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Construction Noise and Vibration Management Plan

Concord Zone Substation - ZN874
31 George Street, North Strathfield, NSW

REPORT No
6961-1.1R

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1.0 EXECUTIVE SUMMARY

An upgrade is proposed for the Concord Zone Substation ZN864, located at 31 George Street, North Strathfield, NSW. The upgrade includes the replacement of aging switchgear and associated equipment. It is also proposed to construct a new switchroom to the east of the existing substation directly adjacent to a multi-storey residential building at 27-29 George Street, North Strathfield, NSW, approximately 10 metres south of the subject site.

The proposed hours of construction are 7 am to 6 pm weekdays and 8 am to 1 pm and Saturdays. No work is to be conducted on Sundays, Public Holidays or during the Christmas/New Year break.

The development site is zoned as *R3: Medium Density Residential* under the Canada Bay Local Environmental Plan (LEP) 2013. Residential dwellings and multi-storey residential apartments and commercial buildings are located on adjacent lots and nearby the subject site. The T9 Train Line is located to the east of the subject site.

The major noise sources associated with the project will be mobile plant and machinery to be used during the excavation and construction phases and the transport of materials to and from the site in trucks whilst the site is being developed.

Cumulative noise levels from excavation, construction and fitout activities have been calculated at the nearest potentially affected residential and commercial premises. Details of our recommendations to reduce the noise emissions from the construction works to comply with the NSW Environment Protection Authority (EPA) noise control guidelines are presented in Section 6.0 of this report.

This construction noise and vibration management plan has been prepared in accordance with the Australian Standard AS2436:2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"*. Construction noise management levels have been derived from the Environment Protection Authority's *Interim Construction Noise Guideline* and are used for a quantitative assessment at the nearest affected residential receiver locations.

There is potential, at least on some occasions, for noise emission from construction works to exceed the noise management level at some residential premises during various stages of the works.

All feasible and reasonable methods to reduce noise emissions and minimise the noise impact on neighbouring properties have been provided in Section 6 of this report. These include, limiting construction activity to within the prescribed hours, selecting quieter equipment, erecting temporary sound barriers, incorporating periods of respite, maintaining community relations, managing noise complaints and conducting ground-borne vibration monitoring where required.

Provided the recommendations in Section 6 of this report are implemented and adhered to, the level of noise from the construction works will be minimised in accordance with the NSW Environment Protection Authority's *Interim Construction Noise Guideline 2009* and Australian Standard AS2436:2010.

2.0 CONSULTING BRIEF

Day Design Pty Ltd has been engaged by Ausgrid to prepare a Construction Noise and Vibration Management Plan for the proposed works at their existing Concord Zone Substation ZN864, located at 31 George Street, North Strathfield, NSW.

This commission involves the following:

Scope of Work:

- Determine the background noise levels at critical locations and times
- Establish the acceptable noise level criterion
- Quantify noise emissions from the demolition, excavation and construction works
- Calculate the level of noise emission, taking into account distance attenuation
- Prepare a site plan identifying the development and nearby noise sensitive locations
- Provide recommendations for noise controls (if necessary)
- Prepare a Construction Noise Management Plan.

3.0 PROJECT DESCRIPTION

3.1 Site Description

The site is located on the east side of George Street, on land zoned *R3; Medium Density Residential* under the Canada Bay Local Environmental Plan (LEP) 2013.

Bounding the subject site to the south is a multi-storey residential apartment building with commercial tenancies on the ground level facing George Street. At the time of preparing this report, the Papilio Early Learning child care centre (Orange Campus) was operating from the ground floor commercial tenancy directly adjacent to the subject site. It was noted that an acoustic barrier wall, approximately 3 metres in height had been constructed between the existing transformer bays and the outdoor play area of the child care centre.

Additional single storey residential dwellings are located on the opposite side of George Street to the west of the subject site.

A large commercial office building (Westpac Service Centre NSW) and associated multi-storey carpark is located on the adjacent lot to the north of the site. The carpark is located in the intervening space (approximately 35 metres) between the subject site and nearest façade of the office building.

A driveway is located to the north of the site between the subject site and carpark area, shown in Figure 1, which provides access to a telecommunications tower to the north. We are advised that this driveway will be used to provide access to the site for various plant (such as a mobile crane) when required.

The T9 Train Line is located to the east of the subject site which regularly carries both passenger and freight services.

The nearest noise sensitive receptors are shown in Figure 1 and in Table 1.

Table 1 Noise Sensitive Receptors

Receptor and Type	Address	Direction From Site	Building type
R1 – Residential	27-29 George Street	South	Multi-Storey
R2 – Commercial	27-29 George Street	South	Ground Floor Tenancy
R3 – Residential	164 George Street	West	Single Storey
R4 – Commercial	1 King Street	North	Single Storey
R5 – Residential	215 Queen Street	East	Two Storey

3.2 Development Description

The upgrades include the replacement of aging switchgear and associated equipment. It is also proposed to construct a new switchroom to the east of the existing substation.

The works will comprise of three main phases, which include:

- Stage 1 – Excavation
    - Expected time frame of up to 8 weeks
    - Activities may include use of trucks, excavator, bobcat and various hand tools.
- Stage 2 – Construction
    - Expected time frame of up to 12 months
    - Activities may include use of trucks, piling, excavator, crane and various hand tools.
- Stage 3 – Equipping of new switchroom, commissioning of new switchgear and decommissioning of existing switchgear
    - Expected time frame of up to 6 months
    - Activities include use of trucks and various hand tools.

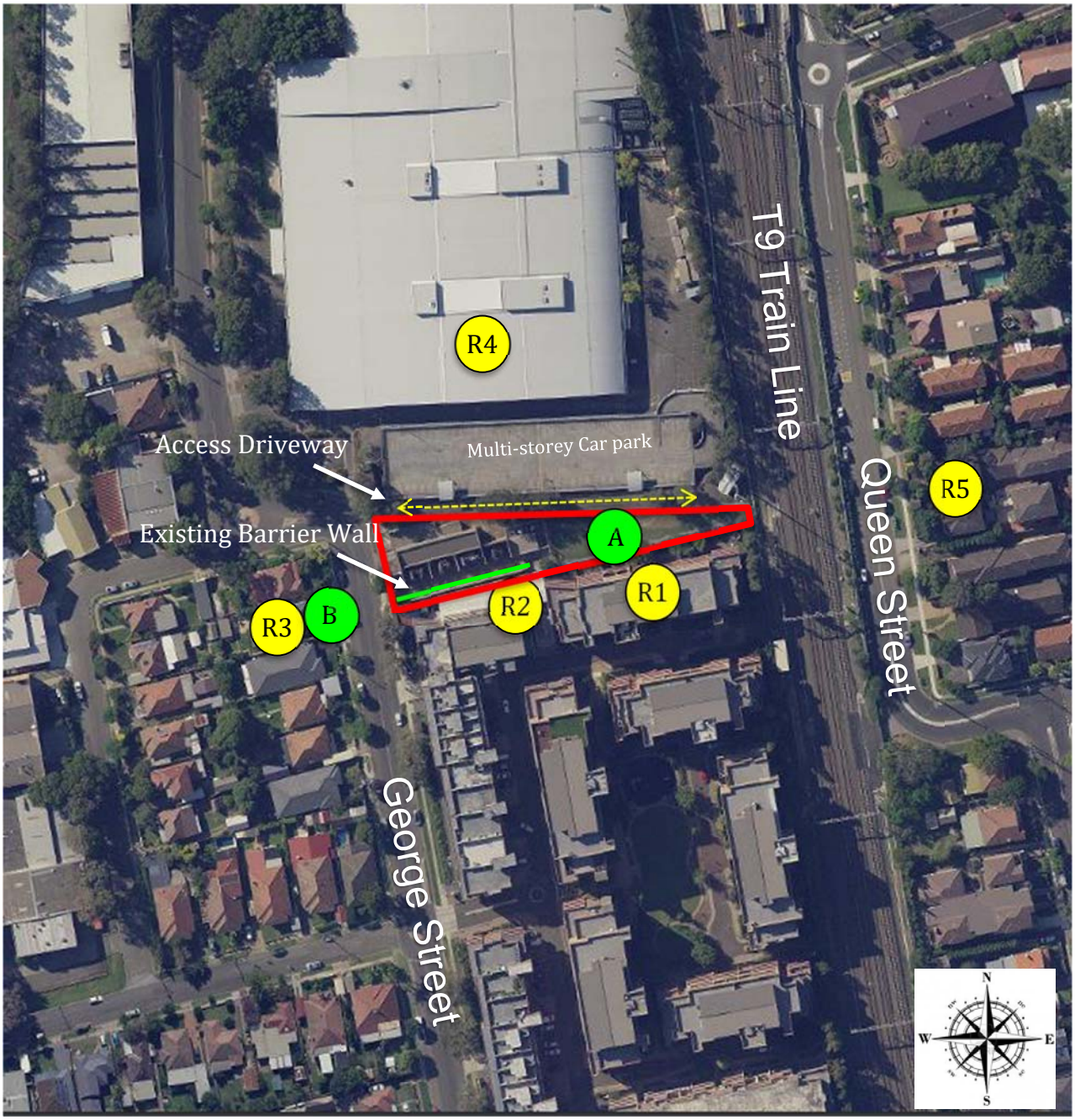


Figure 1 – Location Plan, 31 George Street, North Strathfield, NSW.

3.3 Construction Hours

Appropriate hours for construction works may be derived from the following;

EPA – Interim Construction Noise Guideline

The standard hours for construction works, including delivery of materials to and from the site, as defined by the EPA's *Interim Construction Noise Guideline* are as follows:

- 7 am to 6 pm, Monday to Friday inclusive;
- 8 am to 1 pm Saturdays; and
- No work on Sundays and Public Holidays.

City of Canada Bay

The subject site is located within the Canada Bay LGA. The standard hours for construction works, including delivery of materials to and from the site, as defined by the City of Canada Bay Council, are as follows:

- 7 am to 5 pm, Monday to Saturday inclusive;
- No work on Sundays and Public Holidays.

NSW Government Gazette

NSW Government Gazette № 75 (n2020-975), dated 9 April 2020, includes the *Environmental Planning and Assessment (COVID-19 Development – Infrastructure Construction Work Days) Order 2020*, which states the following with regard to the extension of construction hours:

> *"**6. Infrastructure construction work days***
>
> *(1) The carrying out of any building work or work, or the demolition of a building or work, on a Saturday, Sunday or public holiday is development specified for this Order.*
>
> *(2) The conditions specified for the development are that the development must—*
>
> *(a) must be the subject of an approval granted before the commencement of this Order, and*
>
> *(b) must comply with all conditions of the approval other than any condition that restricts the hours of work or operation on a Saturday, Sunday or public holiday, and*
>
> *(c) for work or operation on a Saturday, Sunday or public holiday—*
>
> *(i) comply with the conditions of the approval that restrict the hours of work or operation on any other day as if the conditions applied to work or operation on a Saturday, Sunday or public holiday, and*
>
> *(ii) not involve the carrying out of rock breaking, rock hammering, sheet piling, pile driving or similar activities during the hours of work or operation that would not be permitted but for this Order, and*
>
> *(iii) take all feasible and reasonable measures to minimise noise.*

(3) In this clause—approval means:

(a) a State significant infrastructure approval,

(b) an approval within the meaning of Division 5.1 of the Act that is granted in relation to an activity the subject of environmental assessment under Division 5.1 of the Act, and

(c) an authorisation under Part 3 of the Water Supply (Critical Needs) Act 2019. condition includes a limitation on the carrying out of an activity required by the determining authority when granting an approval in relation to the activity.

7. Suspension of regulatory instruments

(1) For the purpose of enabling development to be carried out in accordance with clause 6 of this Order, the following regulatory instruments do not apply to the extent necessary to serve that purpose:

(a) any agreement, covenant or other similar instrument that restricts the carrying out of that development, and

(b) an environment protection licence under the Protection of the Environment Operations Act 1997 that was issued before the commencement of this Order.

4.0 NOISE CRITERIA

4.1 Background Noise Level

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

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

The background noise level should be measured at a location representative of the potentially affected receptors, in the absence of any noise sources that may be associated with the proposed development.

Two environmental noise loggers were placed to measure the existing background noise levels in the area. One logger was placed on the subject site, at 1.5 metres above ground level on the southern boundary, designated Location 'A', as shown in Figure 1. Noise levels gathered at this location are representative of the typical background noise levels for residents in the multi-storey residential apartment building which overlook the subject site and residential dwellings on the east side of Queen Street. These residents are exposed to vehicle movements occurring within the carpark to the north and/or train movements on the T9 train line to the east.

Another logger was placed at 1.5 metres above ground level in the front yard of 164 George Street, designated Location 'B', as shown in Figure 1. Noise levels gathered at this location are representative of the typical background noise levels for residential premises facing George Street which are shielded from the train line by the multi-storey buildings on the east side of the street.

The loggers gathered noise data between Thursday 9 April and Thursday 16 April, 2020. Details of instrumentation used during the noise surveys can be seen in the attached Appendix A.

The results of the background noise survey at the logger position is shown in the attached Appendix B and Table 2.

Table 2 Ambient Background Levels

Location	Time Period	L_{90} Rating Background Level - dBA	Existing L_{eq} Noise Levels - dBA
Location 'A' – On-site 31 George Street, North Strathfield Ground Floor Level	Day (7 am – 6 pm)	41	51
	Evening (6 pm – 10 pm)	43	54
	Night (10 pm – 7 am)	38	50
Location 'B' – Front Yard 164 George Street, North Strathfield Ground Floor Level	Day (7 am – 6 pm)	39	56
	Evening (6 pm – 10 pm)	42	58
	Night (10 pm – 7 am)	40	47

Meteorological conditions during the measurement surveys typically consisted of clear skies with temperatures ranging from 9°C to 28°C. Atmospheric conditions were generally considered ideal for noise monitoring, however, some rainfall was recorded during the measurement period. Rain affected data has been removed from the data prior to calculating RBL's.

Noise level measurements were considered reliable and considered to be representative of the background noise levels at all nearby receptor locations, however, it should be noted that background noise measurements were conducted whilst lockdowns were being practiced by the community during the COVID-19 outbreak. Given that a significant proportion of people were working from home during this period, with less traffic and neighbourhood activity, it is likely that the measured ambient noise levels were lower than would normally be present. As such, ambient noise levels may be conservatively low.

4.2 Australian Standard AS2436

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

Section 1.5 'Regulatory Requirements' of the Standard states:

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

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

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

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

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

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

In NSW this is the NSW Environment Protection Authority's *Interim Construction Noise Guideline 2009* as outlined in Section 4.3 below.

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

This report has been prepared in accordance with the guidance provided in AS2436:2010.

4.3 EPA Interim Construction Noise Guideline

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

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

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

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

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

Normal construction hours are defined by the EPA as follows:

- 7 am to 6 pm Monday to Friday;
- 8 am to 1 pm Saturday; and
- No work on Sunday or Public Holidays.

4.3.1 Residential Premises

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

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

Based on the RBL at nearby sensitive residential receiver locations during the daytime, the recommended noise management level during all aspects of the construction program are shown below in Table 3.

Table 3 Noise Management Levels

Receptor Location	Noise Management Level	How to Apply
All Residential Receptors	**39 - 41 dBA** RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq\ (15\ min)}$ noise level is greater than the noise affected level, the proponent should apply all feasible and reasonable* work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences); 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

*Section 6, 'work practices' of The *Interim Construction Noise Guideline*, states: *"there are no prescribed noise controls for construction works. Instead, all feasible and reasonable work practices should be implemented to minimise noise impacts. This approach gives construction site managers and construction workers the greatest flexibility to manage noise"*.

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

4.3.2 Commercial and Industrial Premises

Section 4.1.3 of the Guideline provides advice for assessing commercial and industrial premises, as follows:

Commercial or industrial land can have a broad range of sensitivities to noise from construction. The Guideline separates the process of defining management levels is separated into three categories. The external noise levels should be assessed at the most-affected occupied point of the premises:

- Industrial premises: external $L_{Aeq\ (15\ min)}$ 75 dB(A);
- Offices, retail outlets: external $L_{Aeq\ (15\ min)}$ 70 dB(A);
- Other businesses that may be very sensitive to noise, where the noise level is project specific.

Examples of other noise-sensitive businesses include child care centres. The Guideline recommends that the proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis. The proponent should assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required. During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

4.4 Child Care Centres

The Association of Australasian Acoustical Consultants (AAAC) published Version 2 of the Guideline for Child Care Centre Acoustic Assessment in October 2013. There is no Standard or Guideline that specifies noise criteria for child care centres impacted by construction noise and vibration. However, the AAAC specifies the following external and internal noise criterion for road, rail and industrial noise in Section 7 – *External Noise Impact on Children,* in their Child Care Centre Guideline:

- $L_{Aeq,\ 1\ hour}$ 55 dBA at any point within outdoor play areas; and
- $L_{Aeq,\ 1\ hour}$ 40 dBA at any point within internal play or sleeping areas.

These external and internal noise level criterion will be adopted for the assessment of construction noise impact for the child care centre at 'R2'.

4.5 EPA Vibration Guideline

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

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. The guideline considers vibration from construction activities as Intermittent Vibration. Table 2.4 of the guideline sets out qualitative limits for Vibration Dose Values (VDV) to assess intermittent vibration.

It is not anticipated that activities that may produce significantly levels of vibration, such as rock breaking/hammering will be required for the proposed works. However, in the event of a complaint or where specified by geotechnical engineers, the VDV values to be applied to each of the receptor types nearby the subject site, for the purposes of assessing vibration impacts, is shown in Table 4.

Table 4 Vibration Dose Values (VDV)

Receptor Location	Daytime	
	Preferred value ($m/s^{1.75}$)	Maximum value ($m/s^{1.75}$)
All Residences Child Care Centre	0.20	0.40
Offices	0.40	0.80

The British Standard BS7385-2:1993 *"Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground-borne vibration"* provides guide values for transient vibration relating to cosmetic damage. Based on these values, we recommend that the vibration levels shown in Table 5 are applied for surrounding residential and commercial receptors.

Table 5 Transient Vibration Guide Values for Cosmetic Damage

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

4.6 Project Specific Noise and Vibration Criteria

The EPA published the Interim Construction Noise Guidelines in July 2009. This document is designed to simplify the assessment of the impact of construction noise on neighbouring properties.

In our opinion, the most relevant noise management levels for this development are summarised as follows:

At facades on all floors of the multi-storey residential apartment building and at west facing facades of residential premises facing Queen Street:

- (41 + 10 =) **51 dBA** $L_{eq,\ 15\ minute}$.

At facades of residential dwellings facing George Street:

- (39 + 10 =) **49 dBA** $L_{eq,\ 15\ minute}$.

At facades of offices:

- **70 dBA** $L_{eq,\ 15\ minute}$.

At any point within the external play area of a child care centre:

- **55 dBA** $L_{eq,\ 1\ hour}$.

At any point within an indoor play or sleeping area of a child care centre:

- **40 dBA** $L_{eq,\ 1\ hour}$.

It should be noted that a 10dB reduction is typically achieved by external building facades with windows/doors partially open. As such, the internal levels can be approximated from the calculated external noise level.

It is our opinion, the most relevant vibration management levels for this development are summarised as follows:

- A Vibration Dose Value (VDV) between **0.2 – 0.4 m/s$^{1.75}$** for human annoyance within residential buildings and child care centres;
- A Vibration Dose Value (VDV) between **0.4 – 0.8 m/s$^{1.75}$** for human annoyance within offices and commercial buildings;
- Peak Particle Velocity values for residential and commercial premises, as measured at the foundations of the structure for structural damage of: 5mm/s below 10Hz, 5 – 15mm/s between 10 – 50 Hz, 40 – 50mm/s between 50 – 100Hz.

These vibration management levels are applicable where an assessment of vibration from specific processes or activities occurring on site is required, i.e. in the event of a complaint or where specified by geotechnical engineers.

5.0 NOISE EMISSION

The main sources of noise on the site during excavation, construction and equipping of the new switchroom will be from heavy machinery such as excavators, pile borer, trucks, cranes, hand tools etc.

A schedule of the sound power levels for the main excavation and construction equipment was extracted from Australian Standard AS2436:1981 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites*."

5.1 Phase 1 - Excavation Works

The excavation stage of the development is expected to take approximately 8 weeks. The equipment likely to be used and their corresponding sound power levels are presented below in Table 6.

Table 6 Sound Power Levels - Typical Excavation Plant and Equipment

Description	Sound Power Level, dBA
Excavator (20 ton)	107
Trucks	Up to 107
Bobcat	99

(All sound power levels are derived from AS2436:2010, DEFRA and Day Design noise databases)

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

Calculations include a range of noise levels and assume a worst case scenario with all plant is operating simultaneously and continuously over the assessment period and considers distance attenuation only.

The lower range of noise levels are based on the furthest potential distance at which plant may operate from each respective receptor location.

The upper range of levels are based on the closest potential distance at which each item of plant may operate from each respective receptor location.

The calculated range of noise levels from excavation works at nearby residential receptors are presented in Table 7 below.

Table 7 Calculated Receptor Sound Pressure Levels – Phase 1 Works

Receptor Location	Calculated Sound Pressure Levels - L_{eq}
R1 – 27-29 George Street	63 to 80 dBA
R2 – 27-29 George Street	67 to 83 dBA (External) 57 to 73 dBA (Internal)
R3 – 164 George Street	61 to 74 dBA
R4 – 1 King Street	67 to 73 dBA
R5 – 215 Queen Street	58 to 67 dBA

5.2 Phase 2 – Construction Works

The construction phase is estimated to take up to 12 months and will involve the use of heavy vehicles, power tools and portable mechanical plant such as compressors. Power is currently available on site negating the need for generators. The equipment likely to be used and their corresponding sound power levels are presented below in Table 8.

Table 8 Sound Power Levels - Typical Construction Equipment

Description	Sound Power Level, dBA
Cement Truck	108
Trucks	Up to 107
Light Commercial Vehicle	106
Bobcat	99
Mobile Crane	104
Piling (Bored)	111
Compressor	101
Electric Hand Tools	Up to 110

(All sound power levels are derived from AS2436:2010, DEFRA and Day Design noise databases)

Calculations assume a worst case scenario with all plant operating simultaneously and continuously over the assessment period and considers distance attenuation only.

The lower range of noise levels are based on the furthest potential distance at which plant may operate from each respective receptor location. The upper range of levels are based on the closest potential distance at which each item of plant may operate from each respective receptor location.

The calculated range of noise levels at nearby residential receptors are presented below in Table 9 as a worst case scenario.

Table 9 Calculated Receptor Sound Pressure Levels – Phase 2 Works

Receptor Location	Calculated Sound Pressure Levels - L_{eq}
R1 – 27-29 George Street	66 to 84 dBA
R2 – 27-29 George Street	70 to 87 dBA (External) 60 to 77 dBA (Internal)
R3 – 164 George Street	64 to 78 dBA
R4 – 1 King Street	70 to 76 dBA
R5 – 215 Queen Street	62 to 70 dBA

5.3 Phase 3 – Equipping of Switchroom

It is estimated that the new switchroom is to be equipped with new switchgear over a period of approximately 6 months and will involve the use of hand tools and light commercial vehicles and trucks. The equipment likely to be used and their corresponding sound power levels are presented below in Table 10.

Table 10 Sound Power Levels - Typical Switchroom Fitout Equipment

Description	Sound Power Level, dBA
Trucks	Up to 107
Light Commercial Vehicle	106
Electric Hand Tools	Up to 110

(All sound power levels are derived from AS2436:2010, DEFRA and Day Design noise databases)

During the switchroom fitout stage, work will be more dispersed across the site and within the newly constructed switchroom building. In comparison to the excavation and construction stages, the scale of work is likely to be much less intensive and the cumulative level of noise generated on site is likely to be significantly lower.

Calculations assume a worst case scenario with all plant operating simultaneously and continuously over the assessment period and considers distance attenuation only.

The lower range of noise levels are based on the furthest potential distance at which plant may operate from each respective receptor location. The upper range of levels are based on the closest potential distance at which each item of plant may operate from each respective receptor location.

The calculated noise levels at nearby residential receptors are presented below in Table 11 as a worst case scenario.

Table 11 Calculated Receptor Sound Pressure Levels – Phase 3 Works

Receptor Location	Calculated Sound Pressure Levels - L_{eq}
R1 – 27-29 George Street	61 to 78 dBA
R2 – 27-29 George Street	65 to 82 dBA (External) 55 to 72 dBA (Internal)
R3 – 164 George Street	59 to 72 dBA
R4 – 1 King Street	65 to 71 dBA
R6 – 215 Queen Street	57 to 65 dBA

5.4 Noise Emission Summary

From the above calculated noise levels, the potential level of noise exceedance at each receptor location are presented below in Tables 12 and 13.

Table 12 Calculated $L_{eq\ 15\ minute}$ Noise Levels (Without Noise Controls)

Description	Calculated Noise Levels (dBA)					
	R1	R2 (External)	R2 (Internal)	R3	R4	R5
Phase 1 – Excavation Works	**Up to 80**	**Up to 83**	**Up to 73**	**Up to 74**	**Up to 74**	**Up to 67**
Noise Management Level	51	55	40	49	70	51
Exceedance (Worst Case)	Up to 29	Up to 28	Up to 33	Up to 25	Up to 4	Up to 16
Phase 2 – Construction Works	**Up to 84**	**Up to 87**	**Up to 77**	**Up to 78**	**Up to 78**	**Up to 70**
Noise Management Level	51	55	40	49	70	51
Exceedance (Worst Case)	Up to 33	Up to 32	Up to 37	Up to 29	Up to 8	Up to 19

Table 13 Calculated $L_{eq\ 15\ minute}$ Noise Levels (Without Noise Controls)

Description	Calculated Noise Levels (dBA)					
	R1	R2 (External)	R2 (Internal)	R3	R4	R5
Phase 3 – Switchroom Fitout	**Up to 80**	**Up to 83**	**Up to 73**	**Up to 74**	**Up to 74**	**Up to 67**
Noise Management Level	51	55	40	49	70	51
Exceedance (Worst Case)	Up to 29	Up to 28	Up to 33	Up to 25	Up to 4	Up to 16

It can be seen from Tables 12 and 13 that the levels of noise from activities conducted on the site during each phase of the proposed works has potential to exceed the noise management level at all receptor locations. There is also potential for the highly noise affected level of 75 dBA to be exceeded for short durations at all stages of the development. To minimise the noise impact from the construction activities we recommend that the noise controls and the management plan detailed in Section 6 of this report be implemented.

It should be noted that the calculated noise levels assume a worst case scenario with all plant and equipment operating simultaneously and continuously at the closest point to each receptor location. During each phase of the works, plant and equipment are more likely to be dispersed over the entire site and operated only when required.

Calculations consider distance attenuation only however, additional noise attenuation from buildings and other structures, ground and atmospheric factors may also result in lower noise levels. Therefore, noise levels are likely to be lower in practice.

5.5 Vibration Emission

It is difficult to accurately predict levels of ground borne vibration at remote locations as there are many variables to consider including the surrounding terrain, strata, rock density, etc.

Previous measurements of ground borne vibration from rock hammering show that vibration levels can vary significantly at different distances and receptor locations. Given the distances from neighbouring residences to any activity with the potential to generate high levels of vibration, we recommend that ground borne vibration is monitored and investigated at the nearest residence if and when rock hammering is required.

Activities that generate significant levels of ground borne vibration, such as rock hammering, are not anticipated for the proposed works. As such, on-going vibration monitoring is not required unless in response to a complaint or where specified by geotechnical engineers.

6.0 NOISE CONTROL RECOMMENDATIONS

The calculated level of noise emission from the excavation, construction and fit out activities during the proposed works at the subject site may exceed the noise management levels established in Section 4 of this report. In order to minimise the noise impact from all excavation and construction activities, we recommend that engineering and management noise controls, as described in Sections 6.1 – 6.3 be implemented.

With the implementation of the following management and engineering controls, where reasonable and feasible, noise emission from the site during the proposed works will be reduced as far as practical to meet the established noise management levels in accordance with the EPA's *Interim Construction Noise Guideline*.

6.1 Engineering and Practical Noise Controls

Australian Standard AS2436:2010, Appendix C, Table C3 provides the relative effectiveness of various forms of noise control that may be applicable and implemented on various construction sites and projects. Table C3 is replicated below in Table 14.

Table 14 Relative Effectiveness of Various Forms of Noise Control

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

Distance

Where practical, we recommend locating mechanical plant in the centre of the lot to allow maximum distance to all potentially affected residences.

Enclosure

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

Screening

We recommend erecting temporary sound barrier screens on the site boundaries, particularly where the residential windows are located to provide shielding for the residences adjacent to the site, which have a direct line of sight to the construction area. Sound barrier screens should be erected to a minimum height of 1.8 metres and constructed from, for example 19 mm plywood on steel posts or attached to temporary construction fencing. All sound barriers should be designed by a structural engineer to resist wind loads. If required, such as in the event of a complaint, higher fences may be installed to provide additional noise attenuation.

Alternatively sound absorptive barriers can be hired from **www.echobarrier.com.au**.

Silencing

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

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

6.2 Noise Management Controls

The following noise management controls are derived from, or are in accordance with recommendations given in Australian Standard AS2436:2010 and the EPA's *Interim Construction Noise Guideline*.

Periods of Respite

Standard construction hours, as defined by the EPA, permit works to occur from 7 am to 5 pm Monday to Friday and Saturday 8 am to 1 pm. No work is to take place on Sundays and public holidays. However, appropriate construction hours for the site should be derived in accordance with guidance from the EPA, City of Canada Bay and the NSW Government where applicable.

Further to adopting appropriate construction hours, we recommend that particularly noisy construction activities such as rock hammering (if required) only operate for 2 to 3 hours at a time.

Ensure activities in any one location are staggered where practical. For instance, if hammering is occurring near to a residential receptor, all other construction activities will cease in the same location so as to minimise cumulative noise impacts.

Work Practices

We recommend that workers and contractors be trained in work practices to minimise noise emission such as the following:

- Avoid dropping materials from a height.
- Avoid shouting and talking loudly outdoors.
- Avoid the use of radios outdoors that can be heard at the boundary of residences.
- Turn off equipment when not being used.
- Carry out work only within the recommended hours of operation (see Section 4.3).

Heavy Vehicles and Staff Vehicles

- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Locate site vehicle entrances away from residences where practicable
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Staff parking areas should be located as far from residential receiver locations as practicable.
- No motor vehicles should access the site via, or park within residential areas prior to 7 am on any occasion, in order avoid sleep disturbance.

Community Relations

- Prior to the commencement of works, nearby residents and owners/managers of commercial premises shall be informed via letterbox drops and/or direct consultation, of the proposed excavation and construction works, the anticipated time frame for commencement and completion and time of day where work will be undertaken. Contact numbers for the site foreman shall also be provided to address any complaints or concerns.
- Provide a designated Community Liaison Officer during all stages of the project;
- The Community Liaison Officer shall explain the project, duration of works, potentially noisy periods as well as determine any particularly sensitive receivers or sensitive time periods and schedule works accordingly, as far as reasonably practical;
- A contact number for the Community Liaison Officer shall be clearly displayed on the front fencing for any residents or interested parties to call with complaints or queries.

Once works commence, communication with the community shall be maintained by the Community Liaison Officer. Communication should be maintained via a clearly visible notice board at the site office or on construction site boundaries.

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

Managing a Noise Complaint

The Community Liaison Officer shall receive and manage noise complaints in consultation with the site foreman.

All complaints shall be treated promptly and with courtesy.

Should a justified noise or vibration complaint not be resolved, noise or vibration monitoring may be carried out at the affected receptor location and appropriate measures be taken to reduce the noise or vibration emission as far as reasonably practicable.

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

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

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

6.3 Vibration Monitoring

The recommended allowable vibration limit has been set at Peak Particle Velocities (PPV) of:

- 5mm/s below 10Hz;
- 5 – 15mm/s between 10 – 50 Hz;
- 40 – 50mm/s between 50 – 100Hz;
- For multi-storey residential structures, 15mm/s measured on the horizontal plane of the highest floor.

If vibration measurements are required, i.e. in response to a complaint or as specified by geotechnical engineers, they should be carried out using either an attended or an unattended vibration monitor. An unattended vibration monitor should be fitted with an alarm in the form of a strobe light or siren to make the plant operator aware immediately when the vibration limit is exceeded. The vibration monitor should be set to trigger the alarm when the overall (PPV) exceeds **5 mm/s** at the nearest residential building.

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

7.0 CONCLUSION

Day Design Pty Ltd has been engaged by Ausgrid prepare a Construction Noise Management Plan for the proposed works at their existing Concord Zone Substation ZN864, located at 31 George Street, North Strathfield, NSW.

Provided the recommendations in Section 6 of this report are implemented, the level of noise from the construction works at 31 George Street, North Strathfield, NSW, will be minimised as far as reasonably practical to meet the established noise management levels outlined in Tables 12 and 13 of this report, in accordance with the Australian Standard AS2436:2010 *"Guide to noise and vibration control on construction, demolition and maintenance sites"* and the EPA's *Interim Construction Noise Guideline*, as detailed in Section 4 of this report.

Alexander Mendoza, MDesSc (Audio and Acoustics), MAAS

Acoustic Consultant

for and on behalf of Day Design Pty Ltd

AAAC MEMBERSHIP

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

APPENDICES

Appendix A – Instrumentation
Appendix B – Ambient Noise Survey
AC108-1 to 4 – Glossary of Acoustical Terms

NOISE SURVEY INSTRUMENTATION

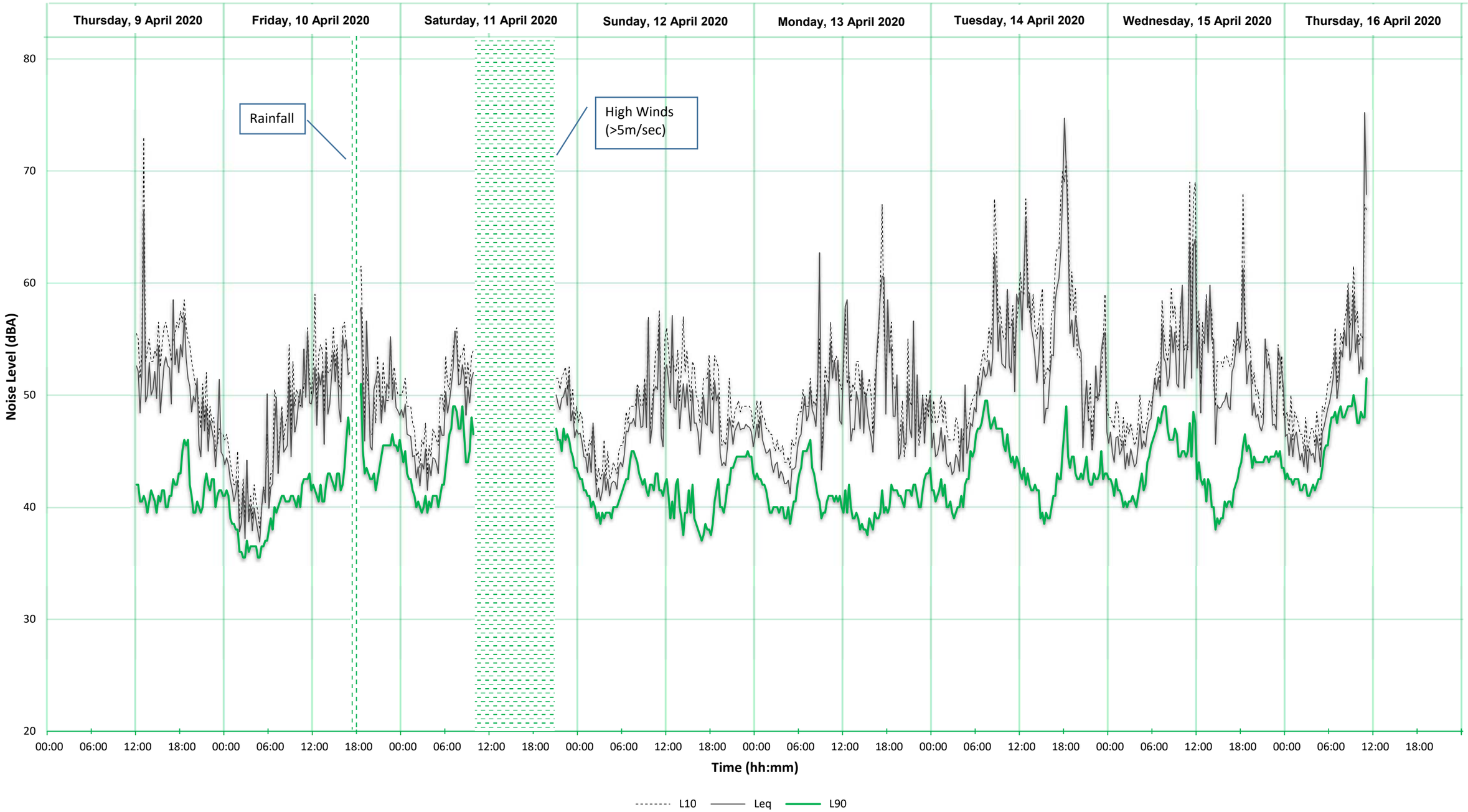
Table A1 Noise Survey Instrumentation

Description	Model No	Serial No
Infobyte Noise Logger (Type 2)	iM4	105
Condenser Microphone 0.5" diameter	MK 250	7112
Infobyte Noise Logger (Type 2)	iM4	113
Condenser Microphone 0.5" diameter	MK 250	113

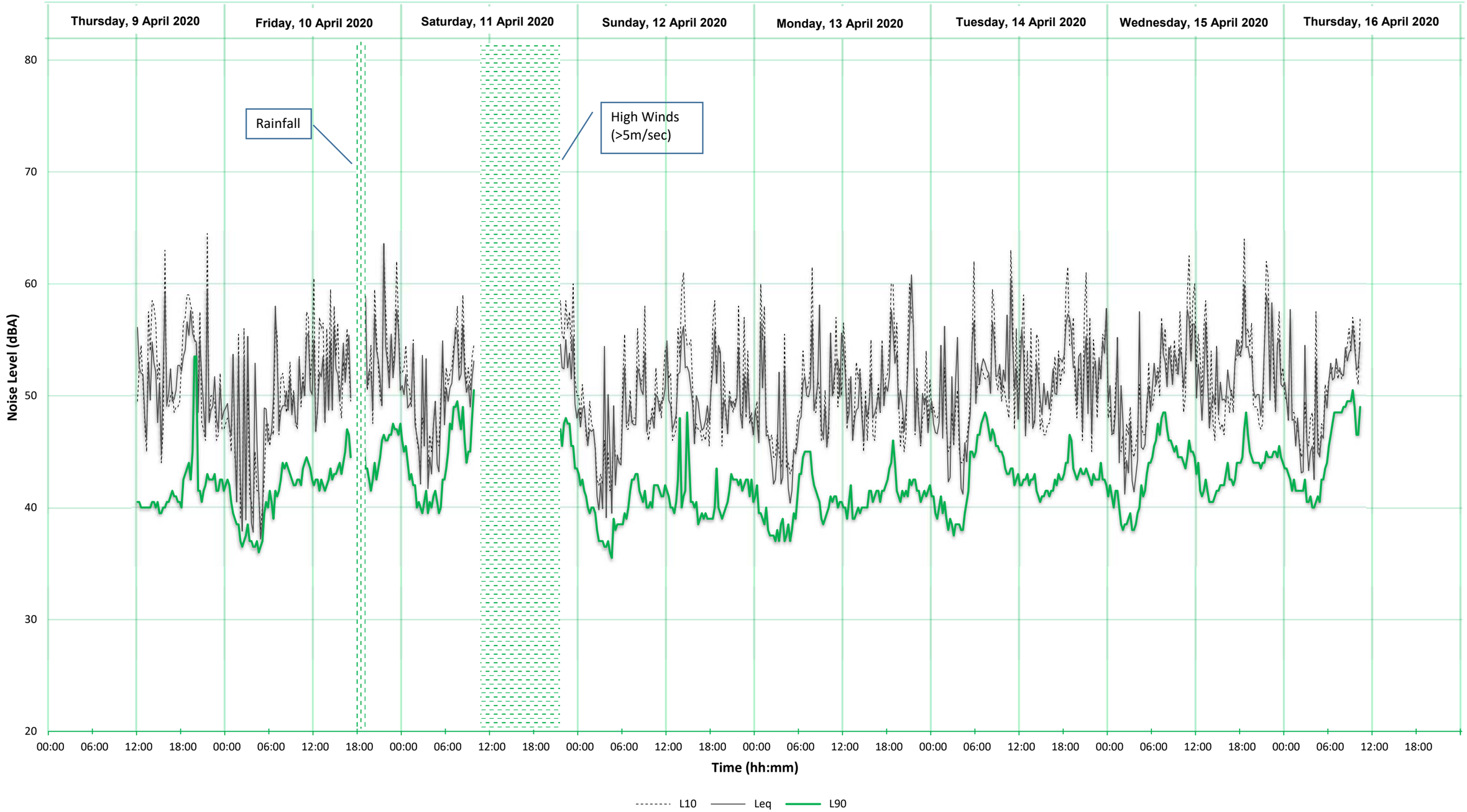
An environmental noise logger is used to continuously monitor ambient noise levels and provide information on the statistical distribution of noise during an extended period of time. The Infobyte Noise Monitor iM4 (#105 & 113) is a Type 2 precision environmental noise monitor meeting all the applicable requirements of AS1259 for an integrating-averaging sound level meter.

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

Located at 164 George St, North Strathfield, NSW



Located at 31 George Street, North Strathfield, NSW



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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