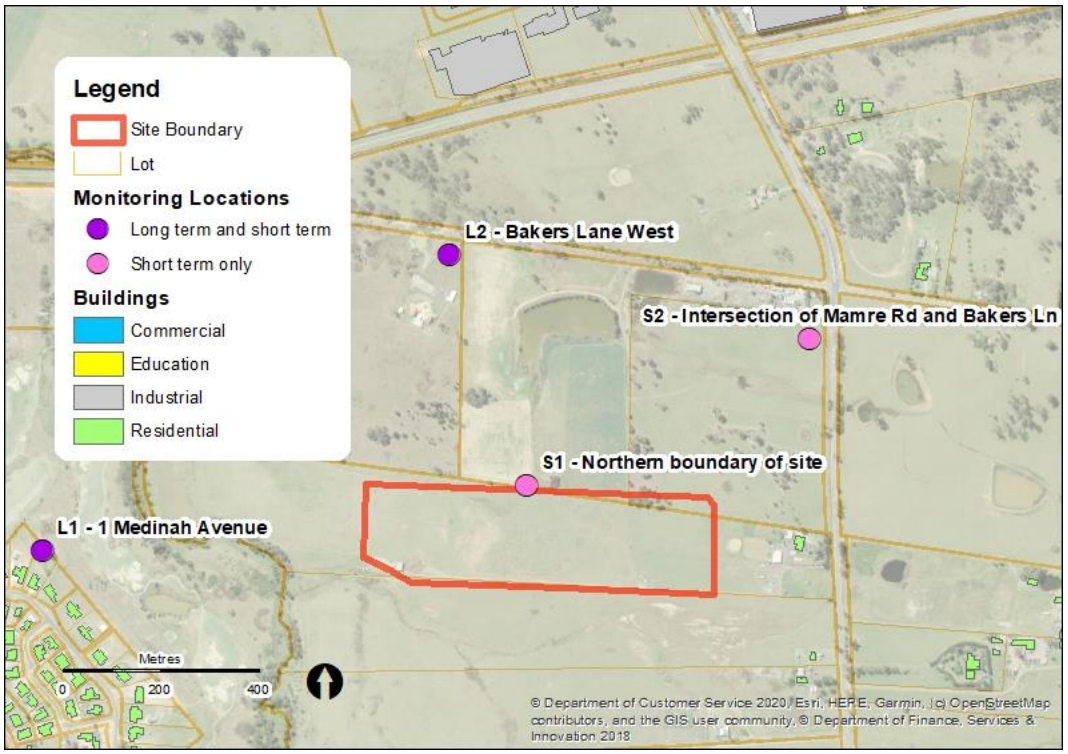


Figure 3: Noise monitoring locations

4.1 Unattended long-term monitoring

Long-term noise monitoring was carried out over two periods from 15 to 23 May 2019 and 25 November to 7 December 2020.

Table 4 summarises the background and ambient noise level results. The long-term noise monitoring methodology and noise level-vs-time graphs of the data are included in Appendix B.

Table 4: Long-term noise monitoring results, dB(A)

Location	NCA	Time period[1]	Rating Background Levels, dBL_{A90}	Ambient dBL_{Aeq} noise levels
L1 - 1 Medinah Avenue, Luddenham	1	Day	37	49
		Evening	36	45
		Night	33	45
L2 – Bakers Lane West, Kemps Creek	2	Day	39	47
		Evening	43	46
		Night	38	46

1 - Day: 07:00-18:00 Monday to Saturday and 08:00-18:00 Sundays & Public Holidays
Evening: 18:00-22:00 Monday to Sunday & Public Holidays
Night: 22:00-07:00 Monday to Saturday and 22:00-08:00 Sundays & Public Holidays
As required by the NPfI, the external ambient noise levels presented are free-field noise levels.

4.2 Attended short-term monitoring

Short-term attended noise measurements were undertaken on Wednesday, 15 May 2019 and Wednesday, 25 November 2020 at four locations shown in Figure 3. The measured noise levels are summarised in Table 5.

Table 5: Short-term noise monitoring results, dB(A)

Location	Date and start time	Measured levels		Noise Sources Contributions
		$dBL_{A90(15min)}$	$dBL_{Aeq(15min)}$	
L1	25/11/20 14:30	39	45	Relatively quiet with limited traffic noise. Insect and bird song fairly present throughout measurements. Occasional helicopter/plane passbys.
L2	15/05/19 13:00	39	48	Traffic noise, light aircraft flyovers, construction noise (jackhammers, reversing alarms), birdsong and insects.
S1	25/11/20 11:14	41	45	Light and heavy traffic from Mamre Road. Insect and bird song fairly present throughout measurement

Location	Date and start time	Measured levels		Noise Sources Contributions
		$dBL_{A90(15min)}$	$dBL_{Aeq(15min)}$	
S2	25/11/20 11:54	55	74	Heavy/light traffic dominated. Some air braking from trucks, Insects audible when traffic noise low.

No industrial noise was noted during measurements.

4.3 Assessment locations

In accordance with the *Noise Policy for Industry* NPfI, the reasonably most-affected residences have been grouped into Noise Catchment Areas (NCAs) based on their acoustic environment as observed on site. NCAs are presented in Figure 2. For clarity, the assessment of residential receivers presented in this report is isolated to the reasonably most-affected receivers listed in Table 6.

Table 6: Reasonably most-affected residential receivers

Receiver ID	Address	No. of floors	NCA
R1	771-781 Mamre Road Kemps Creek	1	2
R2	783-797 Mamre Road Kemps Creek	1	2
R3	799-803 Mamre Road Kemps Creek	2	2
R4	15 Medinah Avenue Luddenham	1	1
R5	9 Medinah Avenue Luddenham	2	1
R6	676-702 Mamre Road Kemps Creek	1	2
R7	676-702 Mamre Road Kemps Creek	1	2

A list of all non-residential noise sensitive receivers within the study area is presented in Table 7.

Table 7: Non-residential receivers

Receiver ID	Name	Address	No. of floors
Education			
E1	Mamre Christian College	45-59 Bakers Lane Kemps Creek	1
Industrial			
I1	Master site boundary East	757-703 Mamre Road Kemps Creek	1
I2	Master site boundary North East	757-703 Mamre Road Kemps Creek	1
I3	Master site boundary North West	757-703 Mamre Road Kemps Creek	1
I4	Master site boundary West	757-703 Mamre Road Kemps Creek	1
I5	DATS	7-9 Distribution Drive Orchard Hills	5

5 Assessment of potential construction impacts

5.1 Construction vibration

Vibration impacts are unlikely to be an issue at the nearest residential premises which lie over 200 m away. Vibration impacts onto the existing site buildings, however, should be managed if vibration intensive works are required near these buildings. Vibration impacts onto existing utilities and buried services also require consideration, and criteria have been provided in Section 5.1.3.

5.1.1 Disturbance to buildings occupants

Concerns regarding impacts on human occupants to buildings would generally be assessed in accordance with the 'intermittent' vibration criteria outlined in the DEC Guideline [4], however reference would typically be made to the Maximum levels. For this project, focus for management purposes is on structural damage, as outlined below.

5.1.2 Structural damage

5.1.2.1 Definition

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [7] and/or German Standard DIN4150-3 [10]. British Standard 7385 Part 1: 1990, defines different levels of structural damage as:

- *Cosmetic - The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

Table 1 of British Standard 7385 Part 2 (1993) sets limits for the protection against cosmetic damage, however the following guidance on minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a*

> *high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "*any permanent effect of vibration that reduces the serviceability of a structure or one of its components"* (p.2). The Standard also outlines:

> *"that for structures as in lines 2 and 3 of Table 1, the serviceability is considered to have been reduced if*
>
> - *cracks form in plastered surfaces of walls;*
> - *existing cracks in the building are enlarged;*
> - *partitions become detached from loadbearing walls or floors.*
>
> *These effects are deemed 'minor damage." (DIN4150.3, 1990, p.3)*

While the DIN Standard defines the above damage as 'minor', the description aligns with BS7385 cosmetic damage, rather than referring to structural failures.

5.1.2.2 British Standard BS7835-2

BS7385-2 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4–250 Hz, and a maximum displacement value below 4 Hz is recommended. Table 8 sets out the BS7385 criteria for cosmetic, minor and major damage. Regarding heritage buildings, British Standard 7385 Part 2 [7, p. 5] notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*".

Table 8: BS 7385-2 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor[2]	100		
		Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

1 - Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

2 - Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

5.1.2.3 German Standard

German Standard DIN 4150 - Part 3 '*Structural vibration in buildings - Effects on Structure'* [10] are generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings. For the subject site, surrounding buildings are not deemed structurally sensitive and therefore the British Standard is considered appropriate for vibration management.

5.1.3 Buried services

A number of buried services existing on the existing Altis Frasers site and require consideration when conducting vibration intensive construction activities.

DIN 4150-2:1999 sets out guideline values for vibration effects on buried pipework and reproduced in Table 9 below.

Table 9: Guideline values for short-term vibration impacts on buried pipework

	Pipe material	**Guideline values for vibration velocity measured on the pipe, mm/s**
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

Note: For gas and water supply pipes within 2m of buildings, the levels given in DIN4150-3 [10] should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

In addition, specific limits for vibration affecting high-pressure gas pipelines is provided in the UK National Grid's *Specification for Safe Working in the Vicinity of National Grid High Pressure Gas Pipelines and Associated Installations – Requirements for Third Parties* (report T/SP/SSW/22, UK National Grid, Rev 10/06, October 2006). This specification states that no piling is allowed within 15 meters of a pipeline without an assessment of the vibration levels at the pipeline. The PPV at the pipeline is limited to a maximum level of 75 mm/s, and where PPV is predicted to exceed 50 mm/sec the ground vibration is required to be monitored.

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

5.2 Construction noise criteria

The NSW *Interim Construction Noise Guideline* [3] (ICNG or Guideline) provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction noise management levels above which all feasible and reasonable work practices should be applied to minimise

the construction noise impact. The ICNG works on the principle of a 'screening' criterion – if predicted or measured construction noise exceeds the ICNG levels then the construction activity must implement all 'feasible and reasonable' work practices to reduce noise levels.

The ICNG provides two methods for assessing construction noise, varying typically on the basis of the project duration, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration and involves the measurement of background noise levels for determination of noise management levels and prediction of construction noise levels. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

This development is expected to warrant a quantitative assessment.

The ICNG sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These noise management levels (NMLs) for residential receivers and other sensitive receivers are reproduced in Table 6 and in Table 7 respectively.

Table 10: Construction noise management levels (NMLs) at residential receivers

Time of day	**NML[1]** $L_{Aeq\ (15\ min)}$	**How to apply**
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq (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 75dB(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: 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 if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of day	NML[1] $L_{Aeq\ (15\ min)}$	How to apply
Outside recommended standard hours	Noise affected RBL + 5dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

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.

Table 11: Construction noise management levels (NMLs) at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq(15\ min)}$[1]
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Industrial premises	External noise level	75 dB(A)

1 - Noise management levels apply when receiver areas are in use only.

Table 12 and Table 13 summarises relevant project construction noise targets for the project for residential and non-residential receivers respectively.

Table 12: Noise Management Levels for residential receivers

Receiver ID	Address	Standard Hours[1] $dBL_{Aeq\ (15\ min)}$
R1	771-781 Mamre road Kemps creek	49
R2	783-797 Mamre road Kemps creek	49
R3	799-803 Mamre road Kemps creek	49
R4	15 Medinah avenue Luddenham	47
R5	9 Medinah avenue Luddenham	47
R6	676-702 Mamre road Kemps creek	49
R7	676-702 Mamre road Kemps creek	49

Notes:

1 - Standard hours are Monday to Friday 7 am to 6 pm and Saturday from 8 am to 1 pm.

Table 13: Noise Management Levels for non-residential receivers

Receiver ID	Address	NML[1] $dBL_{Aeq\ (15\ min)}$
E1	45-59 Bakers lane Kemps creek	55[2]
I1	757-703 Mamre road Kemps creek	75
I2	757-703 Mamre road Kemps creek	75
I3	757-703 Mamre road Kemps creek	75
I4	757-703 Mamre road Kemps creek	75
I5	7-9 Distribution drive Orchard hills	75

Notes:

1 – When in use

2 – Levels which have been adjusted to convert internal NML levels to external, by an addition 10dB. In accordance with the ICNG.

5.3 Construction assessment

5.3.1 Hours of work

Construction would take place between standard working hours:

- Monday to Friday 7 am to 6 pm; and
- Saturday 8 am to 1 pm.

There would be no construction work on Sundays or public holidays.

5.3.2 Assessment methodology

Noise emissions from construction activities have been assessed to criteria outlined in Section 5.2.

Noise emissions have been modelled using SoundPlan 8 in accordance with the CONCAWE algorithm, with a 3 m/s source to receiver wind applied. The model included:

- Construction noise sources listed in Table 15;
- Surrounding buildings;
- Receivers listed in Section 4.3; and
- Ground terrain and absorption.

Noise emissions have been modelled on the following assumptions:

- Equipment, staging, locations and durations are based on information provided by Client.

5.3.3 Activities

Construction details are unavailable at this stage of the project. An assessment of potential construction activities has been conducted on assumed construction activities based on similar datacentre projects, as approved by the Client.

The total construction period is anticipated to take up to 16 months. The construction would involve the stages outlined in Table 14.

Table 14: Construction stages

Stage	Anticipated duration
Stage 1: Site establishment and excavation	1 month
Stage 2: Pavement and road works	3 months
Stage 3: Building construction	10 months
Stage 4: Plant installation and connection	2 months

5.3.4 Plant and equipment sources

Table 15 shows the equipment sound power levels have been determined by reference to AS2436 [12], BS 5228-1:2009 [13] and Arup's measurement database. The equipment below has been assumed to operate concurrently and continuously over a full 15-minute period (a typical worst-case assumption). All construction plant are considered to be 'non-steady sound' sources in accordance with accordance with AS1055:2018 [14] unless specified in Table 15.

Table 15: Equipment and plant sound power levels

Plant item	Plant item SWL, dB(A)	Penalty[1], dB	% of use in worst case 15 mins	Construction Phases			
				Site establishment and excavation	Pavement & road works	Building construction	Plant installation and connection
Backhoe	108	0	100	1			
Compactor	115	5	100	1	1		
Concrete Pump	106	0	100		1	1	
Concrete Pump Truck	113	0	100		1	1	
Crane (Franna)	98	0	100			1	
Crane (Tower)	105	5	100			1	
Excavator (30t) + hydraulic hammer	122	0	100	2	1		
Excavator with breaker	124	0	100	1			
Loader (Front-end) (23t)	112	0	100	1	1		
Generator (Diesel)[2]	113	0	100	1	1	1	

Plant item	Plant item SWL, dB(A)	Penalty[1], dB	% of use in worst case 15 mins	Construction Phases			
				Site establishment and excavation	Pavement & road works	Building construction	Plant installation and connection
Grader	115	0	100	1	1		
Jack Hammer	121	5	100		1		
Roller (Vibrator)	112	0	100	2			
Roller (Smooth-drum)	107	0	100		1		
Pavement Laying Machine	114	0	100		1		
Piling rig (Impact)	129	5	100			1	
Scraper	116	0	100	1			
Truck (>20 tonne)	107	0	100	1	1		
Truck (Water Cart)	108	0	100	2	2	1	
Vehicle (Light Commercial e.g. 4WD)	111	0	100	2	2	2	1

Notes:

1. Penalty applied for impulsive noise characteristic
2. All plant items are considered 'non-steady sounds' except the generator which is considered to be 'steady sound'.

5.3.5 Noise prediction results

Predicted residential and non- residential construction noise levels at surrounding receivers are presented in Table 16.

Table 16: Predicted construction noise levels for residential and non-residential receivers

Receiver	NML	Construction phase			
		Site Establishment and Excavation	Pavement & Road Works	Building Construction	Plant Installation and Connection
Residential receivers					
R1 - 771-781 Mamre road Kemps creek	49	64	64	69	46
R2 - 783-797 Mamre road Kemps creek	49	64	64	69	46
R3 - 799-803 Mamre road Kemps creek	49	64	64	69	46
R4 - 15 Medinah avenue Luddenham	47	60	60	65	42
R5 - 9 Medinah avenue Luddenham	47	60	60	65	42
R6 - 676-702 Mamre road Kemps creek	49	59	59	64	41

Receiver	NML	Construction phase			
		Site Establishment and Excavation	Pavement & Road Works	Building Construction	Plant Installation and Connection
R7 - 676-702 Mamre road Kemps creek	49	60	60	65	42
Non-residential receivers					
E1 - 45-59 Bakers lane Kemps creek	55	50	50	55	32
I1 - Master site boundary - east	75	82	82	87	64
I2 - Master site boundary - north east	75	82	82	87	64
I3 - Master site boundary - north west	75	82	82	87	64
I4 - Master site boundary - west	75	84	84	89	66

Note:

Levels shaded in grey indicate a notional exceedance of NMLs based on the worst-case assumptions noted above.

Results shown in Table 16 indicate that exceedances are predicted at surrounding residential receivers during site establishment and excavation, pavement and road works and building construction phases.

It should also be noted predicted noise levels represent a conservative worst case scenario where all indicated equipment is operating simultaneously and continuously over fifteen minutes. Noise levels experienced by surrounding receivers are likely to be lower than those predicted. In addition, the highest predicted levels are only likely to occur intermittently, as the majority of equipment operate intermittently, and all equipment operating concurrently

The highest predicted noise levels are during the building construction phase, where noise levels of up to 69 dBA are predicted at the nearest residential receivers to the south. This represents an exceedance of NMLs of 20 dB, however is not considered ‘highly affected’ as noise levels are below 75 dBA.

Noise levels up to 89 dBA are predicted at the adjacent industrial boundary. This represents a significant impact, however the number of building occupants anticipated to be affected by these noise levels are low, due to the industrial nature of the premise. Lower noise levels are predicted during the site establishment and excavation and pavement and road work phases. Noise levels from the plant installation and construction phase are predicted to comply with established NMLs.

Noise levels at the nearest educational receiver E1 are predicted to comply in all phases.

5.4 Construction noise and vibration management

The contractor will have a key role in managing the noise and vibration levels during the works to reduce noise and vibration as far as is reasonably practicable. Recommended management measures are provided in Section 7.

6 Assessment of potential operational impacts

6.1 Operational noise scenarios

To assess potential noise impacts during operation, two scenarios comprising typical equipment has been developed based on our understanding of the project. These scenarios are considered representative of the noisiest operational activities likely to occur and are described below and in Section 6.3.2:

- **Standard operations:** Assumes all non-emergency equipment operating, and one generator being tested per sub site. Generator testing is included as part of standard (normal) operations as 62 generators need to be tested per month and that the testing duration per generator ranges from one to four hours.
- **Critical power failure**: Assumes all emergency generators (62) operating simultaneously.

6.2 Operational noise criteria

6.2.1 Standard operations noise criteria

The *Protection of the Environment Operations Act 1997* requires that authorities examine and consider matters affecting the environment when making decisions about development and activities. Operational noise emissions from the project have been assessed in accordance with the *Noise Policy for Industry* (NPfI) [2], which is primarily concerned with controlling intrusive noise impacts in the short-term for residences and maintaining long-term noise level amenity for residences and other land uses.

The NPfI sets out the procedure to determine the project noise trigger levels relevant to an industrial development. The project noise trigger level is a level that, if exceeded would indicate a potential noise impact on the community and so 'trigger' a management response.

6.2.1.1 Intrusive noise trigger level

The intrusiveness noise trigger level is applicable to residential premises only and is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5 dB

  (where $L_{Aeq,15minute}$ represent the equivalent continuous noise level of the source)

6.2.1.2 Recommended and project amenity noise level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from **all** industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the NPfI where feasible and reasonable. An extract from the policy is given below in Table 17.

Table 17: NPfI Recommended Amenity Noise Levels (RANLs)

Receiver	Noise amenity area	Time of Day	Recommended amenity noise levels (RANLs) dBL_{Aeq}
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
School classroom - internal	All	Noisiest 1-hour period when in use	35 (see notes for table)
Industrial premises	All	When in use	70

Notes:

The recommended amenity noise levels (RANLs) refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

1. The NPfI defines day, evening and night time periods as:
    - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
    - Evening: the period from 6 pm to 10 pm.
    - Night: the remaining period.

The recommended amenity noise levels (RANLs) represent the objective for **total** industrial noise at a receiver location, whereas the **project amenity noise level (PANL)** represents the objective for noise from a **single** industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

- *Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A)*

Residences have been grouped into two NCAs, categorised as either Rural or Suburban Residential in accordance with the NPfI [2].

NCA 1 has been categorised as Rural, defined as "*an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse".*

NCA 2 has been categorised as Suburban Residential, defined as an area *"an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry"*.

Proposed future development in the area, including the development of the Altis-Frasers estate, is anticipated to increase the overall noise level of the area,

therefore the categories currently assigned are considered to be conservative for a future scenario.

Table 18 summarises the RANLs and the PANLs applicable for the project.

Table 18: NPfI RANLs and PANLs

Receivers	**Indicative Noise Amenity Area**	**Time of day**[1]	**Recommended Amenity Noise Level (RANL) $dBL_{Aeq(period)}$**	**Project Amenity Noise Level (PANL)**	
				$dBL_{Aeq(period)}$	**$dBL_{Aeq(15min)}$**[2]
Residences in NCA 1	Rural	Day	50	45	48
		Evening	45	40	43
		Night	40	35	38
Residences in NCA 2	Suburban	Day	55	50	53
		Evening	45	40	43
		Night	40	35	38
School classroom - internal	All	Noisiest 1-hour period when in use	45[3]	40	43
Industrial premises	All	When in use	70	65	68

Notes

1. The NPfI defines day, evening and night time periods as:
   - Day: the period from 7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays.
   - Evening: the period from 6 pm to 10 pm.
   - Night: the remaining period.
2. 3 dB added to $L_{Aeq(period)}$ to determine $L_{Aeq(15min)}$ as per NPfI.
3. External noise level based on 10dB reduction through open window

6.2.1.3 Sleep disturbance

The NPfI recommends the following screening criteria for the assessment of potential sleep disturbance, for the period between 10 pm and 7 am:

- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater

As noise sources associated with datacentres, namely mechanical and electrical plant, have constant noise characteristics, sleep disturbance arising from high maximum noise levels is not anticipated to be an issue and has not been assessed further.

6.2.1.4 NPfI Project specific noise levels

Based on the background noise monitoring, Table 19 summarises the derived project specific noise levels based on the NPfI.

Table 19: NPfI Project specific noise levels - Residences

Receiver	Time Period	Project Specific Noise Levels, $dBL_{Aeq(15min)}$		
		Intrusive Noise Trigger Levels	Project Amenity Noise Level (PANL)	Project Noise Trigger Level (PNTL)
NCA 1	Day	42	48	42
	Evening	41	43	41
	Night	38	38	38
NCA 2	Day	44	53	44
	Evening	44[1]	43	43
	Night	43	38	38

Notes

1. The NPfI states "in determining project noise trigger levels for a particular development, it is generally recommended that the project intrusiveness noise level for evening be set at no greater than the project intrusiveness noise level for daytime. The project intrusiveness noise level for night-time should be no greater than the project intrusiveness noise level for day or evening. Alternative approaches to these recommendations may be adopted if appropriately justified."

6.2.2 Maintenance testing criteria

Maintenance testing of emergency plant is anticipated to occur during daytime period (7 am to 6 pm Monday to Saturday; or 8 am to 6 pm on Sundays and Public Holidays. between 7am and 6pm). The total testing regime for all 62 generators is summarised in Table 20.

Table 20: Annual testing regime

Month	Test	Duration (min)		Colo gen testing		Admin gen testing		Total Gens Tested	Total Mins
		Run	Cooldown	Number of tests	Gens run per test[1]	Number of tests	Gens run per test[1]		
1	**Bi-monthly, no load**	**10**	**0**	**30**	**2**	**2**	**1**	**62**	**320**
2	No test							62	0
3	Quarterly, 70% load	30	5	60	1	2	1	62	2170
4	**Bi-monthly, no load**	**10**	**0**	**30**	**2**	**2**	**1**	**62**	**320**
5	No test							62	0
6	Quarterly, 70% load	30	5	60	1	2	1	62	2170
7	**Bi-monthly, no load**	**10**	**0**	**30**	**2**	**2**	**1**	**62**	**320**
8	No test							62	0
9	Quarterly, 70% load	30	5	60	1	2	1	62	2170
10	**Bi-monthly, no load**	**10**	**0**	**30**	**2**	**2**	**1**	**62**	**320**
11	No test							62	0
12	Annual, 100% load	60	5	60	1	2	1	62	4030

Month	Test	Duration (min)		Colo gen testing		Admin gen testing		Total Gens Tested	Total Mins
		Run	Cooldown	Number of tests	Gens run per test[1]	Number of tests	Gens run per test[1]		
								Total minutes per year	**11820**
								Total hours per year	**197**

Note:

Rows in **BOLD** indicate a potential worst case scenario regarding noise emissions which have been assessed.

1. Colo generator testing will be conducted separately from admin generator testing.

This equates to 197 hours of testing per year.

Two potential worst case scenarios including generator testing have been identified:

- Bi-monthly no load – two colo generators being tested concurrently with no load applied, i.e. no load bank operating; and
- Annual 100% load – single colo generator being tested with 100% load applied, i.e. load bank operating.

These two scenarios have been included in the assessed scenarios.

Quarterly testing noise emissions are expected to generate noise emissions lower than annual testing, based on the same operating scenario but with the load bank only be operating at 70% load.

Note that generator testing has been included as part of standard operations considering that 62 generators need to be tested per month and that testing duration for all generators annually would be 197 hours per year.

6.2.3 Critical power failure criteria

While design criteria for the development includes scheduled testing of emergency plant, targets are not considered reasonable for critical power failure conditions, and would be considered unreasonable to implement noise treatment due to the low likelihood of this scenario. Furthermore, if power failure was to occur, the duration of an outage would be expected to be hours rather than days.

6.3 Stationary plant assessment

6.3.1 Noise sources

The primary outdoor noise sources on site are outlined in Table 21. Where equipment has yet to be selected, the sound power levels and octave band spectra have been estimated based on expected equipment power ratings and past project experience.

This list represents a preliminary list of primary equipment. Some equipment items may be redundant, may share loads, may operating at no load, or may be switched off, thereby reducing sound power levels. This assessment therefore represents a conservative assessment scenario.

Noise emissions from all equipment is characterised as steady-state sound in accordance with AS1055:2018 [14], i.e. constant noise emissions.

Note that the emergency generators are proposed to be located within dedicated enclosures.

Table 21: Project equipment, quantities and unmitigated sound power levels (per unit)

Major Equipment and function	Description / function	Number of items on site	Overall sound power level, dBA	Octave band (Hz)							
				63	125	250	500	1k	2	4	8
				Sound power level, dB(Z)							
Generator inlet louvre - Generator used to provide power in critical power failure scenario.	Inlet of acoustic generator enclosure	62	89	101	104	87	60	58	54	61	80
Generator outlet louvre - Generator used to provide power in critical power failure scenario.	Outlet of acoustic generator enclosure	62	89	101	104	87	56	54	51	60	80
Generator exhaust - Generator used to provide power in critical power failure scenario.	Generator diesel engine exhaust.	62	89	59	64	85	81	82	84	82	76
Load Bank - Provides the electrical load representative of the datacentre operational load to allow maintenance testing of generators.	Provides the electrical load representative of the datacentre operational load to allow maintenance testing of generators.	3	111	114	111	109	105	105	104	102	95
Data Hall Transformers - Steps down power for supply to the data centre at the required voltages	3 MVA capacity	480	87	91	88	91	87	78	69	69	64
Site Transformers - Steps down power for supply to the data centre at the required voltages	70 MVA	3 operational, 1 idle.	92	96	93	96	92	83	74	74	69
Data hall – contains server racks and cooling fans. Noise breaking out through data hall exhaust louvres.	Level 1 exhaust louvre outlet based on internal data hall noise level of 90dBA	1 per data hall. 30 data halls	62	72	69	62	56	56	53	49	49
	Level 2 exhaust louvre outlet based on internal data hall noise level of 90dBA	1 per data hall. 30 data halls	66	72	69	64	61	61	59	55	55
Data hall – contains server racks and cooling fans. Noise breaking out through data hall roof.	Roof construction: metal deck, absorption between purlins, two layers of plasterboard	1 per data hall. 30 data halls	76	89	91	76	62	54	51	55	45

Major Equipment and function	Description / function	Number of items on site	Overall sound power level, dBA	Octave band (Hz)							
				63	125	250	500	1k	2	4	8
				Sound power level, dB(Z)							
AHU – supplies ventilation air to data hall	Fresh air inlets open to louvred plantrooms.	8 per data hall level, 480 overall	63	81	75	66	53	46	44	34	40
	Supply air ducted to data hall, anticipated to be mitigated by data hall building and through exhaust paths	8 per data hall level, 480 overall	Not anticipated to generate significant noise levels compared to other equipment on site. If required, mitigation of these minor noise sources will be possible through typical acoustic treatment methods, eg. attenuators, enclosures.								
Admin transformers / isolation transformers (within data halls) - Steps down power for supply to the data centre at the required voltages		3									
Condensing units – facilitates ventilation of admin building	Domestic type	Servicing admin buildings									
Toilet exhaust fans – ventilates toilets		Servicing admin buildings									

Refer to architectural layouts in Table 1 for proposed location of equipment.

6.3.2 Operating Scenarios

Operating scenarios assessed outlined in Table 22. The scenarios are considered representative of the noisiest operational activities likely to occur. In practice, mechanical systems will vary in load dependant on internal and external temperatures, therefore, operation is expected to be typically lower than assessed.

Table 22: Modelling scenarios and corresponding plant and equipment

Project equipment	**Model scenarios**			
	1A. Standard Operation – Daytime, bi-monthly generator testing[1]	**1B. Standard Operation – Daytime, annual generator testing[1]**	**2. Standard Operation – Evening and night**	**3. Critical power failure – 24 hours**
	Number of equipment modelled in 15-minute assessment period.			
Generator inlet louvre	1	2	-	62
Generator outlet louvre	1	2	-	62
Generator exhaust	1	2	-	62
Load Bank	1	-	-	-
Data Hall Transformers	60	60	60	60
Site Transformers	3	3	3	3
Level 1 data hall exhaust	30	30	30	30
Level 2 data hall exhaust	30	30	30	30
Data hall roof	30	30	30	30
AHU fresh air inlet	480	480	480	480

Notes:

1. See Section 6.2.2

6.3.3 Assessment methodology

Noise emissions have been modelled using SoundPlan 8 using the CONCAWE algorithm with a 3m/s source to receiver wind applied representing worst case meteorological conditions which is considered appropriate for this scenario with nearest receivers located further than 100 metres of the noise sources.

The model included:

- Activity noise sources listed in Section 6.3.1;
- On-site and surrounding buildings;
- Receivers listed in Section 4.3; and
- Ground terrain and absorption.

6.3.4 Results

6.3.4.1 Unmitigated results

Table 23 presents predicted operational noise levels at residential receivers with no acoustic mitigation measures implemented.

Table 23: Unmitigated standard operations – residential receivers, $dBL_{eq,15min}$

Receiver	1A. Day			1B. Day			2. Evening			3. Night		
	PNTL	Predicted Noise level	Complies	PNTL	Predicted Noise level	Complies	PNTL	Predicted Noise level	Complies	PNTL	Predicted Noise level	Complies
R1 - 771-781 Mamre Road Kemps Creek	42	47	No	42	46	No	41	42	No	38	42	No
R2 - 783-797 Mamre Road Kemps Creek	42	45	No	42	45	No	41	42	No	38	42	No
R3 - 799-803 Mamre Road Kemps Creek	42	46	No	42	46	No	41	42	No	38	42	No
R4 - 15 Medinah Avenue Luddenham	44	37	Yes	44	37	Yes	43	34	Yes	38	34	Yes
R5 - 9 Medinah Avenue Luddenham	44	36	Yes	44	36	Yes	43	34	Yes	38	34	Yes
R6 - 676-702 Mamre Road Kemps Creek	42	36	Yes	42	36	Yes	41	33	Yes	38	33	Yes
R7 - 676-702 Mamre Road Kemps Creek	42	39	Yes	42	37	Yes	41	34	Yes	38	34	Yes

Results show operational noise levels during the day, evening and the night periods are predicted to exceed PNTLs by up to 5 dB. Due to the number of operational noise sources on site, the exceedances are attributed to a range of plant, including contributions from site transformers, data hall exhausts and AHU plantroom inlets.

During the daytime, when maintenance testing of generators would take place, the load bank and generators operating are noted to contribute individually, however due to the high number of other mechanical and electrical plant, the cumulative contributions from other plant largely controls overall noise emissions.

Table 24 presents highest predicted noise levels at non-residential receiver. Noise levels represent impacts during the loudest period of operation, during the day during bi-monthly testing of generators. Compliance during this period is considered to demonstrate compliance during other quieter periods of operation.

Table 24: Unmitigated standard operations – non-residential receivers, $dBL_{eq,15min}$

Receiver	PNTL	Predicted Noise level – 1A. Day	Complies
E1 - Mamre Christian College	43	30	Yes
I1 - Master site boundary East	68	57	Yes
I2 - Master site boundary North East	68	43	Yes
I3 - Master site boundary North West	68	39	Yes
I4 - Master site boundary West	68	42	Yes
I5 - DATS	68	37	Yes

Results show noise levels at non-residential receivers comply with PNTLs.

Table 25 shows predicted noise levels during an critical power failure scenario. No criteria have been established for this scenario, levels are presented for information only.

Table 25: Unmitigated critical power failure scenario – all receivers

Receiver	Predicted Noise level $dBL_{eq,15min}$
Residential receivers	
R1 - 771-781 Mamre Road Kemps Creek	50
R2 - 783-797 Mamre Road Kemps Creek	49
R3 - 799-803 Mamre Road Kemps Creek	50
R4 - 15 Medinah Avenue Luddenham	43
R5 - 9 Medinah Avenue Luddenham	43
R6 - 676-702 Mamre Road Kemps Creek	38
R7 - 676-702 Mamre Road Kemps Creek	41
Non-residential receivers (when in use)	
E1 - Mamre Christian College	32
I1 - Master site boundary East	61
I2 - Master site boundary North East	46
I3 - Master site boundary North West	44
I4 - Master site boundary West	52
I5 - DATS	39

6.3.4.2 Mitigated results

An investigation into the highest contributors to noise levels at receivers, feasibility and reasonableness of mitigation to noise sources was conducted. Noise mitigation measures have been coordinated with the electrical, mechanical and architectural design teams and are outlined in Section 7.

Table 26 and Table 27 present highest predicted noise levels at non-residential receivers. Noise levels represent impacts during the loudest period of operation, during the day during bi-monthly testing of generators. Compliance during this period is considered to demonstrate compliance during other quieter periods of operation.

A graphical output of results are presented in

Table 27 presents predicted operational noise levels following the implementation of mitigation measures outlined in Section 7.

Table 26: Mitigated standard operations – residential receivers, $dBL_{eq,15min}$

Receiver	1A. Day			1B. Day			2. Evening			3. Night		
	PNTL	Predicted Noise level	Complies	PNTL	Predicted Noise level	Complies	PNTL	Predicted Noise level	Complies	PNTL	Predicted Noise level	Complies
R1 - 771-781 Mamre Road Kemps Creek	42	42	Yes	42	40	Yes	42	37	Yes	38	37	Yes
R2 - 783-797 Mamre Road Kemps Creek	42	42	Yes	42	40	Yes	42	37	Yes	38	37	Yes
R3 - 799-803 Mamre Road Kemps Creek	42	40	Yes	42	40	Yes	42	37	Yes	38	37	Yes
R4 - 15 Medinah Avenue Luddenham	44	30	Yes	44	31	Yes	43	29	Yes	38	29	Yes
R5 - 9 Medinah Avenue Luddenham	44	30	Yes	44	31	Yes	43	29	Yes	38	29	Yes
R6 - 676-702 Mamre Road Kemps Creek	42	33	Yes	42	30	Yes	42	30	Yes	38	30	Yes
R7 - 676-702 Mamre Road Kemps Creek	42	36	Yes	42	32	Yes	42	32	Yes	38	32	Yes

Results show all predicted noise levels comply with established PNTLs.

An assessment of modifying factor corrections have been conducted in accordance with Fact Sheet C of the NPfI [2]. No tonal or low-frequency penalties are incurred when cumulative site noise emissions and measured ambient noise spectra are assessed, however compliance was determined to be marginal. Should sound power spectra of final plant selections vary significantly from those presented in Table 21, low frequency noise or tonal noise penalties may apply, discussed further in Section 7.

Table 27 presents highest predicted noise levels at non-residential receivers. Noise levels represent impacts during the loudest period of operation, during the day during bi-monthly testing of generators. Compliance during this period is considered to demonstrate compliance during other quieter periods of operation.

Table 27: Mitigated standard operations – non-residential receivers, $dBL_{eq,15min}$

Receiver	PNTL	Predicted Noise level – 1A. Day	Complies
E1 - Mamre Christian College	43	22	Yes
I1 - Master site boundary East	68	54	Yes
I2 - Master site boundary North East	68	35	Yes
I3 - Master site boundary North West	68	32	Yes
I4 - Master site boundary West	68	34	Yes
I5 - DATS	68	27	Yes

Results show predicted mitigated noise levels comply with PNTLs for non-residential receivers.

Table 28 presents the predicted noise levels during an critical power failure scenario when all generators will be operating concurrently.

Table 28: Mitigated critical power failure scenario– all receivers, $dBL_{eq,15min}$

Receiver	Predicted Noise level
Residential receivers	
R1 - 771-781 Mamre Road Kemps Creek	47
R2 - 783-797 Mamre Road Kemps Creek	47
R3 - 799-803 Mamre Road Kemps Creek	46
R4 - 15 Medinah Avenue Luddenham	40
R5 - 9 Medinah Avenue Luddenham	39
R6 - 676-702 Mamre Road Kemps Creek	32
R7 - 676-702 Mamre Road Kemps Creek	36
Non-residential receivers (when in use)	
E1 - Mamre Christian College	24
I1 - Master site boundary East	59
I2 - Master site boundary North East	40
I3 - Master site boundary North West	40
I4 - Master site boundary West	50
I5 - DATS	31

6.3.5 On site noise impact from noise generated by the development

NSW noise policies do not specifically address noise impacts generated by a development onto the development itself (i.e. Office/FOH). In this instance, selection of appropriate internal noise targets is at the discretion of the applicant. Guidance may be sought from AS/NZS 2107:2016 “Acoustics, Recommended design sound levels and reverberation times for building interiors” for steady-state internal noise targets.

Acoustic input into the design of façade elements would be required to meet typical office noise criteria.

Final mechanical and electrical services equipment have not been selected at this early stage of design such that acoustic specification of façade elements can be determined. During ongoing design of the development, mechanical and electrical services equipment will be selected enabling acoustic specification of architectural elements such as the façade to meet the adopted internal noise targets.

6.4 Service vehicles

A maximum of 10 service vehicles are expected to access the site per day. This is the volume expected during periods of heavy maintenance.

A linear profile has been assumed for the arrival distribution of service vehicles to the site, i.e. the 10 service vehicles will arrive linearly between 8am and 5pm. All servicing vehicles are assumed to exit the site within the hour they arrive. All service vehicles have been conservatively assessed as 19 m B-doubles.

The RNP states:

> *In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.*

Noise increases due to the additional service vehicles over forecast volumes along Mamre Road have been predicted in Table 29. A 15 hour assessment has been conducted as Mamre Road is defined as a sub-arterial road in accordance with the *Road Noise Policy* [9] as it “provides connection between arterial roads and local roads” and “may support arterial roads during peak periods”.

Table 29: Traffic assessment – service vehicles on Mamre Road

	Light vehicles	**Heavy vehicles**	**Total**
Forecast 2025 Mamre Road volume (15 hour day)	17002	2318	19320
Service vehicles	0	10	10
Increase in traffic noise level due to service vehicles, dBA	**0.00**	**0.02**	**0.02**

Results show noise increases as a result of service vehicle traffic are less than the 2 dB increase criteria, therefore increases in traffic noise are not anticipated to be significant.

On site, the impact of a single vehicle arriving then leaving site is not anticipated to generate significant noise impacts at nearby receivers.

6.5 Cumulative noise impact

Cumulative noise impacts are addressed as part of the prescribed procedure outlined in the NPfI [2] Project Noise Trigger Levels (PNTLs). The PNTLs consist of the project intrusiveness noise level and the Project Amenity Noise Level (PANL). The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the PANL seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Applying the most stringent requirement as the PNTL ensures that both intrusive noise is limited and amenity is protected and that no single industry can unacceptably change the noise level of an area. PNTLs established for this project are summarised in Section 6.2.1, Table 19.

Recommended Amenity Noise Levels (RANLs) are specified in Table 2.2 of the NPfI [2].The RANLs represent the objective for total industrial noise at a receiver location, whereas the PANL represents the objective for noise from a single industrial development at a receiver location.

To ensure that any new industrial source of noise is within the RANLs for an area, the PANL applies for each new source of industrial noise as follows:

Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A).

Considering the above, satisfying the PNTLs ensures that noise amenity and cumulative noise impacts are appropriately limited. Section 6.3.4.2 demonstrates compliance with the PNTLs.

7 Environmental management measures

A summary of recommended operational and construction mitigation measures are presented in Table 30.

Table 30: Environmental management measures for acoustic impacts

ID	Impacts	Mitigation	Responsi-bility	Timing
Operation				
Operational noise	Exceedance of established noise emission criteria	Implement acoustic treatment measures in Table 32.	Detailed design team	Detailed design stage
Application of low frequency penalty or tonal noise penalty.	If final plant selections generate more significant low frequency noise or tonal noise, up to a 5dB penalty may be applied to predicted noise levels, pushing levels to above PNTLs.	Overall noise characteristics at receivers shall be considered throughout the detailed design process. Should penalties be required, attended noise measurements at night may provide further clarity on the existing ambient noise environment, which is considered when assessing the application of penalties.	Detailed design team	Detailed design stage
Critical power failure noise	High noise impacts during an emergency power failure scenario	Clarity on predicted emergency noise impacts has been provided, shown in Table 25 and Table 28 Further mitigation measures are considered inappropriate for the infrequency and short duration of these events.	-	Post construction
Construction				
Noise and vibration management plan	Adverse noise and vibration impacts	A Construction Noise and Vibration Management Plan shall be prepared prior to the issuing of a Construction Certificate. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities.	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Staffing	Adverse noise and vibration impacts	Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration; Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise; Ensuring good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable; Avoid the use of radios or stereos outdoors; and Avoid shouting and minimise talking loudly and slamming vehicle doors.	Contractor	Construction
Plant and equipment	Adverse noise impacts	Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers. Minimise use of noisy construction methods where quieter alternatives are feasible. Consider using electric / hydraulic equipment where possible. Using the smallest equipment as is practical. All plant and equipment used on site must be: • maintained in a proper and efficient condition; and • operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use. Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable. Maximise off-site prefabrication.	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Scheduling	Adverse noise impacts	Ensure that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays or public holidays) High noise activities will be programmed to occur during the standard construction hours wherever possible and will be scheduled with due consideration to the nearest sensitive receivers.	Contractor	Construction
Work site training	Adverse noise impacts	'Toolbox talks' will be held at regular intervals with the contractor workers, including discussion of noise and vibration mitigation, monitoring and assessment. These topics will also be covered under induction processes. Operate two-way radios at the minimum effective volume, and avoid shouting or whistling at the site. Identification of all reasonable and feasible noise mitigation methods will be conducted by the Responsible Person on a daily basis during noisy works. The Responsible Person will have the authority to modify work practices in response to complaints, where this is considered appropriate.	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Community liaison	Adverse noise and vibration impacts	Ensuring that the Responsible Person keeps the local community advised on expected activities and coordinates scheduling and locations of noisy works around any critical user events where practicable. This shall include face to face meetings with nearby receivers if requested and a letter box drop, and shall include close liaison with neighbours during construction, including the Meriton towers and residences to the north of Parramatta River. Maintaining appropriate records of complaints to include timing, reported issues, actions taken and measures to be included for on-going works. The complaints log will need to be filed with the Responsible Person.	Contractor	Construction
Reversing alarms	Adverse noise impacts	The use of audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers must be implemented. Where practicable, broadband, non-tonal reversing alarms should be utilised on site equipment. Ensure that the difference in volume between the reversing warning devices and the base machine noise level (at maximum governed speed under no load at any given test location) is minimised (in accordance with International Standard ISO9533:1989), and ensure that warning devices are no more than 5 dB above the Australian Standard level;	Contractor	Construction
Material handling	Adverse noise and vibration impacts	Avoid dropping equipment/materials from a height or into trucks. Where practicable, use sound dampening material to cover the surfaces on to which any materials must be dropped.	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Equipment Location	Adverse noise impacts	Site noisy equipment away from noise-sensitive areas. Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas; Locate site access roads and site compounds as far away as possible from noise sensitive receptors; Plan truck movements to avoid residential streets where possible;	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Vibration management	Adverse vibration impacts	The safe working distances presented in Table 31 should be maintained between activities and buildings and structures. Distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. The contractor will be required to manage vibration as well as noise and make use of best practice in the management of vibration using simple and practicable techniques such as avoiding dropping heavy items. Buried services are located on the Altis Frasers site adjacent to the proposed site location, and the contractor shall maintain compliance with buried services vibration criteria outlined in Table 5.1.3. Where vibration intensive works are required within the minimum working distances outlined in Table 31, vibration monitoring at the nearest potential affected building should be considered, where real-time alerts can be generated when measured vibration levels exceed criteria. Less vibration intensive methods of construction would then be required, such as the use of lower capacity equipment over a longer duration. Given the structures immediately adjacent to the site, adverse effects to both human comfort and structural damage are possible if management measures are not adhered to.	Contractor	Construction

Table 31 provides recommended minimum working distances for vibration intensive plant proposed as part of the construction works. These are based on international standards and guidance.

Table 31: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage[1] (BS 7385)	Human response (OH&E Vibration Guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 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
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure
Piling rig	Diesel impact piling	To be developed as part of the CNVMP[2]	

Note:

1. More stringent conditions may apply to heritage or other sensitive structures. Vibration impacts on buried services require consideration when final construction works are determined.
2. Once piling details such as impact frequency and energy is known.

7.1 Recommended plant acoustic treatment

Preliminary noise mitigation measures have been recommended and incorporated into the current design of the site. Further detailed acoustic design will be required to finalise mitigation specifications during the detailed design phase of the development. The following measures therefore must not be used for construction without certification by an acoustic consultant.

Table 32: Indicative noise mitigation measures

Item	Location	Description
All plant	Throughout site	• To meet indicative sound power levels provided in Table 21.
Loadbank	Enclosure	• Enclosure to achieve 75 dBA at 1 m
Diesel generators (backup power only)	Inlet	• Rectangular attenuator to achieve 75 dBA at 1m
	Discharge	• Rectangular attenuator to achieve 75 dBA at 1m
	Exhaust	• Primary attenuator • Exhaust to achieve 81 dBA at 1 m

Item	Location	Description
Site transformers	Substation yard	To achieve an indicative 9 dB reduction to site transformer contributions to residences to the south, one or more of the following mitigation measures is recommended: • Quieter transformer selection • Noise barrier extending 2 m above top of transformers at a distance of 2 m to the south of the transformer, turning back to the north as indicated in Figure 4. • Grit filling of stiffeners
Building envelope	Exhaust riser walls	• Precast concrete
	Roof	• Kingzip roof system, made of metal deck roofing, insulation layer and two layers of acoustic plasterboard to achieve R_w 40
	Datahall exhaust louvres	• Acoustic louvres for data hall exhaust outlets. An indicative insertion loss of 5 dB is required, provided the pressure drop does not impact the mechanical ventilation requirements. Indicative specifications for the acoustic louvre are: o Minimum overall noise reduction of 5 dB o Maximum pressure drop of 40 Pa o Face velocity of 3 m/s Manufacturers which have indicated a bespoke louvre design can meet these requirements include IAC Acoustics, Kinetics Noise Control and Noise Control Engineering • Junctions between louvres/attenuators or duct work penetrations of the building envelope will need to be fully sealed such that the overall building attenuation is not compromised.
Inlet and exhaust path treatment	AHU plantroom	Internally line with minimum 50mm acoustic absorptive material: • underside of roof / soffit and topside of ceiling in both the Level 1 and Level 2 ceiling plenums • underside of ceiling in AHU plantrooms • internal face of exhaust risers These locations are shown in Figure 5 and Figure 6.
	Level 2 exhaust louvres	A baffle is required to prevent discharge air from Level 2 mixing with AHU plantroom inlet louvres on Level 1. This baffle is required to extend to the top of the discharge louvres to control noise emissions, as indicated in Figure 7.

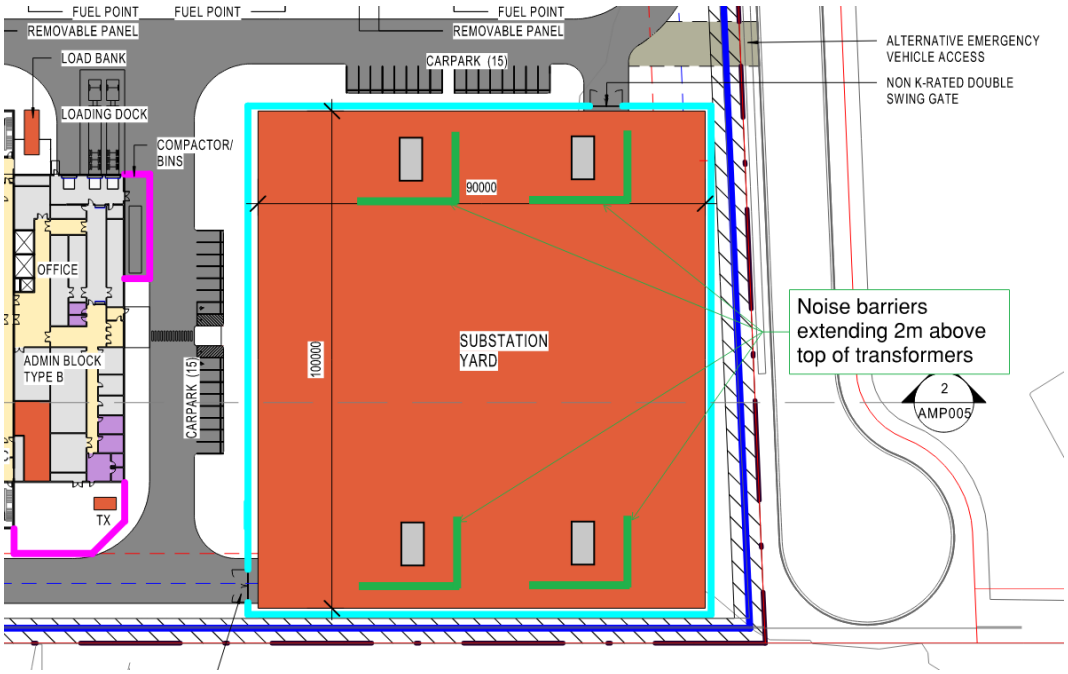


Figure 4: Indicative site transformer noise barrier locations

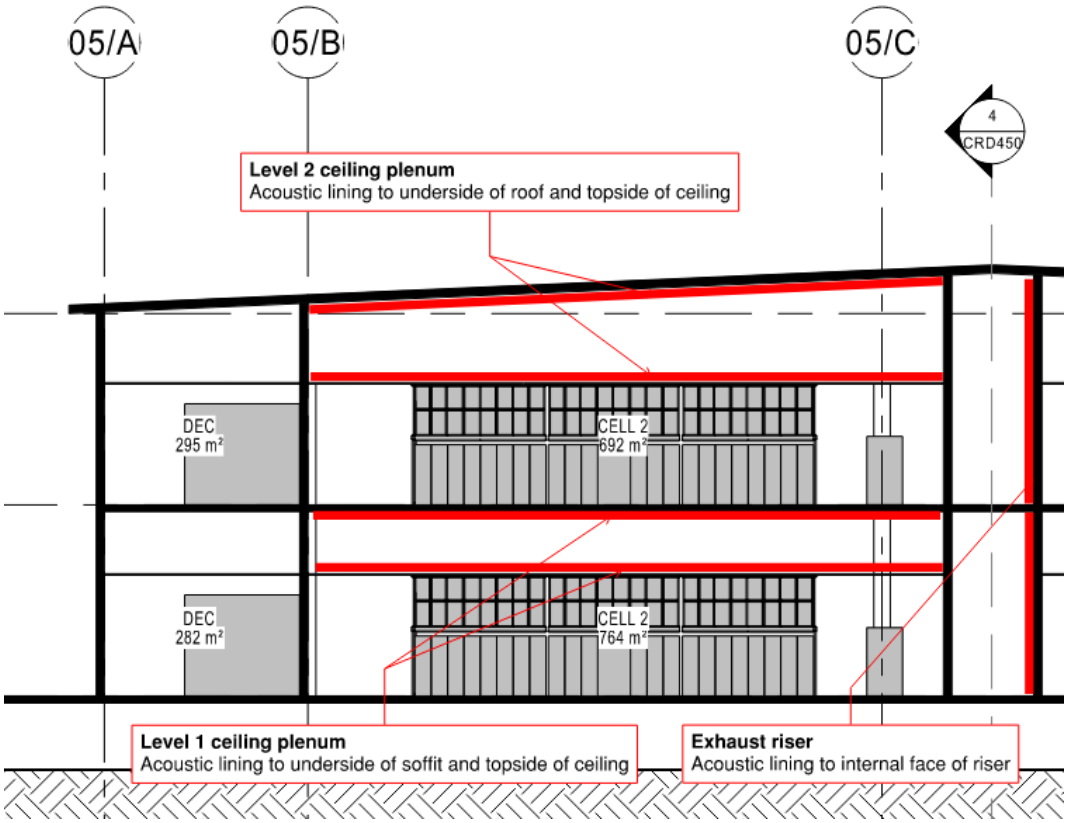


Figure 5: Indicative internal acoustic lining requirements – east-west section

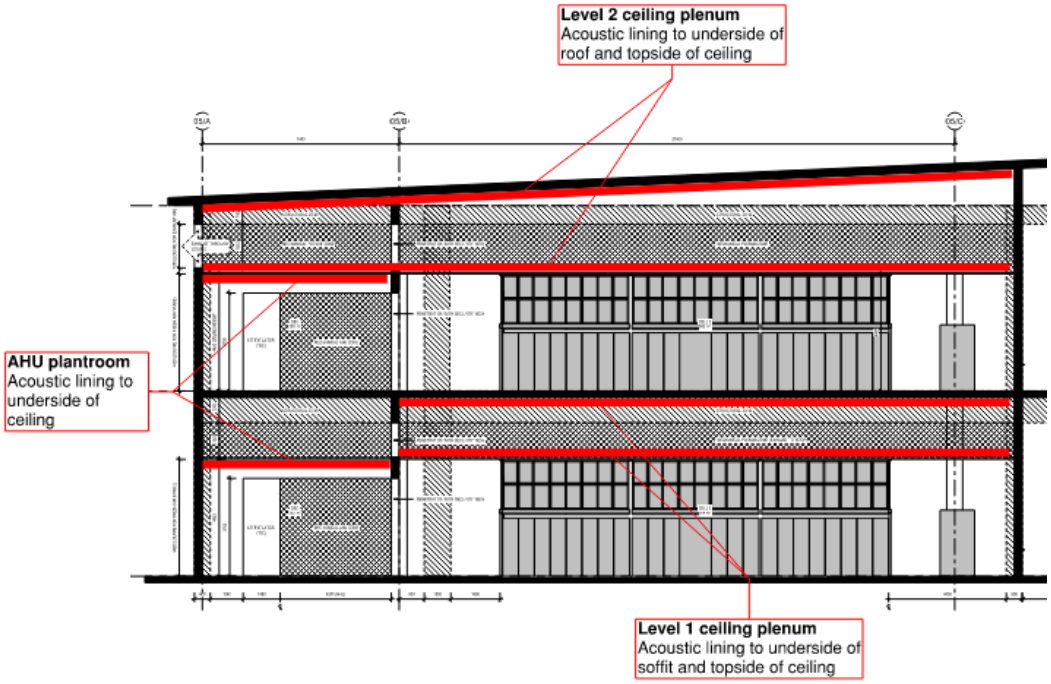


Figure 6: Indicative internal acoustic lining requirements – north-south section

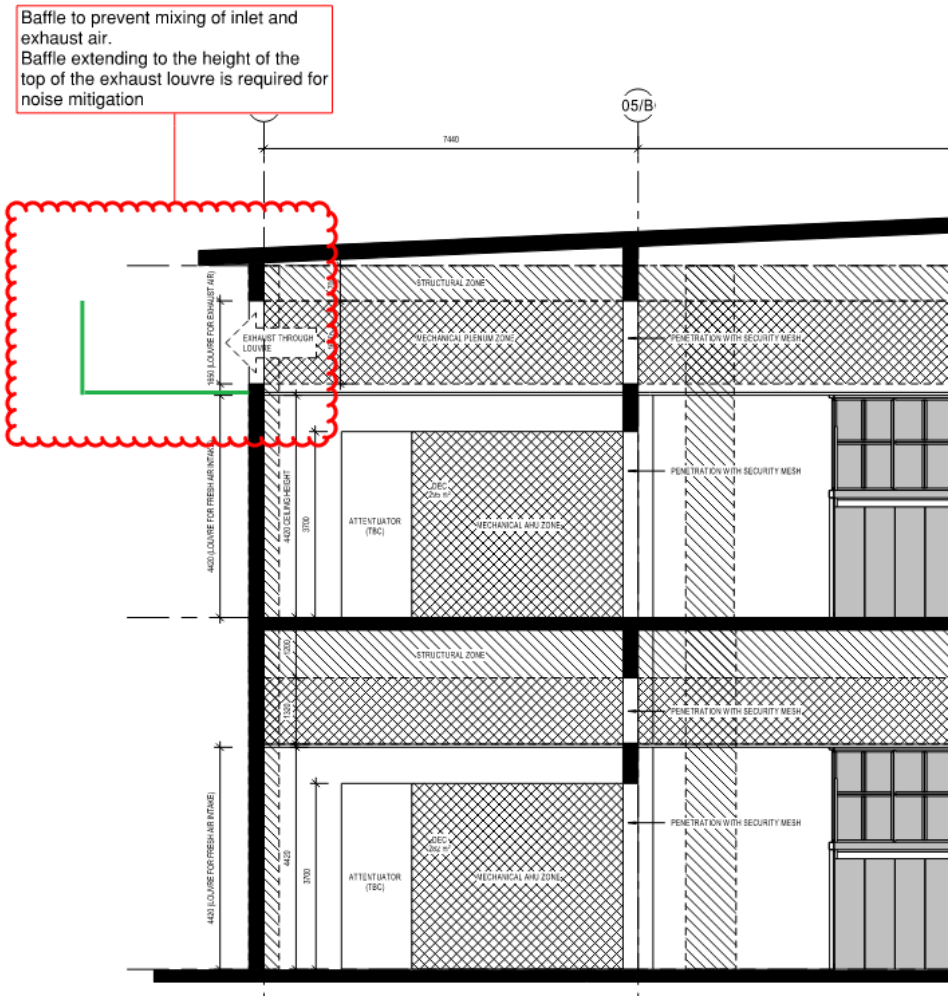


Figure 7: Acoustic requirements for baffle to separate discharge and inlet air

8 Summary of residual impacts

This section provides a summary of the construction and operational risks both pre-mitigation and any residual impacts remaining after the implementation of the management measures describe in Section 7. Pre-mitigation and residual impacts are summarised in Table 33.

Table 33: Summary of pre-mitigation and residual impacts

Potential pre-mitigation adverse impact	Relevant management measures	Potential residual impact after implementation of management measures
Construction		
Adverse noise impacts affecting community	Preparation and implementation of a CNVMP.	Some residual noise impacts are likely to exceed noise management levels however receivers are not predicted to be 'highly affected', i.e. experience noise levels of 75 dBA or above. Disturbances to the community will be minimised by the implementation of recommended management measures.
Vibration impacts on human comfort or structural damage	Preparation and implementation of a CNVMP.	Low likelihood of residual vibration impacts if vibration management measures are implemented.
Operation		
Operational noise adversely impacting community	Implement recommended mitigation measures	Low likelihood of residual noise impacts on community.
Road traffic noise affecting community	None	Low likelihood of residual noise impacts on community.

9 Conclusion

An acoustic assessment has been carried out for the proposed data centre in accordance with the requirements of the NSW Department of Planning, Industry and Environment (DPIE), which has included consideration of the operational and construction phases of the development.

The operational noise assessment established project noise goals and carried out noise predictions in accordance with the NSW *Noise Policy for Industry* [2]. Indicative noise mitigation measures are provided in Section 7. Detailed acoustic design will be required during the design development phase to confirm the detailed specification of equipment and mitigation measures.

Regarding construction, while specific activities and work schedules are not yet known, criteria has been established in accordance with the NSW ICNG [3] and *Assessing Vibration: a technical guideline* [4]. Recommendations with regard to mitigation and management measures are also outlined and are expected to be developed further in a formal Construction Noise and Vibration Management Plan, to be prepared prior to commencement of works.

References

[1] Penrith City Council, “Draft Mamre Road Precinct Development Control Plan,” Penrith City Council, Penrith, 2020.

[2] NSW Environment Protection Authority, “NSW Noise Policy for Industry,” NSW Environment Protection Authority , Sydney, 2017.

[3] Department of Environment and Climate Change NSW, “Interim Construction Noise Guideline,” Department of Environment and Climate Change NSW, Sydney, 2009.

[4] Department of Environment and Conservation (NSW), “Assessing Vibration: A technical guideline,” Department of Environment and Conservation (NSW), Sydney, 2006.

[5] NSW Environment Protection Authority, “Environmental Criteria for Road Traffic Noise,” NSW Environment Protection Authority, Sydney, 1999.

[6] NSW Environment Protection Authority, “Noise Guideline for Local Government,” NSW Environment Protection Authority, Sydney, 2013.

[7] Bristish Standard Institution, “BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Pt 2: Guide to damage levels from groundborne vibration,” Bristish Standard Institution, London, 1993.

[8] Transport for NSW, “Construction Noise and Vibration Strategy V4,” Transport for NSW, 2018.

[9] Department of Environment, Climate Change and Water NSW, “NSW Road Noise Policy,” NSW Environmental Protection Authority, Sydney, 2011.

[10] Deutsches Institut fur Normung, “DIN 4150-3 (1999) Structural vibration - Effects of vibration on structures,” Deutsches Institut fur Normung, Berlin, 1999.

[11] Acousticworks, “State Significant Development Application for a proposed Warehouse, Logistics and Facilities Hub Development 657 – 769 Mamre Road Kemps Creek,” Acousticworks, Sydney, 2020.

[12] Standards Australia, “AS 2436-2010 - Guide to noise and vibration control on construction, demolition and maintenance sites,” Standards Australia, 2010.

[13] British Standards, “BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites. Noise,” British Standards, 2009.

[14] Standards Australia, “AS 1055 Acoustics—Description and measurement of environmental noise,” Standards Australia, Sydney, 2018.

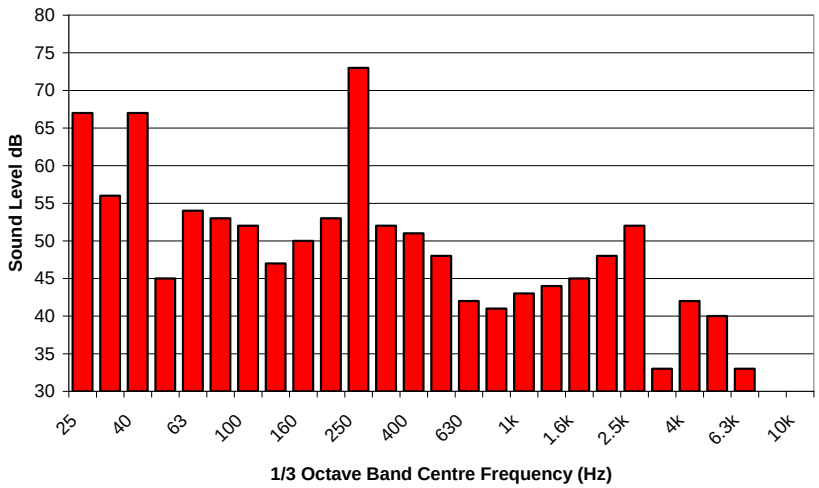
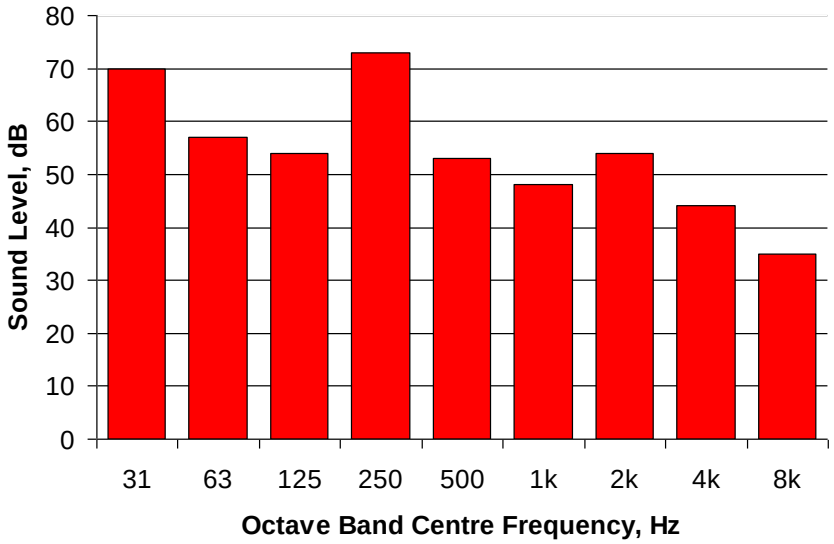
Appendix A

Acoustic terminology

A1 Acoustic terminology

Term	Definition
Ambient Noise Level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a city building is being investigated, the ambient noise level is the noise level from all other sources without the fan running. This would include sources such as traffic, birds, people talking and other nearby fans on other buildings.
Background Noise Level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. **Assessment Background Level (ABL)** A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background LA90 noise levels – i.e. the measured background noise is above the ABL 90% of the time. **Rating Background Level (RBL / min $L_{A90,1hour}$)** A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey. This parameter is denoted RBL in NSW, and min $L_{A90,1hour}$ in QLD.
Decibel	The decibel scale is a logarithmic scale which is used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressure levels, which would be unwieldy if presented on a linear scale. Therefore, a logarithmic scale, the decibel (dB) scale, is used to describe sound levels. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.
dBA	dBA denotes a single-number sound pressure level that includes a frequency weighting (“A-weighting”) to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dBA.

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td></td><td>Some typical dBA levels are shown below.
<table>
<tr><th>Sound Pressure Level dBA</th><th>Example</th></tr>
<tr><td>130</td><td>Human threshold of pain</td></tr>
<tr><td>120</td><td>Jet aircraft take-off at 100 m</td></tr>
<tr><td>110</td><td>Chain saw at 1 m</td></tr>
<tr><td>100</td><td>Inside nightclub</td></tr>
<tr><td>90</td><td>Heavy trucks at 5 m</td></tr>
<tr><td>80</td><td>Kerbside of busy street</td></tr>
<tr><td>70</td><td>Loud stereo in living room</td></tr>
<tr><td>60</td><td>Office or restaurant with people present</td></tr>
<tr><td>50</td><td>Domestic fan heater at 1m</td></tr>
<tr><td>40</td><td>Living room (without TV, stereo, etc.)</td></tr>
<tr><td>30</td><td>Background noise in a theatre</td></tr>
<tr><td>20</td><td>Remote rural area on still night</td></tr>
<tr><td>10</td><td>Acoustic laboratory test chamber</td></tr>
<tr><td>0</td><td>Threshold of hearing</td></tr>
</table></td></tr>
<tr><td>L_1</td><td>The L_1 statistical level is often used to represent the maximum level of a sound level that varies with time.
Mathematically, the L_1 level is the sound level exceeded for 1% of the measurement duration. As an example, 87 dB $L_{A1,15min}$ is a sound level of 87 dBA or higher for 1% of the 15 minute measurement period.</td></tr>
<tr><td>L_{10}</td><td>The L_{10} statistical level is often used as the “average maximum” level of a sound level that varies with time.
Mathematically, the L_{10} level is the sound level exceeded for 10% of the measurement duration. L_{10} is often used for road traffic noise assessment. As an example, 63 dB $L_{A10,18hr}$ is a sound level of 63 dBA or higher for 10% of the 18 hour measurement period.</td></tr>
<tr><td>L_{90}</td><td>The L_{90} statistical level is often used as the “average minimum” or “background” level of a sound level that varies with time.
Mathematically, L_{90} is the sound level exceeded for 90% of the measurement duration. As an example, 45 dB $L_{A90,15min}$ is a sound level of 45 dBA or higher for 90% of the 15 minute measurement period.</td></tr>
<tr><td>L_{eq}</td><td>The ‘equivalent continuous sound level’, Leq, is used to describe the level of a time-varying sound or vibration measurement.
Leq is often used as the “average” level for a measurement where the level is fluctuating over time. Mathematically, it is the energy-average level over a period of time (i.e. the constant sound level that contains the same sound energy as the measured level). When the dBA weighting is applied, the level is denoted dB LAeq. Often the measurement duration is quoted, thus LAeq,15 min represents the dBA weighted energy-average level of a 15 minute measurement.</td></tr>
</table>

Term	Definition
L_{max}	The Lmax statistical level can be used to describe the "absolute maximum" level of a sound or vibration level that varies with time. Mathematically, Lmax is the highest value recorded during the measurement period. As an example, 94 dB LAmax is a highest value of 94 dBA during the measurement period. Since Lmax is often caused by an instantaneous event, Lmax levels often vary significantly between measurements.
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as "pitch". Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or "low-pitched" and sounds with a higher frequency are perceived as "treble" or "high pitched".  
Peak Particle Velocity (PPV)	Peak Particle Velocity (PPV) is the highest velocity of a particle (such as part of a building structure) as it vibrates. Most sound level meters measure root mean squared (RMS) values; it is common to approximate the PPV based on an RMS measurement. PPV is commonly used as a vibration criterion, and is often interpreted as a PPV based on the Lmax or Lmax,spec index.

Term	Definition
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Vibration	Waves in a solid material are called “vibration”, as opposed to similar waves in air, which are called “sound” or “noise”. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (eg a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

Appendix B

Noise monitoring

B1 Noise monitoring

B1.1 Equipment

Unattended and attended monitoring was carried out using the following equipment:

Table 34: Monitoring equipment details

Measurement location	Equipment/model	Serial No.	SLM Type
Meas. L1	Ngara	878005	Class 1
Meas. L2	Ngara	8780A3	Class 1
Short term measurements	B&K 2250	2449851	Class 1

Notes: All meters comply with AS IEC 61672.1 2004 “Electroacoustics - Sound Level Meters” and are designated either Class 1 or Class 2 as per Table 34, and are suitable for field use.

The equipment was calibrated prior and subsequent to the measurement period using a Bruel & Kjaer Class 4231 calibrator. No significant drift in calibration was observed.

B1.2 Meteorological conditions

In accordance with the NPfI, any noise monitoring conducted during periods of extraneous weather conditions was excluded from the data set. The NPfI advises that data may be affected where adverse weather, such as wind speeds higher than 5 m/s or rain, occurs. During the measurement period for this assessment, periods of adverse weather occurred during three daytime periods. This was confirmed by using weather data from the Bureau of Meteorology’s (BOM) Badgery’s Creek weather station.

B1.3 Long-term unattended noise measurements

Long-term noise monitoring was carried out by Arup over two rounds from 15 to 23 May 2019 and 25 November 2020 to 7 December 2020. Monitoring was conducted in accordance with Appendix B1 of the NPfI [2]. The NPfI separates the 24-hour day into three different time periods – day, evening and night, as detailed below in Table 35.

Table 35: Standard NPfI time periods

Period	Day of Week	Time period
Day	Monday-Saturday Sunday, Public Holidays	7:00 am-6:00 pm 8:00 am-6:00 pm
Evening	Monday-Sunday	6:00 pm -10:00 pm
Night	Monday-Saturday Sunday, Public Holidays	10:00 pm -7:00 am 10:00 pm -8:00 am

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Bakers Lane (West), Kemps Creek (Free Field)

Additional detail:

Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

Date	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
	Day[1]	Evening[2]	Night[3]	Day[1]	Evening[2]	Night[3]
Wednesday-15-May-2019		43	38		47	47
Thursday-16-May-2019	41	44	38	49	48	46
Friday-17-May-2019	40	43	36	48	47	43
Saturday-18-May-2019	34	40	36	47	44	42
Sunday-19-May-2019	32	43	38	43	46	47
Monday-20-May-2019	39	43	40	48	47	47
Tuesday-21-May-2019	40	40	39	48	45	47
Wednesday-22-May-2019	38	40	34	47	45	43
Thursday-23-May-2019						
Representative Weekday[5]	**40**	**43**	**38**	**48**	**46**	**46**
Representative Weekend[5]	**33**	**41**	**37**	**45**	**45**	**45**
Representative Week[5]	**39**	**43**	**38**	**47**	**46**	**46**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}

Road / Rail noise monitoring results

Date	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
	Day[1]	Night[2]	Day	Night
Wednesday-15-May-2019	47	47	48	52
Thursday-16-May-2019	48	46	50	52
Friday-17-May-2019	48	43	50	46
Saturday-18-May-2019	46	42	49	44
Sunday-19-May-2019	44	47	46	52
Monday-20-May-2019	48	47	49	51
Tuesday-21-May-2019	48	47	52	50
Wednesday-22-May-2019	47	43	47	46

Thursday-23-May-2019	47		49	
Representative Weekday[3]	**47**	**46**	**50**	**50**
Representative Weekend[3]	**45**	**45**	**48**	**49**
Representative Week[3]	**47**	**46**	**49**	**50**

Notes:

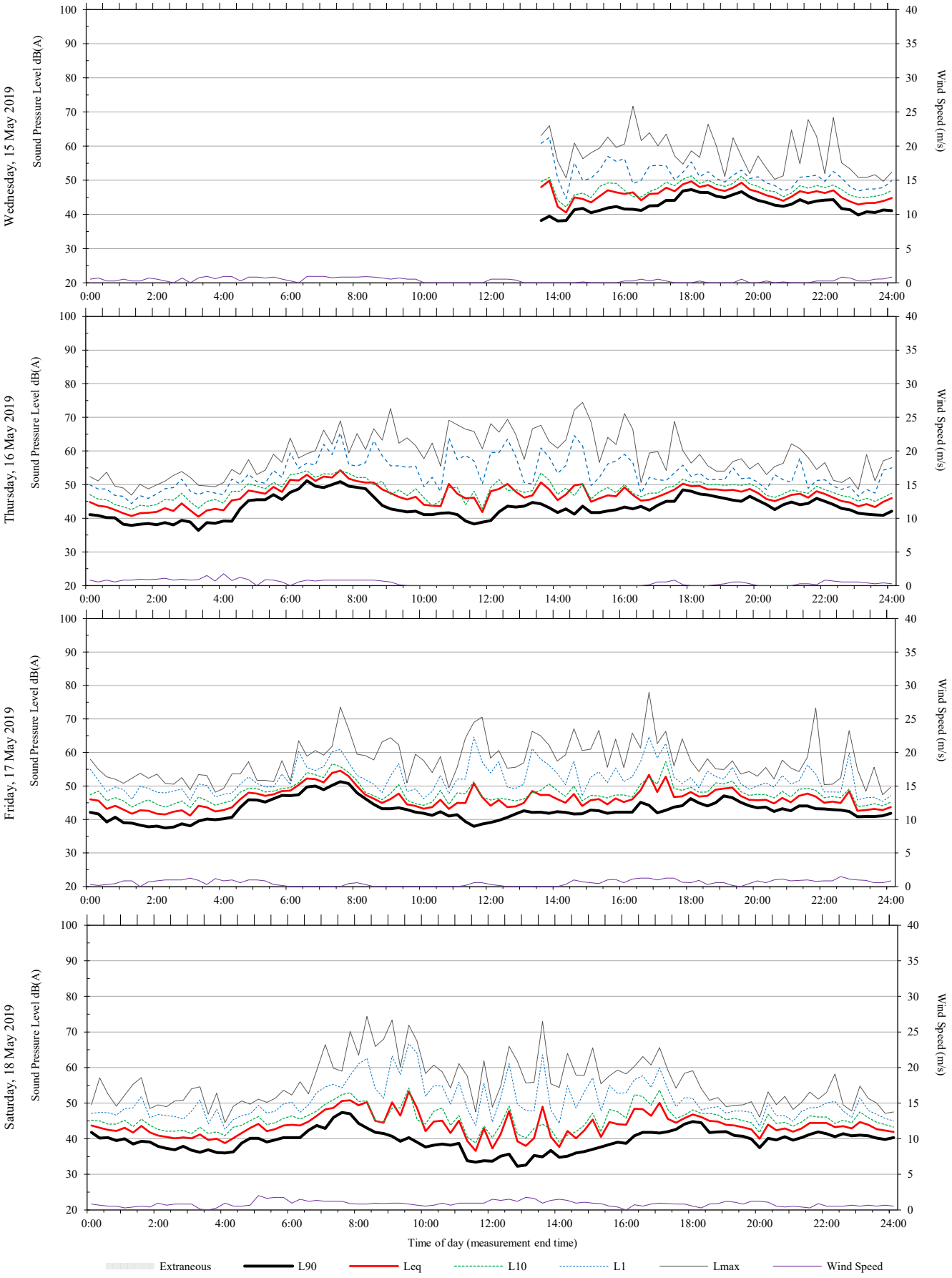
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

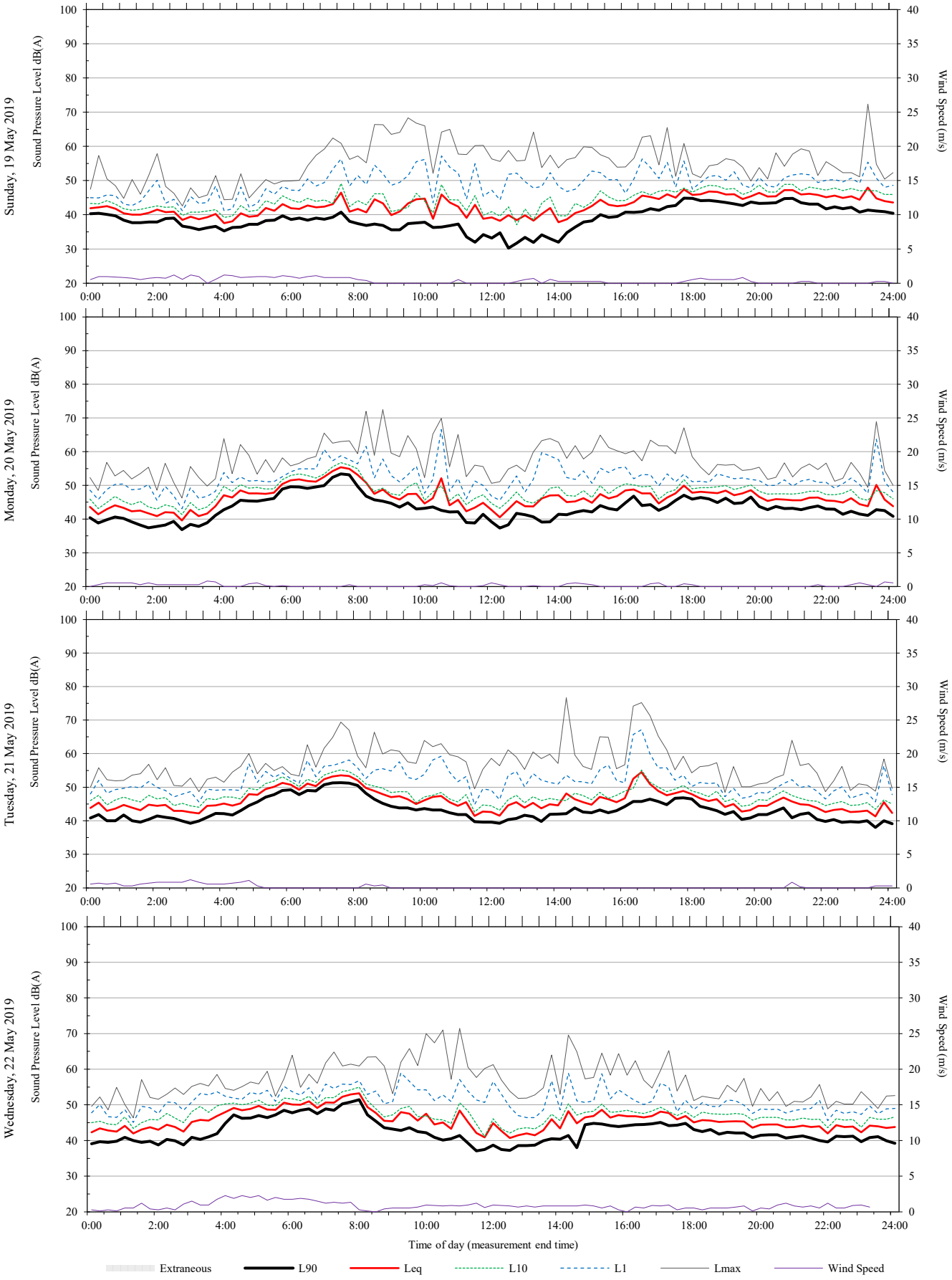
Unattended monitoring: Bakers Lane (West), Kemps Creek (Free Field)

ARUP



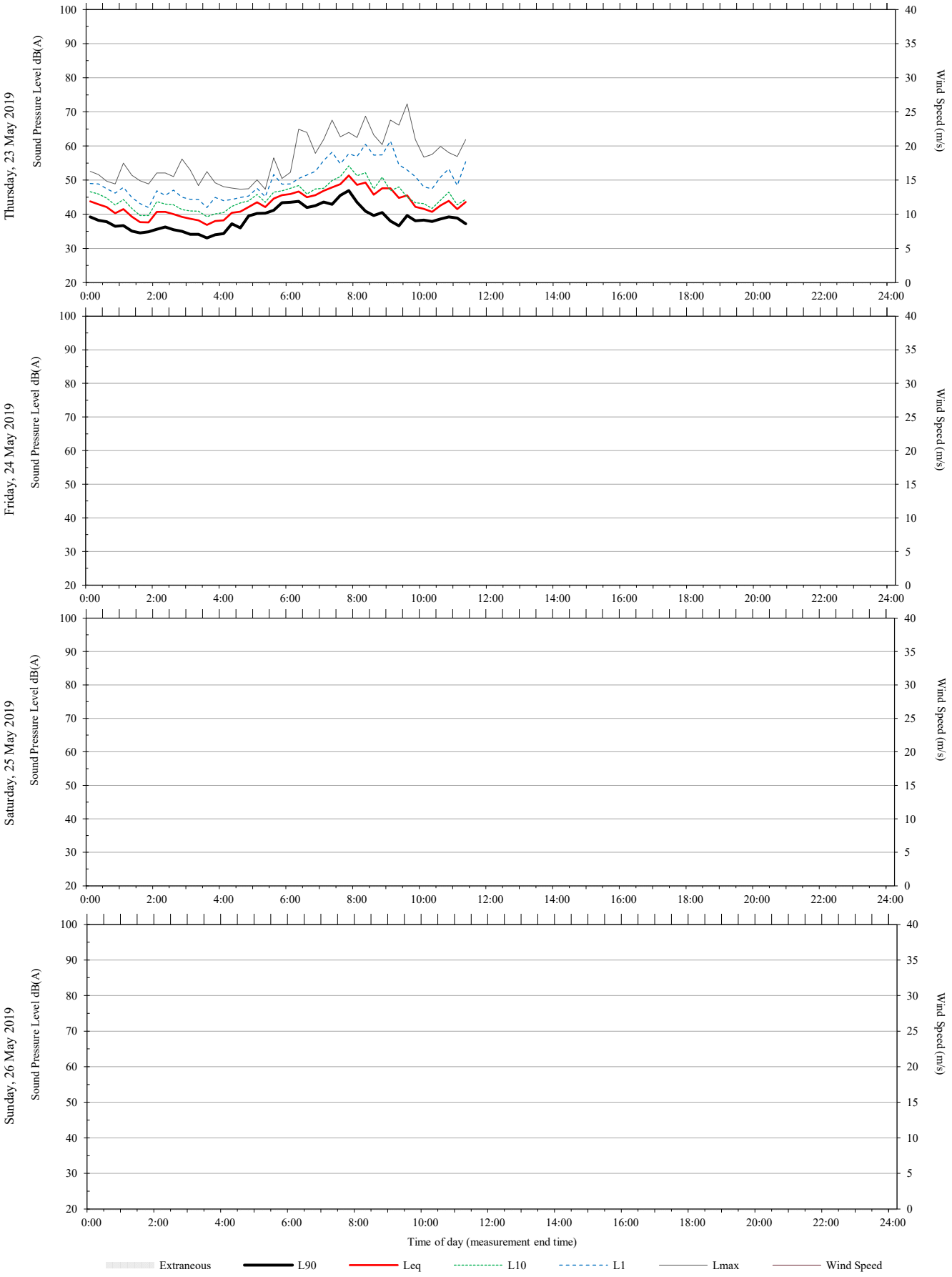
Unattended monitoring: Bakers Lane (West), Kemps Creek (Free Field)

ARUP



Unattended monitoring: Bakers Lane (West), Kemps Creek (Free Field)

ARUP



ARUP

1 Medinah Avenue, Luddenham (Free Field)

Additional detail:

Background and ambient noise monitoring results - NSW 'Industrial Noise Policy', 2000

	L_{A90} Background noise levels[4]			L_{Aeq} Ambient noise levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Wednesday-25-November-2020			35			42
Thursday-26-November-2020	35		31	47		43
Friday-27-November-2020	37		37	47		49
Saturday-28-November-2020	37			46		
Sunday-29-November-2020						
Monday-30-November-2020	37		34	46		44
Tuesday-01-December-2020						
Wednesday-02-December-2020	38			48		
Thursday-03-December-2020	39			48		
Friday-04-December-2020	35			54		
Saturday-05-December-2020	37		32	47		45
Sunday-06-December-2020	36	36	29	47	45	42
Monday-07-December-2020						
Representative Weekday[5]	**37**	**N/A[6]**	**34**	**49**	**N/A[6]**	**45**
Representative Weekend[5]	**37**	**36**	**30**	**47**	**45**	**43**
Representative Week[5]	**37**	**36 [6]**	**33**	**49**	**45**	**45**

Notes:

1. Day is 8:00am to 6:00pm on Sunday and 7:00am to 6:00pm at other times
2. Evening is 6:00pm to 10:00pm
3. Night is the remaining periods
4. Assessment Background Level (ABL) for individual days
5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq}
6. Although all but one evening level has been excluded due to extraneous weather or noise events, this level is in line with anticipated evening RBL, i.e. in line with the daily profile anticipated for a suburban environment, lower than the day and higher than the night, therefore is considered appropriate as the evening RBL. Of note, the evening period is not the critical period of assessment, hence does not change the outcome of the assessment.

Road / Rail noise monitoring results

	L_{Aeq} Noise levels		$L_{Aeq\ 1hr}$ Noise levels (upper 10th percentile)	
Date	**Day[1]**	**Night[2]**	**Day**	**Night**
Wednesday-25-November-2020	53	42	61	47

Thursday-26-November-2020	48	43	50	48
Friday-27-November-2020	47	49	49	57
Saturday-28-November-2020	46	46	47	51
Sunday-29-November-2020	49	46	53	49
Monday-30-November-2020	46	44	51	46
Tuesday-01-December-2020	48	44	54	46
Wednesday-02-December-2020	48		51	
Thursday-03-December-2020	48		52	
Friday-04-December-2020	53	44	0	46
Saturday-05-December-2020	47	45	50	50
Sunday-06-December-2020	47	42	48	47
Monday-07-December-2020	47		50	
Representative Weekday[3]	**50**	**45**	**54**	**51**
Representative Weekend[3]	**47**	**45**	**50**	**49**
Representative Week[3]	**49**	**45**	**53**	**50**

Notes:

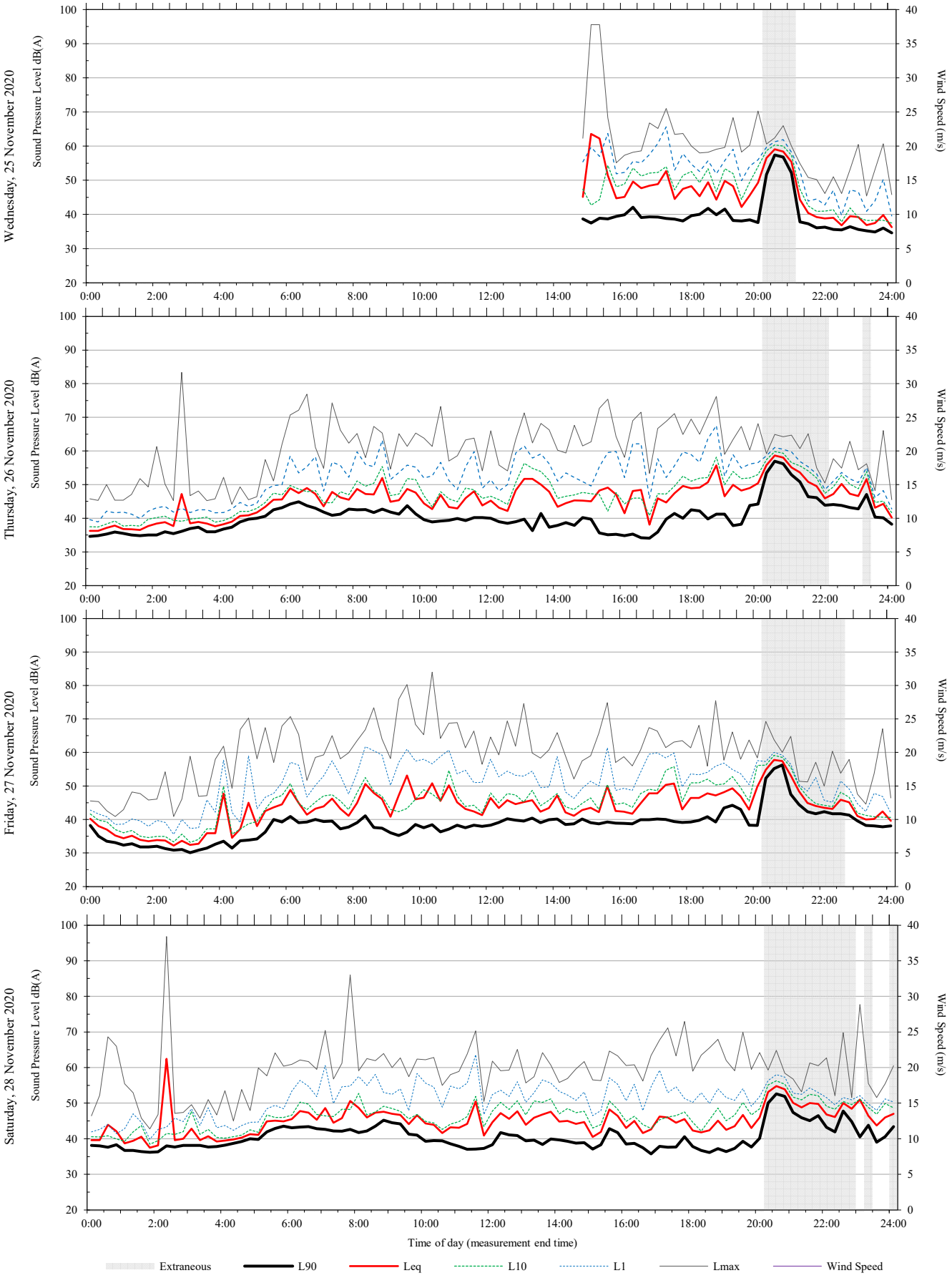
1. Day is 7:00am to 10:00pm

2. Night is 10:00pm to 7:00am

3. Logarithmic average of daily L_{Aeq}

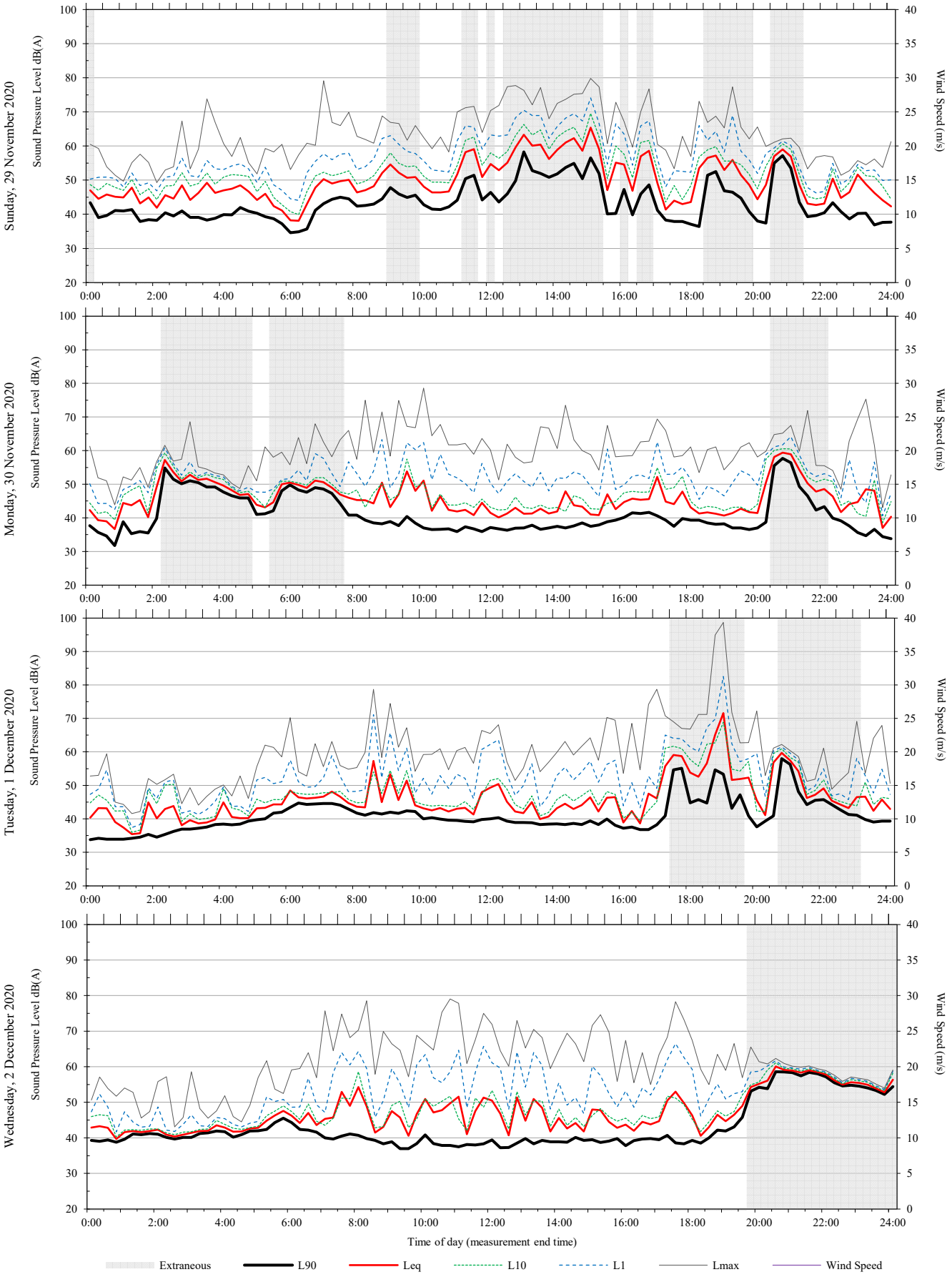
Unattended monitoring: 1 Medinah Avenue, Luddenham (Free Field)

ARUP



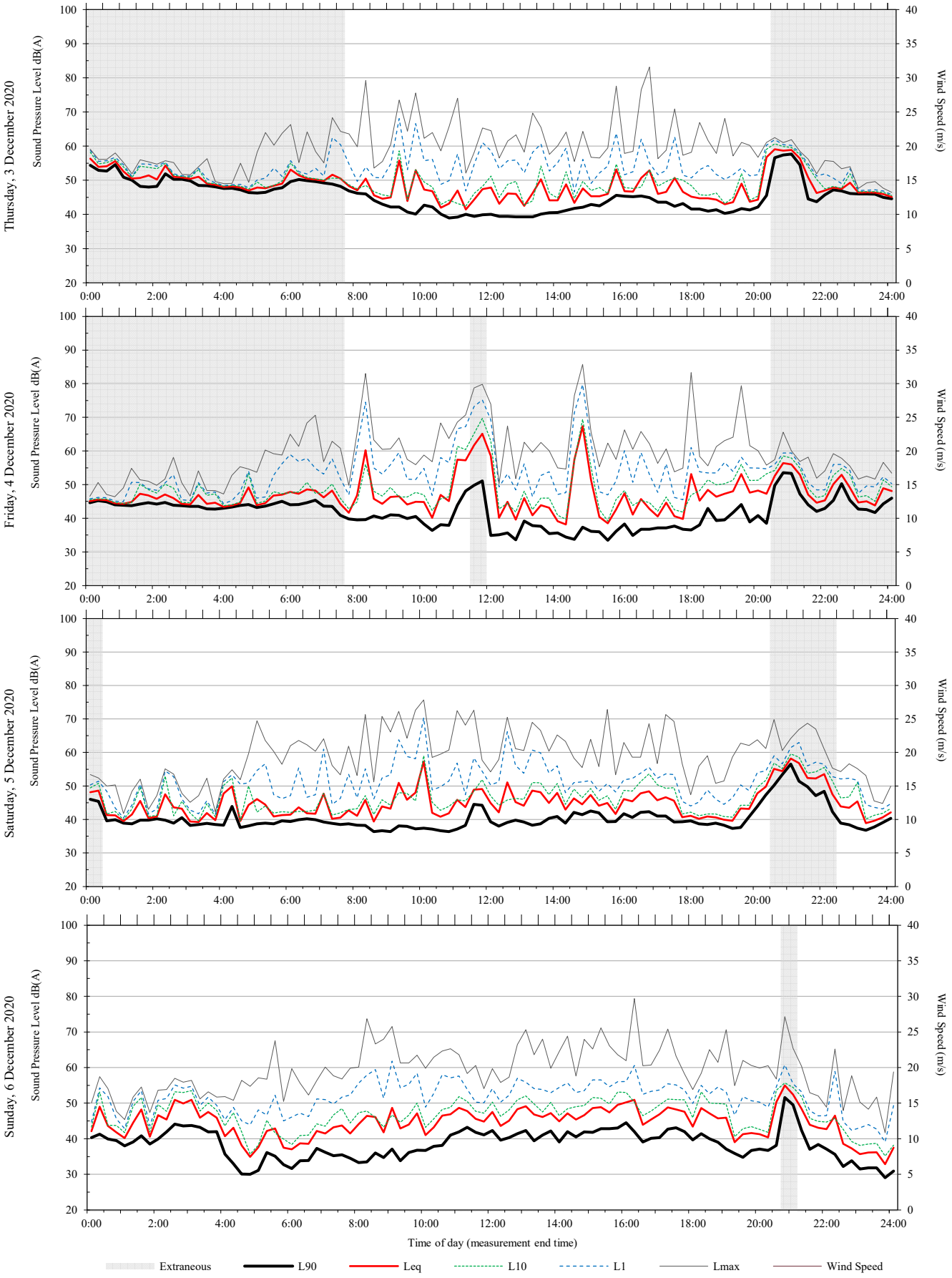
Unattended monitoring: 1 Medinah Avenue, Luddenham (Free Field)

ARUP



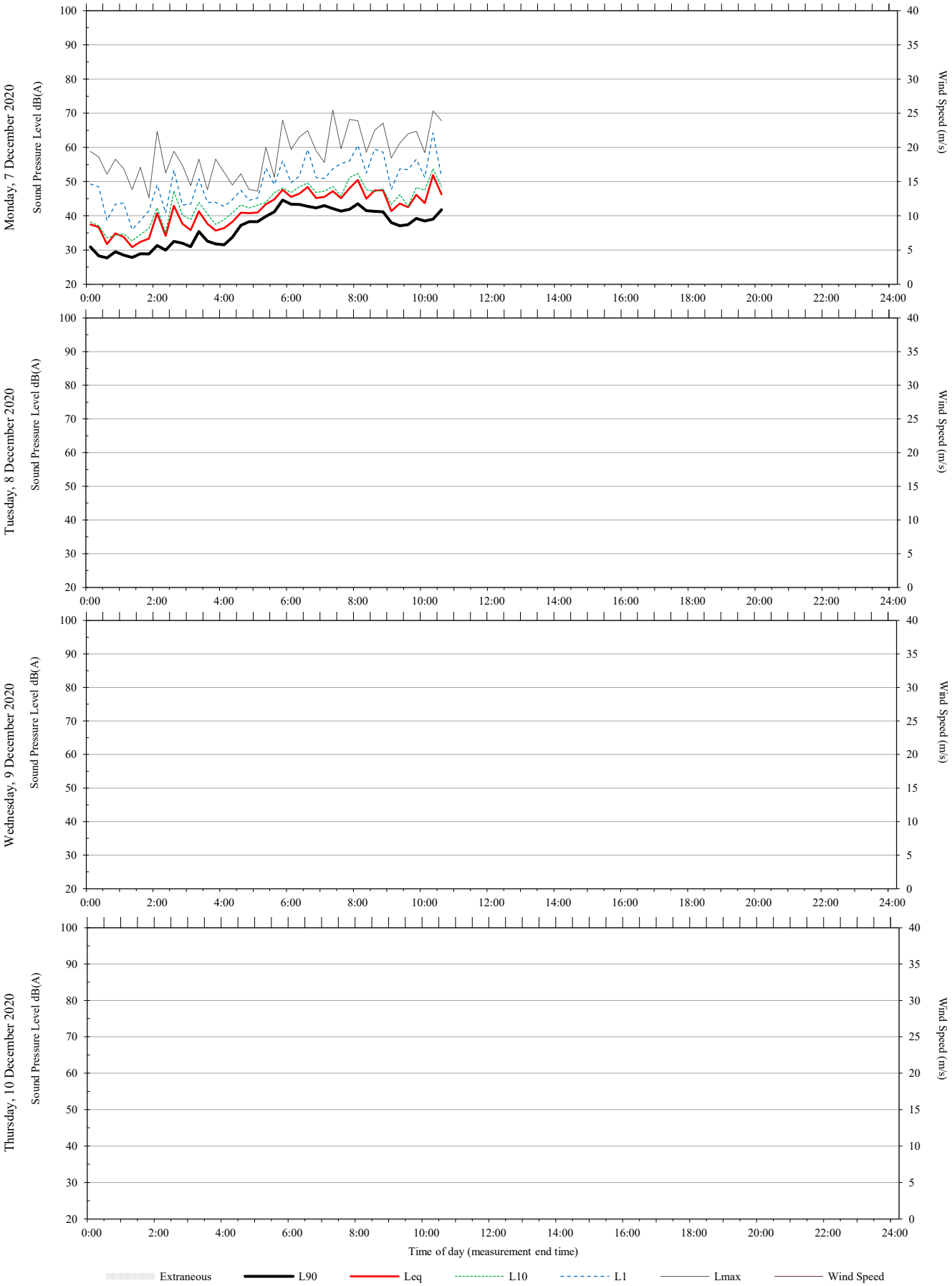
Unattended monitoring: 1 Medinah Avenue, Luddenham (Free Field)

ARUP



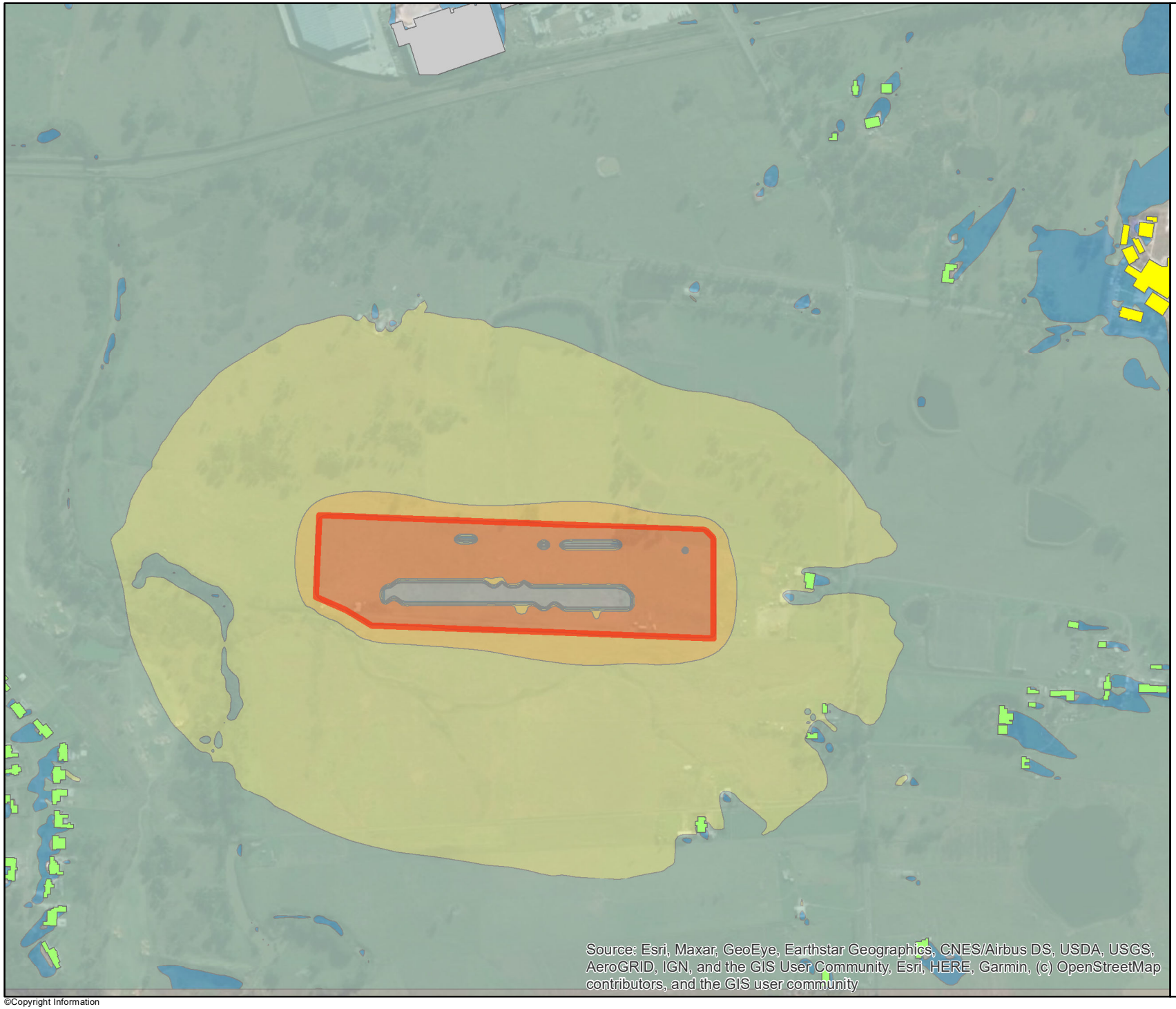
Unattended monitoring: 1 Medinah Avenue, Luddenham (Free Field)

ARUP



Appendix C

Noise Contour Maps



Legend

Site Boundary

Receivers

- Commercial
- Education
- Industrial
- Residential

Sound Pressure Level, $dBL_{Aeq(15min)}$

40 50 60 70 80 90

Metres

0 200 400

ARUP

Client
Confidential

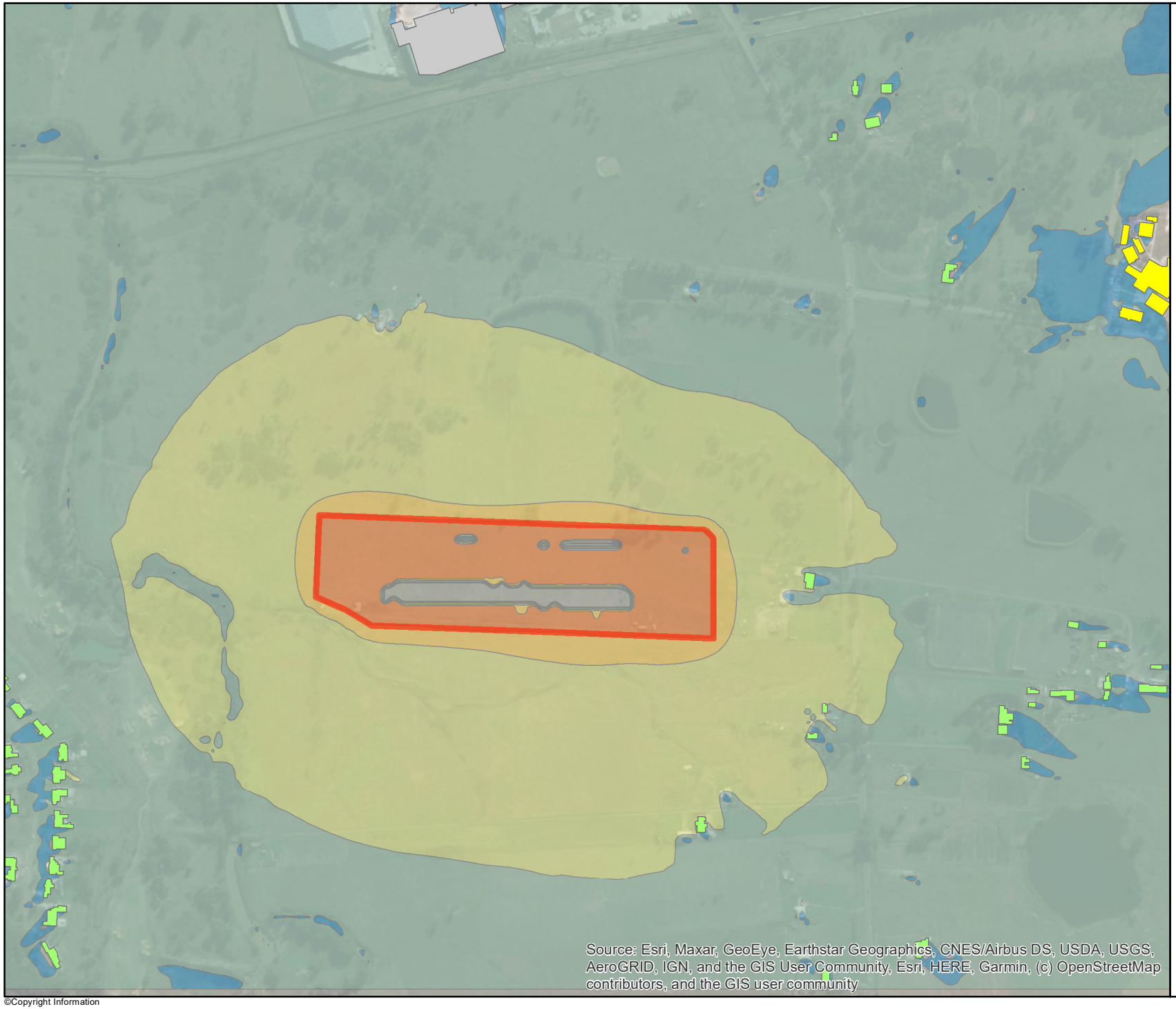
Job No
277863

Project
Syd05 Kemps Creek

Map Title
Construction noise contours - Stage 1

Revision
1

Map No
001



Legend

Site Boundary

Receivers

- Commercial
- Education
- Industrial
- Residential

Sound Pressure Level, $dBL_{Aeq(15min)}$

40 50 60 70 80 90

Metres

0 200 400

ARUP

Client
Confidential

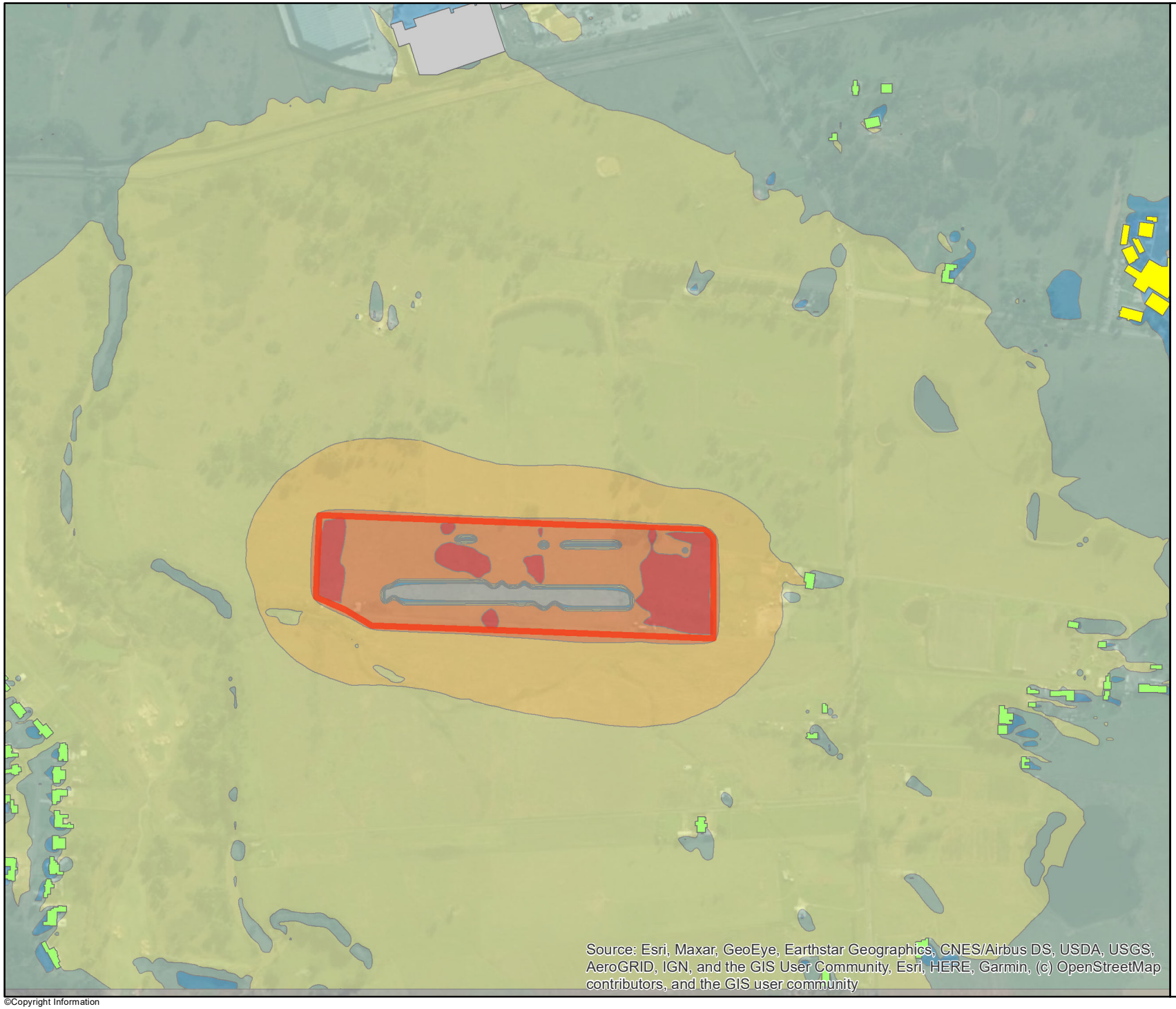
Job No
277863

Project
Syd05 Kemps Creek

Map Title
Construction noise contours - Stage 2

Revision
1

Map No
001



Legend

Site Boundary

Receivers

- Commercial
- Education
- Industrial
- Residential

Sound Pressure Level, $dBL_{Aeq(15min)}$

40 50 60 70 80 90

Metres

0 200 400

ARUP

Client	Job No
Confidential	**277863**

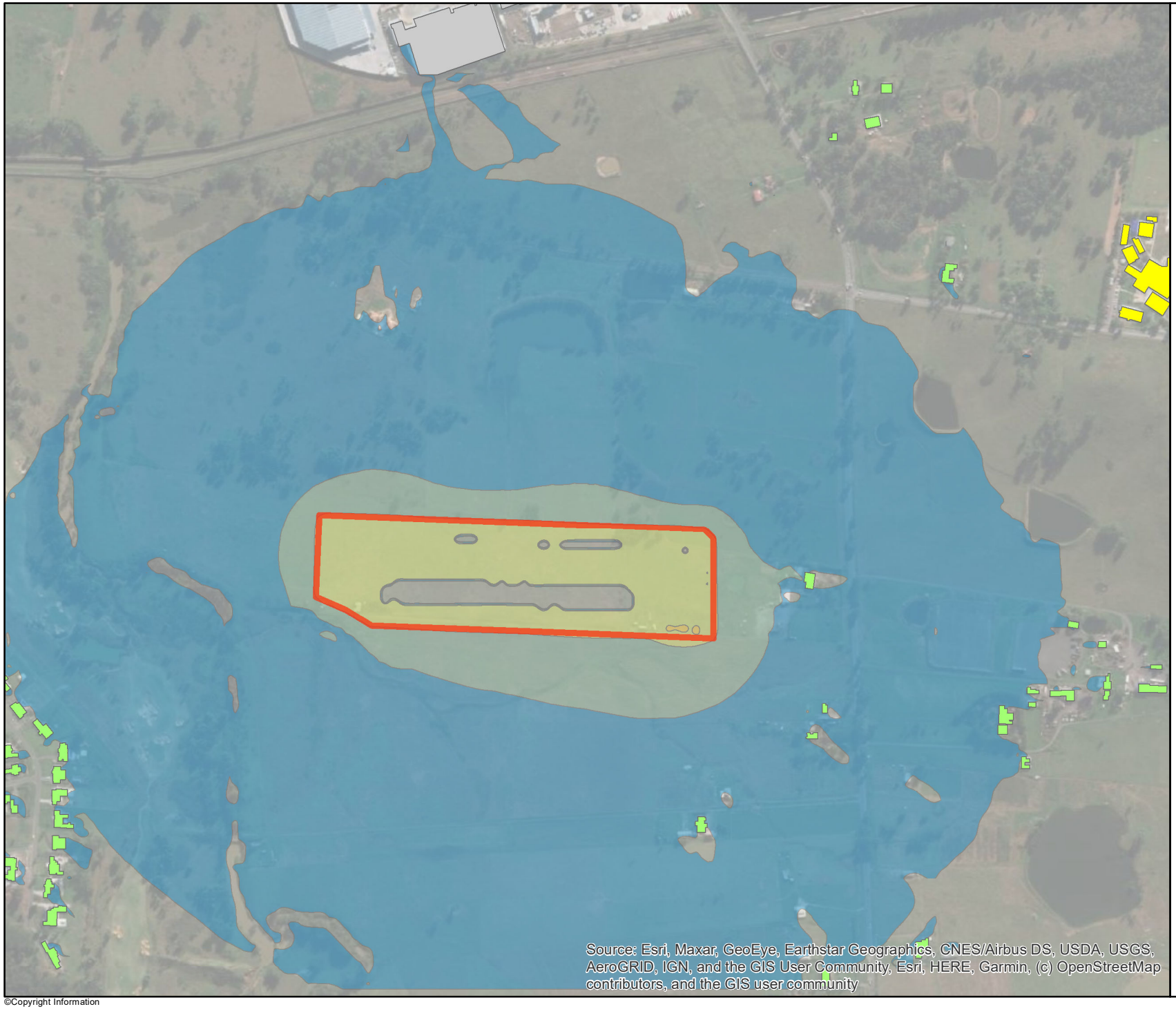
Project

Syd05 Kemps Creek

Map Title

Construction noise contours - Stage 3

Revision	Map No
1	**001**



Legend

Site Boundary

Receivers

- Commercial
- Education
- Industrial
- Residential

Sound Pressure Level, dBL$_{Aeq(15min)}$

40 50 60 70 80 90

Metres

0 200 400

ARUP

Client
Confidential

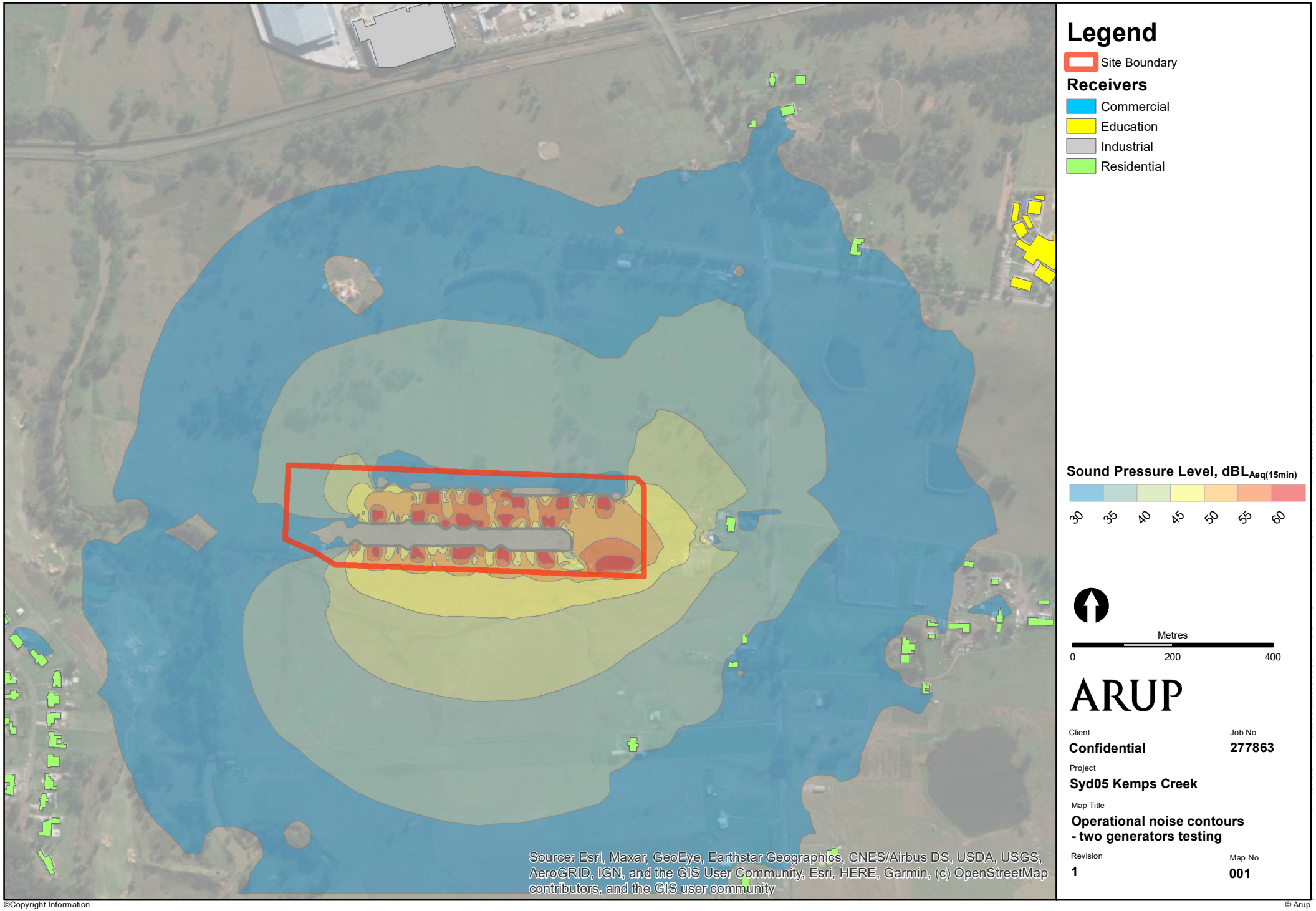
Job No
277863

Project
Syd05 Kemps Creek

Map Title
Construction noise contours - Stage 4

Revision
1

Map No
001



ARUP

Client
Confidential

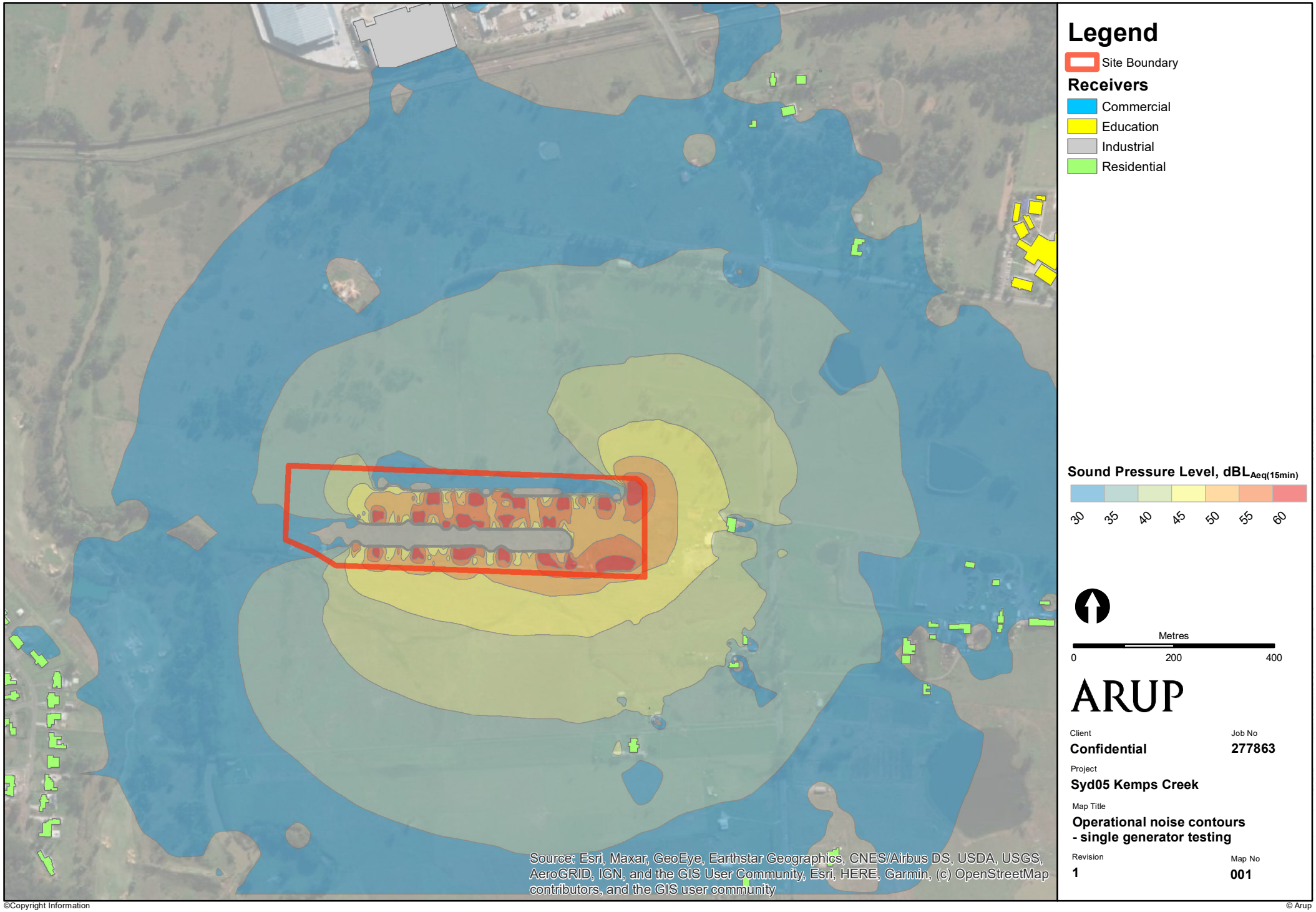
Job No
277863

Project
Syd05 Kemps Creek

Map Title
Operational noise contours - two generators testing

Revision
1

Map No
001



ARUP

Client
Confidential

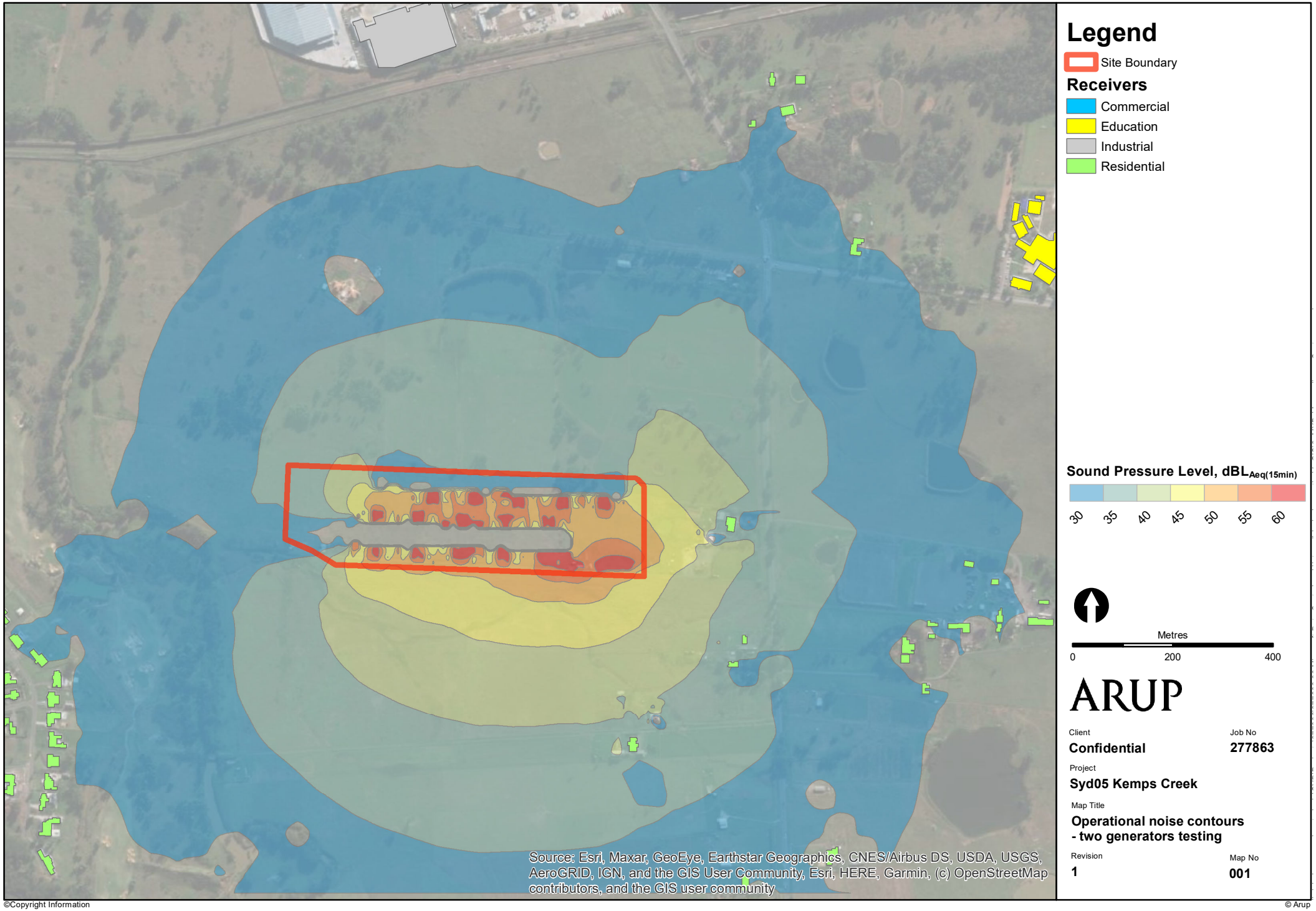
Job No
277863

Project
Syd05 Kemps Creek

Map Title
Operational noise contours - single generator testing

Revision
1

Map No
001



ARUP

Client
Confidential

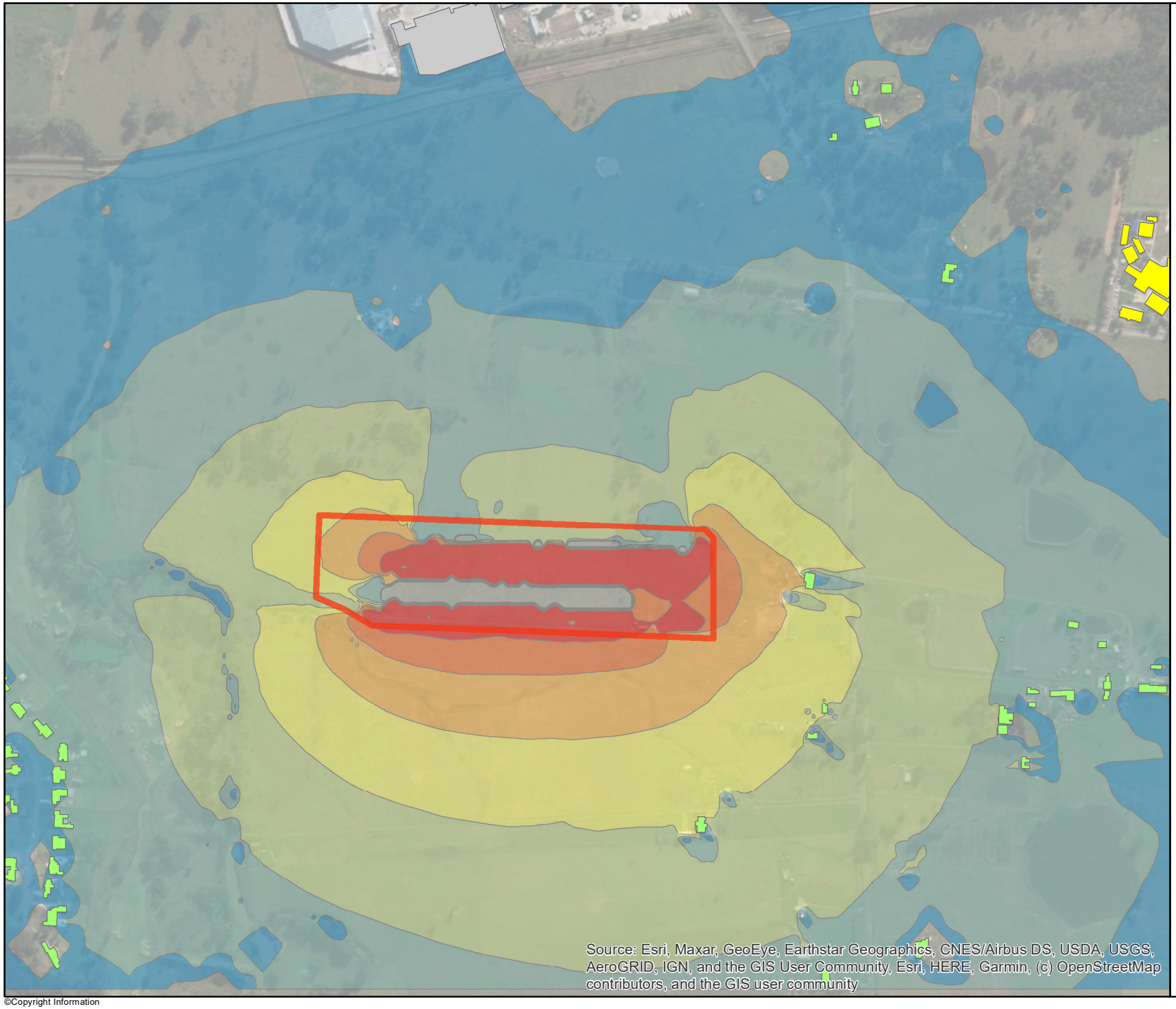
Job No
277863

Project
Syd05 Kemps Creek

Map Title
Operational noise contours - two generators testing

Revision
1

Map No
001



Legend

Site Boundary

Receivers

- Commercial
- Education
- Industrial
- Residential

Sound Pressure Level, $dBL_{Aeq(15min)}$

30 35 40 45 50 55 60

Metres

0 200 400

ARUP

Client
Confidential

Job No
277863

Project
Syd05 Kemps Creek

Map Title
Operational noise contours - critical power failure

Revision
1

Map No
001