DAY DESIGN PTY LTD
CONSULTING ACOUSTICAL ENGINEERS

SUITE 17, 808 FOREST ROAD, PEAKHURST 2210 ABN 73 107 291 494
P. 02 9046 3800 ACOUSTICS@DAYDESIGN.COM.AU WWW.DAYDESIGN.COM.AU

Acoustic Assessment

Proposed Macquarie Subtransmission Substation, 17-21 Waterloo Road, Macquarie Park, NSW

REPORT No
6639-2.1R

DATE ISSUED
15 January 2019

Prepared For:
Ausgrid
GPO Box 4009
Sydney NSW 2001

Attention: Ms Annette Comerford

Revision History

Report	Date	Prepared	Checked	Comment
Draft	06/11/2018	Stephen Gauld	William Wang	By email, for client review
Final	15/01/2019	Stephen Gauld	William Wang	

Document R\6639-2.1r, 30 pages plus attachments

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1.0 CONSULTING BRIEF

Day Design Pty Ltd was engaged by Ausgrid to assess the environmental noise impact from the operation of a new subtransmission substation (designated Macquarie STS), located at 17-21 Waterloo Road, Macquarie Park, NSW.

The Macquarie STS will consist of two 120MVA, 132kV/33kV/11kV transformers and two 200/75 kVA, 11kV/433V/240V auxiliary transformers.

An assessment of the noise impact from the construction of the Macquarie STS was also carried out. This commission involves the following:

Scope of Work:

- Inspect the site and environs.
- Measure the background noise levels at critical locations and times.
- Establish acceptable noise level criterion.
- Quantify noise emissions from the subtransmission substation.
- Quantify noise emissions from the construction works associated with the installation of subtransmission substation.
- Calculate the level of noise emission, taking into account building envelope transmission loss, screen walls and distance attenuation.
- Prepare a site plan identifying the development and nearby noise sensitive locations.
- Provide recommendations for noise control (if necessary).
- Prepare an Environmental Noise Assessment Report.

2.0 PROJECT DESCRIPTION AND SUMMARY OF FINDINGS

A new subtransmission substation (Macquarie STS) is proposed to be constructed at 17-21 Waterloo Road, Macquarie Park comprising of two 120MVA, 132kV/33kV/11kV transformers and two 200/75 kVA, 11kV/433V/240V auxiliary transformers.

The Macquarie STS will be located on the south-western side of the lot adjacent to an existing Ausgrid 132/11kV zone substation. The site is immediately adjacent to commercial premises to the east and west. Located to the south west, across Waterloo Road, are a child care centre and sporting club approximately 65 m and 50 m away respectively. Beyond the child care centre and sporting club, across Epping Road, the nearest potentially affected residential premises is located approximately 420 m away from the proposed substation in North Ryde. The site and surrounding environs is shown in Figure 1 on the following page.

The substation will operate 24 hours a day, 7 days a week.

The transformers convert high voltage electricity to 33kV supply electricity and typically generate a low frequency 'hum' at 100 Hz. The noise levels from the proposed subtransmission substation have been calculated at the nearest effected property boundary.

The installation of the subtransmission substation will require construction works to be carried out including heavy vehicles and machinery. The majority of the construction works will occur during business hours. The EPA's *Interim Construction Noise Guideline* has been used to assess the construction noise impact of the proposed works to surrounding receptors.

Acceptable intrusive noise levels from the noise generated by the transformers to surrounding premises are based on the requirements within the *Environmental Operations (Noise Control) Regulation* and the *Environmental Protection Authority's* (EPA) *Noise Policy for Industry* (NPI) *2017*.

The nearest affected receptors are given in Table 1 below and are shown in Figure 1. The noise levels from the proposed transformers and the associated construction works at Macquarie STS have been calculated and will meet the EPA's NPI.

Table 1 Noise Sensitive Receptors

Receptor and Type	Address	Distance From Site (Direction)
R1 – Residential	82 Epping Road	420 m (south-west)
R2 – Commercial	23-25 Waterloo Road	25 m (west)
R3 – Commercial	9-13 Waterloo Road	50 m (east)
R4 – Child Care Centre	16 Waterloo Road	65 m (south-west)
R5 – Active Recreation	18 Waterloo Road	50 m (south-west)

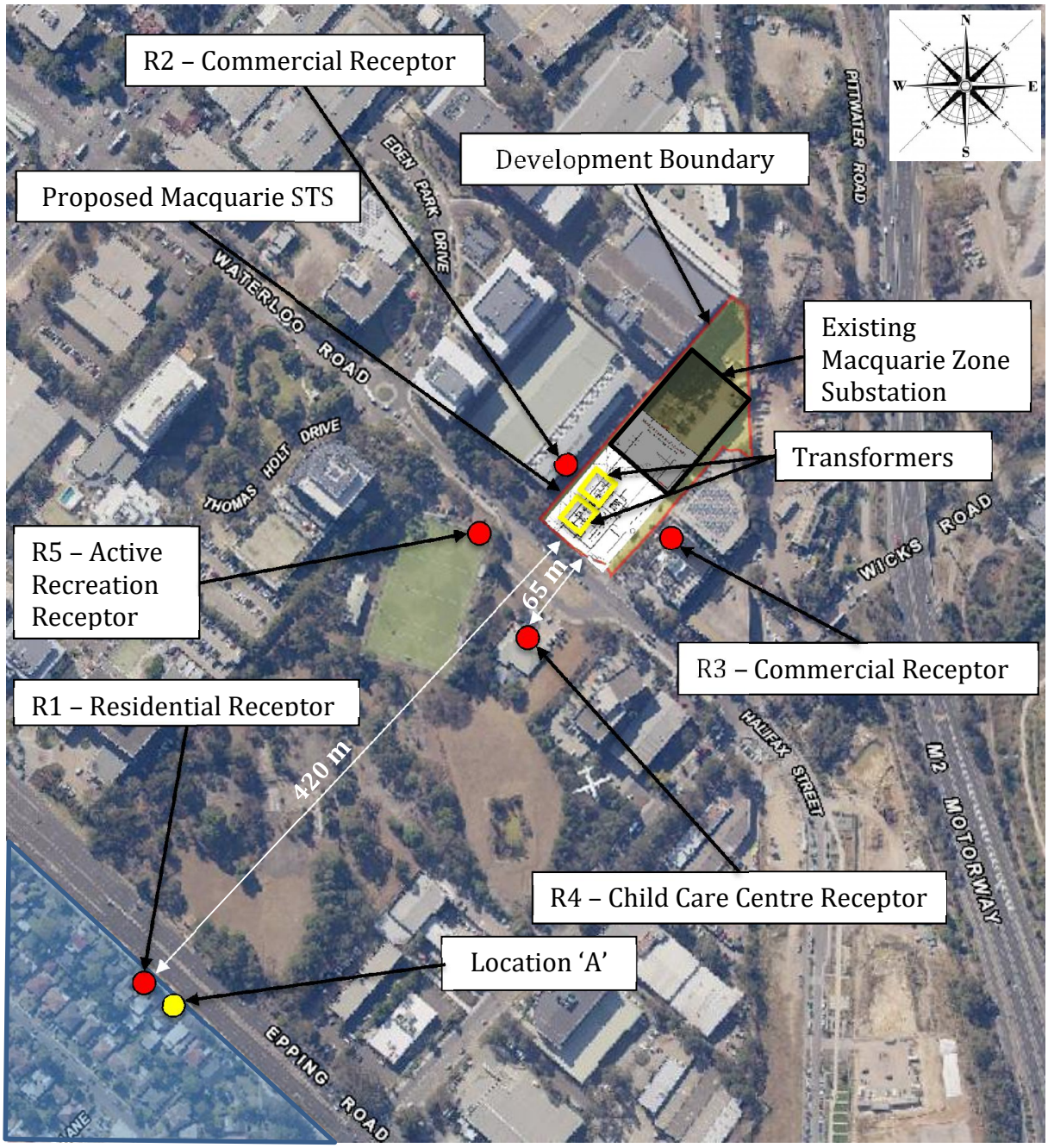


Figure 1 – Site Map, Macquarie STS

3.0 NOISE SURVEY INSTRUMENTATION

Noise level measurements and analysis were made with instrumentation as follows in Table 2:

Table 2 Noise Instrumentation

Description	Model No.	Serial No.
Infobyte Noise Logger (Type 1)	iM4	120
Condenser Microphone 0.5" diameter	MK 250	15361

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 Monitors iM4 #120 is a Type 1 precision environmental noise monitor meeting all the applicable requirements of AS1259 for an integrating-averaging sound level meters.

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 unattended measurements. No adjustments for instrument drift during the measurement period were warranted.

4.0 MEASURED AMBIENT NOISE LEVELS

In order to assess the severity of a possible environmental noise problem in a residential area it is necessary to measure the ambient background noise level at the times and locations of worst possible annoyance. The lower the background noise level, the more perceptible the intrusive noise becomes and the more potentially annoying.

The ambient L_{90} background noise level is a statistical measure of the sound pressure level that is exceeded for 90% of the measuring 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 times of operation.

The places with the greatest potential to be affected by noise annoyance are the nearest residential, commercial, private recreation and child care premises shown in Figure 1 above. The times of worst annoyance will be during the night for residences and non-peak hour operating times for the remaining premises, typically when ambient noise is at its lowest.

A noise logger was placed at 78 Epping Road, North Ryde from 1 November 2018 to 12 November 2018 to determine the Rating Background Level for the nearest effected residences. This location is shown on Figure 1 as Location 'A'.

The measured noise levels are presented in the attached Appendix A and also in Table 3 below.

Table 3 Rating Background Level

Noise Measurement Location	Time Period	Rating Background Level	Existing L_{eq} Level
Location 'A' – 78 Epping Road, North Ryde	Day (7 am to 6 pm)	**56 dBA**	**68 dBA**
	Evening (6 pm to 10 pm)	**55 dBA**	**67 dBA**
	Night (10 pm to 7 am)	**42 dBA**	**64 dBA**

Meteorological conditions during the testing typically consisted of clear skies with temperature of 11 to 37°C. Atmospheric conditions were ideal for noise monitoring. Noise measurements were therefore considered reliable and typical for the receptor area. Rain affected data has been removed from the assessment period.

The ambient noise survey at Location 'A' is attached as Appendix A.

5.0 ACCEPTABLE NOISE LEVELS

5.1 NSW Industrial Noise Policy

The Environment Protection Authority (EPA) published their NSW Noise Policy for Industry (NPI) in October 2017. The NPI is specifically aimed at assessing noise from industrial noise sources scheduled under the Protection of the Environment Operations Act 1997 (POEO, 1997).

The Macquarie STS is not a 'scheduled premises' under the Protection of the Environment Operations Act 1997 as it is not required to hold a licence under that Act for operations at the site. However, the NPI provides a useful framework to assess noise emission from non-scheduled premises, whether that premises produces intrusive or non-intrusive noise.

While the NPI is not strictly applicable to this site, as the site is not scheduled, in the absence of other relevant standards the limits set out in the NPI will be used as a guide in determining whether the level of noise is considered intrusive or not.

5.2 Residential Receptor Intrusiveness Criteria

The EPA states in Section 2.3 of the NPI that the L_{eq} level of noise intrusion from broad-band industrial noise sources may be up to 5 dB above the L_{90} background noise level at the receptor without being considered intrusive.

The L_{90} Rating Background Level at Location 'A' was 56 dBA during the day, 55 dBA during the evening and 42 dBA during the night.

Therefore the acceptable L_{eq} noise intrusiveness criteria in this area is:

- (56 + 5 =) **61 dBA** during the day.
- (55 + 5 =) **60 dBA** during the evening.
- (42 + 5 =) **47 dBA** at night.

5.3 Residential Amenity Criterion

Depending on the type of area in which the noise is being made, there is a certain reasonable expectancy for noise amenity. Table 4 below is based on Table 2.2 in the NPI. It provides a schedule of recommended L_{eq} industrial noise levels that under normal circumstances should not be exceeded. If successive developments occur near a residential area, each one allowing a criterion of background noise level plus 5 dB, the ambient noise level will gradually creep higher.

Table 4 Amenity Criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Acceptable Recommended L_{eq} Noise Level, dBA
Residence	Suburban	Day	60
		Evening	50
		Night	45
Commercial premises	All	When in use	65
Active Recreation	All	When in use	55
School classroom – Internal	All	Noisiest 1-hour period when in use	35

The project amenity noise level for industrial developments is equal to the recommended amenity noise levels given in Table 4 minus 5 dB.

The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the project amenity noise level. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardise the time periods for the intrusiveness and amenity noise levels, the *NPI* assumes that the $\mathbf{L_{Aeq,15min}}$ will be taken to be equal to the $\mathbf{L_{Aeq,\,period}}$ **+ 3 decibels (dB)**.

Compliance with the amenity criteria will limit ambient noise creep. Wherever the existing L_{eq} noise level from industrial noise sources approaches or exceeds the amenity criteria at a critical receptor location, the intrusive L_{eq} noise from the noise source in question must be reduced to a level that may be as much as 10 dB below the existing L_{eq} industrial noise level.

Additionally, for cases where the level of road traffic noise is high enough to make noise from an industrial source effectively inaudible, the project amenity noise level may be derived from the $\mathbf{L_{Aeq,\,period\,(traffic)}}$ **- 15 decibels (dB)**.

The high traffic project amenity noise level only applies if traffic noise is identified as the dominant noise source at the site, the existing traffic noise level measured is 10 dB or more above the recommended amenity noise level and traffic noise is highly unlikely to decrease in the future.

The L_{Aeq} Noise Level at Location 'A' was 68 dBA during the day, 67 dBA during the evening and 64 dBA during the night. With all the above information considered the residential amenity criterion is given by the following:

- (60 – 5 + 3 =) **58 dBA** during the day.
- (67 – 15 + 3 =) **55 dBA** during the evening.
- (64 – 15 + 3 =) **52 dBA** at night.

5.4 Commercial Receptor Amenity Criterion

The allowable L_{eq} intrusive level at nearby noise sensitive locations on commercial premises is (65 -5 + 3 =) **63 dBA** as derived from Table 4 above.

5.5 Active Recreation Amenity Criterion

The allowable L_{eq} intrusive level at nearby noise sensitive locations on active recreational areas is (55 -5 + 3 =) **53 dBA** as derived from Table 4 above.

5.6 Child Care Centre Amenity Criterion

The allowable L_{eq} intrusive level at nearby noise sensitive locations at school classroom premises is (35 -5 +3 =) **33 dBA** in indoor areas and (55 -5 + 3 =) **53 dBA** in outdoor areas as derived from Table 4 above.

5.7 Modifying Factors

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level.

Fact Sheet C of the NPI provides modifying factor corrections to account for the additional annoyance where applicable. The modifying factor corrections are to be applied to the measured or predicted source noise level, at the receiver location, prior to comparison with the project specific noise criterion detailed above.

The modifying factor corrections from Fact Sheet C of the NPI are applied only to external measurements or predicted noise levels.

Where a complaint is made regarding transformer noise, the character of the intrusive noise typically contains tonal components and significant low frequency content. The relevant section of Table C1 and C2 of Fact Sheet C, regarding tonality and low frequency noise, is reproduced in Tables 5 to 7.

Table 5 NSW Noise Policy for Industry – Table C1: Modifying Factor Corrections

Factor	Assessment/ Measurement	When To Apply	Correction[1]	Comments
Tonal Noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: · 5dB or more if the centre frequency of the band containing the tone is in the range 500Hz-10kHz · 8dB or more if the centre frequency of the band containing the tone is in the range 160Hz-400Hz · 15dB or more if the centre frequency of the band containing the tone is in the range 25Hz-160Hz	5 dB	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. Note: Narrow-band analysis using the reference method in ISO1996:2:2007, Annex C, may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands

[1] *Corrections to be added to the measure or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.*

Table 6 NSW Noise Policy for Industry – Table C1: Modifying Factor Corrections

Factor	Assessment/ Measurement	When To Apply	Correction	Comments
Low Frequency Noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10-160Hz	Measure/assess source contribution C- and A-weighted Leq,T levels over same time period. Correction must be applied where the C minus A level is 15dB or more and: Where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5dB and cannot be mitigated a 2dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period Where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated/predicted A-weighted levels applies for the evening/night period and a 5dB(A) positive adjustment applies for the day time period.	2 or 5 dB[2]	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalanced spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.

Table 7 NSW Noise Policy for Industry – Table C2: One-third octave low-frequency noise thresholds

Hz/dB(Z)	One-third octave $L_{Zeq,\ 15\ min}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

2 Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range, that is, below 160Hz.

5.8 EPA Construction Noise Guideline

The NSW Environmental Protection Authority published the *Interim Construction Noise Guideline* in July 2009. The guideline has been developed to focus on applying a range of work practices most suited to minimise construction noise impacts, rather than focusing only on achieving numerical noise levels. 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.

Normal construction hours are defined by the EPA as follows:

- 7:00 am to 6:00 pm Monday to Friday
- 8:00 am to 1:00 pm Saturday, and
- No work on Sunday or Public Holidays.

The Guideline is designed to employ a series of work practices to minimise construction noise at nearby residential premises instead of setting specific noise goals. The Guideline presents to ways of assessing construction noise impacts; the quantitative method and the qualitative method.

Quantitative Assessment Method

The *Interim Construction Noise Guideline* details a quantitative method 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 noise levels provided for residences in Table 2 of the guideline, is extracted as Table 8 below.

Table 8 Noise at Residences using Quantitative Assessment

Time of day	Management level L_{Aeq} (15 min)	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. · Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level · The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise levels and duration, as well as contact details.

Table 8 Noise at Residences using Quantitative Assessment (con't)

Time of day	Management level L_{Aeq} (15 min)	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Highly noise affected 75 dB(A)	The highly affected noise level represents the point above which there may be a strong community reaction to noise. · Where the noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	· A strong justification would typically be required for works outside the recommended standard hours. · The proponent should apply all feasible and reasonable work practices to meet the noise affected level. · Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

The noise levels provided for non-residential land uses in Table 3 of the guideline, is extracted as Table 9 below.

Table 9 Noise at Non-residential Land Uses using Quantitative Assessment

Land Use	Management level L_{Aeq} (15 min)
Classrooms at schools and other educational institution	45 dBA (internal) 55 dBA (external)
Active recreation areas	65 dBA (external)
Commercial (offices, retail outlets)	70 dBA (external)

5.9 Qualitative Assessment Method

The Interim Construction Noise Guideline details a qualitative assessment method for construction noise that may be applied for short term construction works that are likely to affect nearby residential premises for less than 3 weeks. This method of assessment is simplified in a manner to identify potential noise sources and manage them through reasonable and feasible means.

5.10 EPA Vibration Guideline

The NSW Environmental Protection Authority 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 limits for Vibration Dose Values to assess intermittent vibration and is extracted in Table 10 below for residential receptor locations.

Table 10 Vibration Dose Values (VDV) from Construction Activities

Receptor Location	Preferred value ($m/s^{1.75}$)	Maximum value ($m/s^{1.75}$)
Residences – Day-time	0.20	0.40
– Night-time	0.13	0.26

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, extracted in Table 11 below for residential buildings. We recommend that the vibration level outside any nearby residential buildings not exceed these values from the construction activities.

Table 11 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	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

In our opinion, an overall peak particle velocity of **15 mm/s** at the boundaries will comply with the recommended values in Table 5 and is an acceptable criterion for intermittent vibration to prevent cosmetic damage to the adjacent buildings.

5.11 Project Specific Noise Criteria

When all the above factors are considered, we find that the most stringent noise criterion during operation of the substation is:

Operation

- **58 dBA for broadband noise sources** during the day,
- **55 dBA for broadband noise sources** in the evening,
- **47 dBA for broadband noise sources** at night.

In addition, the following criteria also apply at non-residential areas:

- **63 dBA at nearby commercial premises,**
- **53 dBA at nearby active recreation areas,**
- **33 dBA internally and 53 dBA externally at nearby child care premises.**

Construction

During construction of Macquarie STS we find the most stringent noise criterion is:

- At residences:
  - **66 dBA** for **broadband construction noise** during standard construction hours,
  - **61 dBA** for **broadband construction noise** during day-time, non-standard construction hours,
  - **60 dBA** for **broadband construction noise** during the evening,
  - **47 dBA** for **broadband construction noise** during the night.
- **70 dBA externally at nearby commercial premises,**
- **65 dBA externally at nearby active recreation areas,**
- **55 dBA externally at nearby child care premises.**

These criteria apply at the most-affected point on or within the property boundary. For upper floors, the noise is assessed outside the nearest window.

6.0 NOISE EMISSION DURING OPERATION

The main sources of noise from the proposed Macquarie Park Subtransmission Substation are the two 120MVA, 132kV/33kV/11kV transformers and two 200/75 kVA, 11kV/433V/240V auxiliary transformers that will operate continually throughout the day and night. The transformer noise level does not change appreciably from the day to the night and therefore the predicted noise level at night will be the worst-case scenario.

Fire blast walls of 8 m height are proposed on the north-east, south-east and south-west side of each main transformer as shown in Appendix B.

6.1 Measured Sound Power Levels

Ausgrid has proposed transformers with sound power level specifications from the manufacturer as follows:

- Main Transformers – maximum sound power level at 77 dBA, no load;
- Auxiliary Transformers – maximum sound power level of 55 dBA, no load.

Noise surveys have been carried out by Day Design at a number of Substations around Sydney, to determine the level and character of high voltage transformers. Manufacturer's data was also used to determine the overall sound power level of the proposed transformers.

Typical sound power level data has been used for the proposed transformers at no load. A schedule of the no load sound power levels are given in Table 12 below.

Table 12 Transformer L_{eq} Sound Power Levels

Description	**dBA**	**Sound Power Levels (dB) at Third Octave Band Centre Frequencies (Hz)**						
		50	100	200	400	800	1k6	3k15
		63	125	250	500	1k	2k	4k
		80	160	315	630	1k25	2k5	5k
Primary Transformer, 132/11kV, 120 MVA, (No load - Energised)	**77**	57	79	79	70	63	56	44
		52	61	71	66	60	54	39
		60	64	82	68	60	49	35
Auxiliary Transformer, 132/11kV, 45 MVA, (No load - Energised)	**55**	61	62	57	52	47	45	39
		58	54	53	48	46	43	38
		56	52	60	47	44	41	35

6.2 Predicted Noise Emission

Knowing the sound power level of a noise source (see Table 12 above), 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, sound barriers, etc.

Fire blast walls, of 8 m height, are proposed to be constructed on the north-east, south-east and south-west of each main transformer. This barrier has been included in the noise emission calculations. The location of the transformer bay and its proximity to the surrounding location is provided in drawings attached as Appendix B.

The calculated level of noise generated by the transformer substation at each receptor is shown in Table 13 below and graphically in Appendix C.

Table 13 Predicted L_{eq} Noise Levels at Nearby Receptors

Receptor Location	Predicted $L_{eq,\ 15\ minute}$ Noise Level, dBA (No Load - Full Load)	Acceptable Noise Level, dBA	Compliance (Yes/No)
R1 – Residential	**10-16**	**47 (night)**	**Yes**
R2 – Commercial	**50-56**	**63**	**Yes**
R3 – Commercial	**28-34**	**63**	**Yes**
R4 – Child Care Centre	**23-29**	**33 (Indoor)** **53 (Outdoor)**	**Yes**
R5 – Active Recreation	**25-31**	**53**	**Yes**

The predicted levels of noise for the proposed Macquarie STS will meet the noise criteria at all residential, commercial, child care and active recreation premises.

7.0 NOISE EMISSION DURING CONSTRUCTION

The construction of Macquarie STS will utilise various items of heavy vehicles associated with the construction and transportation of materials and equipment by large trucks.

The earthworks required will use a variety of heavy construction equipment, including a loader, excavator and trucks. The construction phase will also utilise concrete trucks and a crane.

Noise level data for the machinery to be used in this project was gathered from a number of sources, including previous projects and equipment manufacturer's technical specifications. Noise levels were then selected that were typical of the best available machinery in each category. Machinery should be chosen to comply with the noise levels shown below and should be well maintained and operated to comply with the Environment Protection Authority "best management practice" (BMP).

If the noise from any one item of equipment is suspected to be excessive, it is possible to check compliance with the above industry standards by measurement of the sound pressure level at a distance of approximately 7 metres in a free field. The measured sound pressure level at this distance should be approximately 25 dBA less than the sound power levels listed in Table 14.

Noise criteria and noise emission are always stated and measured in decibels of sound pressure level (L_p), which varies with distance (D) and weather conditions. Machinery noise ratings in this report are expressed in decibels of sound power level (L_w), which are absolute and independent of distance. If the sound power level is known, the sound pressure level at a distance (D) can be calculated by the formula: $L_p = L_w - 10\log(D) - 8$.

The various construction activities, including vehicles and equipment used during the construction of Macquarie STS are listed in Table 14 below. Table 14 also details the sound power level (dBA), predicted sound level at each receptor (dBA), acceptable noise level at each receptor, and a statement of compliance for each noise receptor.

Table 14 Construction L_{eq} Sound Power Levels and Predicted Noise Level at R1

Construction Activity	Sound Power Level, dBA	Predicted $L_{eq,\ 15\ minute}$ Noise Level, dBA	Acceptable Noise Level, dBA	Compliance (Yes/No)
Standard Construction Hours				
· Mobile Crane (20T)	110	53	66	Yes
· 20 to 30 Tonne Truck	105	48	66	Yes
· Excavator	100	43	66	Yes
· Generator	100	42	66	Yes
Non-Standard Construction Hours - Day				
· Mobile Crane (20T)	110	53	61	Yes
· 20 to 30 Tonne Truck	105	48	61	Yes
· Excavator	100	43	61	Yes
· Generator	100	42	61	Yes
Non-Standard Construction Hours - Evening				
· Mobile Crane (20T)	110	53	60	Yes
· 20 to 30 Tonne Truck	105	48	60	Yes
· Excavator	100	43	60	Yes
· Generator	100	42	60	Yes
Non-Standard Construction Hours - Night				
· Mobile Crane (20T)	110	**53**	47	**No**
· 20 to 30 Tonne Truck	105	48	47	Yes*
· Excavator	100	43	47	Yes
· Generator	100	42	47	Yes

* A predicted exceedance of up to 2 dBA is considered acceptable in accordance with the NSW Noise Policy for Industry, Chapter 4, Table 4.1 – Significance of residual noise impacts.

Table 15 Construction L_{eq} Sound Power Levels and Predicted Noise Level at R2

Construction Activity	Sound Power Level, dBA	Predicted $L_{eq, 15\ minute}$ Noise Level, dBA	Acceptable Noise Level, dBA	Compliance (Yes/No)
· Mobile Crane (20T)	110	70	70	Yes
· 20 to 30 Tonne Truck	105	65	70	Yes
· Excavator	100	60	70	Yes
· Generator	100	60	70	Yes

Table 16 Construction L_{eq} Sound Power Levels and Predicted Noise Level at R3

Construction Activity	Sound Power Level, dBA	Predicted $L_{eq, 15\ minute}$ Noise Level, dBA	Acceptable Noise Level, dBA	Compliance (Yes/No)
· Mobile Crane (20T)	110	71	70	Yes*
· 20 to 30 Tonne Truck	105	66	70	Yes
· Excavator	100	61	70	Yes
· Generator	100	61	70	Yes

Table 17 Construction L_{eq} Sound Power Levels and Predicted Noise Level at R4

Construction Activity	Sound Power Level, dBA	Predicted $L_{eq, 15\ minute}$ Noise Level, dBA	Acceptable Noise Level, dBA	Compliance (Yes/No)
· Mobile Crane (20T)	110	**69**	55	**No**
· 20 to 30 Tonne Truck	105	**64**	55	**No**
· Excavator	100	**59**	55	**No**
· Generator	100	**58**	55	**No**

* A predicted exceedance of up to 2 dBA is considered acceptable in accordance with the NSW Noise Policy for Industry, Chapter 4, Table 4.1 – Significance of residual noise impacts.

Table 18 Construction L_{eq} Sound Power Levels and Predicted Noise Level at R5

Construction Activity	Sound Power Level, dBA	Predicted $L_{eq,\ 15\ minute}$ Noise Level, dBA	Acceptable Noise Level, dBA	Compliance (Yes/No)
· Mobile Crane (20T)	110	**71**	65	**No**
· 20 to 30 Tonne Truck	105	**66**	65	**No**
· Excavator	100	61	65	Yes
· Generator	100	61	65	Yes

It is proposed to use a large crane (150-200 tonne) for the installation of the transformers. This will occur for only one day per transformer. The noise level during use of this crane is expected to be up to 10 dB higher than for the 20 tonne mobile crane used throughout construction. We recommend installation of the transformers be carried out during the hours recommended in Section 8.3.

8.0 NOISE CONTROL RECOMMENDATIONS

The predicted level of noise emission from the construction activities is in excess of the noise management levels established in Section 5.11 of this report. Therefore, we recommend the following noise controls to minimise the noise impact from all construction activities.

8.1 Temporary Sound Barriers

Temporary construction barriers should be erected on the north-western and south-western boundaries of the site throughout the duration of the construction of the Macquarie STS. The barriers may be 19 mm ply or a flexible construction barrier which may be fixed to standard construction fences. The height of the barriers should be minimum:

- 1.8 m on the south-western boundary, and
- 1.8 m on the north-western boundary.

Appendix B displays the location of each barrier on the site.

8.2 Acoustic Enclosures

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

8.3 Scheduled Use of the Crane

The use of the proposed mobile crane generally meets the noise level criteria set out in Section 5.10 during standard construction hours at Receptors R1 to R3. The predicted noise level at Receptors R4 and R5 exceed the noise criteria by up to 14 dB during the daytime.

Two options are provided to mitigate the noise impact.

- **Consult and notify** - Provide to the affected receptor at R4, ahead of time, the periods when the crane is scheduled to be used.
- **Operate crane outside of standard construction hours** – Scheduling all use of the crane outside of standard construction hours, but not at night, where possible will allow compliance to all nearby affected receptors. The recommended hours to operate the crane include:
    - Monday to Friday – 6 pm to 10 pm,
    - Saturday – 8 am to 10 pm, and
    - Sunday –8 am to 10 pm.

Provided the above recommendations are met the noise emissions from the construction of the Macquarie STS will be minimised in accordance with the NSW Environmental Protection Authority's requirements.

8.4 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

We recommend that noisy construction activities only operate for 2 to 3 hours at a time.

Work Practices

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

1. Avoid dropping materials from a height.
2. Avoid shouting and talking loudly outdoors.
3. Avoid the use of radios outdoors that can be heard at the boundary of residences.
4. Turn off equipment when not being used.

Heavy Vehicles and Staff Vehicles

1. 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).
2. 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.
3. Contractor parking areas should be located as far from residential receiver locations as practicable.

Community Relations

1. A Community Liaison Officer is to be appointed by the contractor prior to the commencement of any works;
2. The officer will approach all potentially affected residents prior to the commencement of any works as an initial introduction and provide his or her contact details;
3. The officer will 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;
4. A contact number will be provided for any residents to call with complaints or queries.

Once works commence, communication with the community should be maintained by the officer. Communication should be maintained via a range of media including, for example, continued individual contact, letter box drops or a clearly visible notice board at the site office or on construction site boundaries.

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

Managing a Noise Complaint

The Liaison Officer should receive and manage noise complaints.

All complaints should be treated promptly and with courtesy.

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

Where it is not practicable to stop the noise, or reduce the noise, a full explanation of the event taking place, the reason for the noise and times when it will stop should be given to the complainant.

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

1. Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
2. Give complaints a fair hearing.
3. Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
4. 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.
5. Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
6. Implement all feasible and reasonable measures to address the source of complaint.
7. 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.

8.5 Construction Disclaimer

Recommendations made in this report are intended to resolve acoustical problems only. We make no claims of expertise in other areas of building construction and therefore the recommended noise controls should be implemented into the building design in consultation with other specialists to ensure they meet the structural, fire or other aspects of construction.

We encourage clients to check with us before using materials or equipment that are alternative to those specified in our Acoustical Report.

9.0 CONCLUSION

The level of noise emitted by two 120MVA, 132kV/33kV/11kV transformers and two 200/75 kVA, 11kV/433V/240V auxiliary transformer proposed to be located at Macquarie STS, 17 - 21 Waterloo Road, Macquarie Park, NSW has been assessed at all residential, commercial, child care and active recreational locations.

The predicted noise levels from the proposed transformers at the new Macquarie STS will meet the noise criteria set out in NSW NPI at all nearby receptor locations provided that the transformer bays are constructed as detailed in Appendix B.

Provided the recommendations made in Section 8 of this report are implemented, the level of noise from the construction works for the installation of the Macquarie STS will be minimized in accordance with the NSW Environmental Protection Authority's requirements as detailed in Section 5 of this Report

Stephen Gauld, BE (Mechanical), MEngSc (Noise and Vibration), MIEAust, MAAS
Principal Acoustical Consultant
for and on behalf of Day Design Pty Ltd

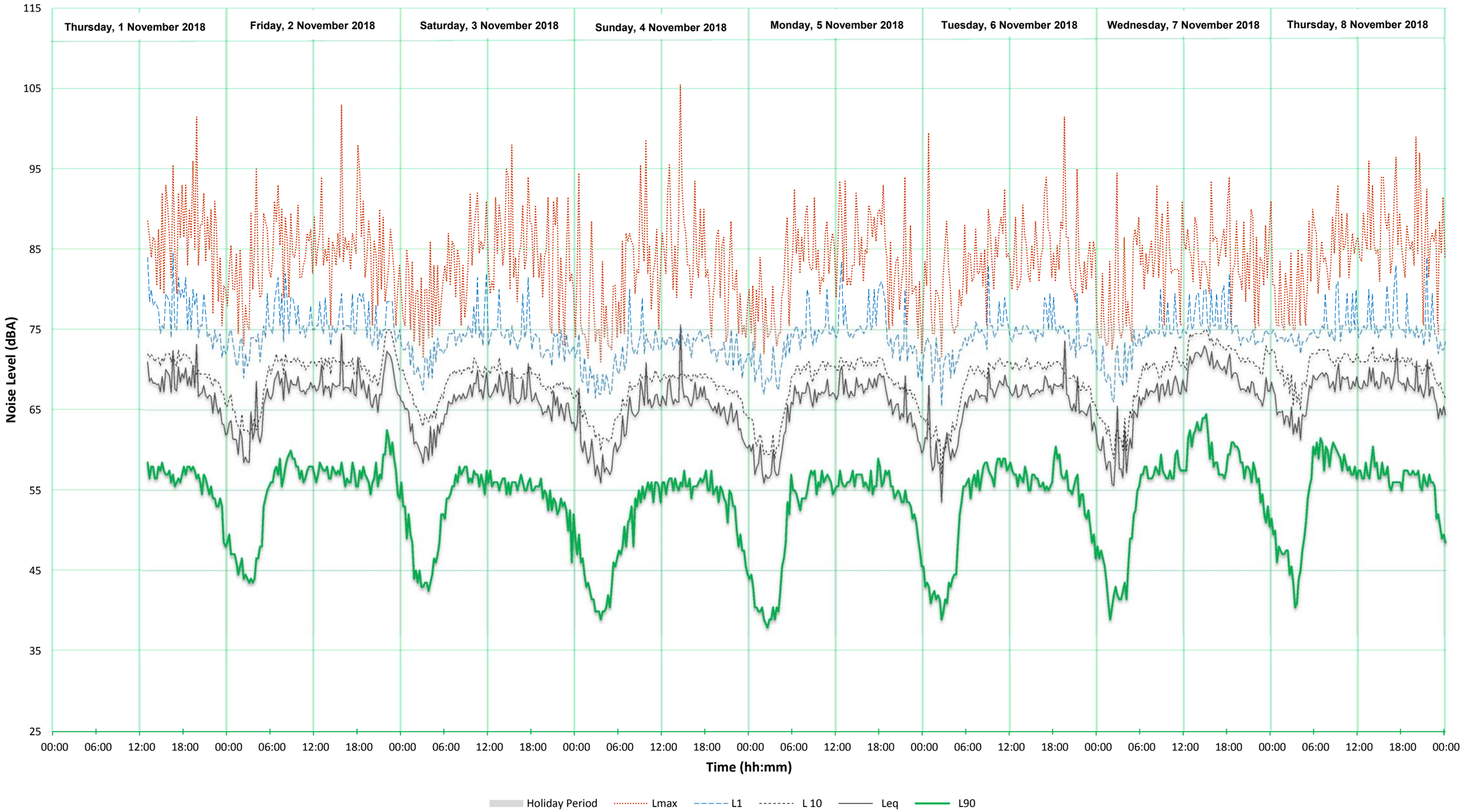
AAAC MEMBERSHIP

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.

Attachments:

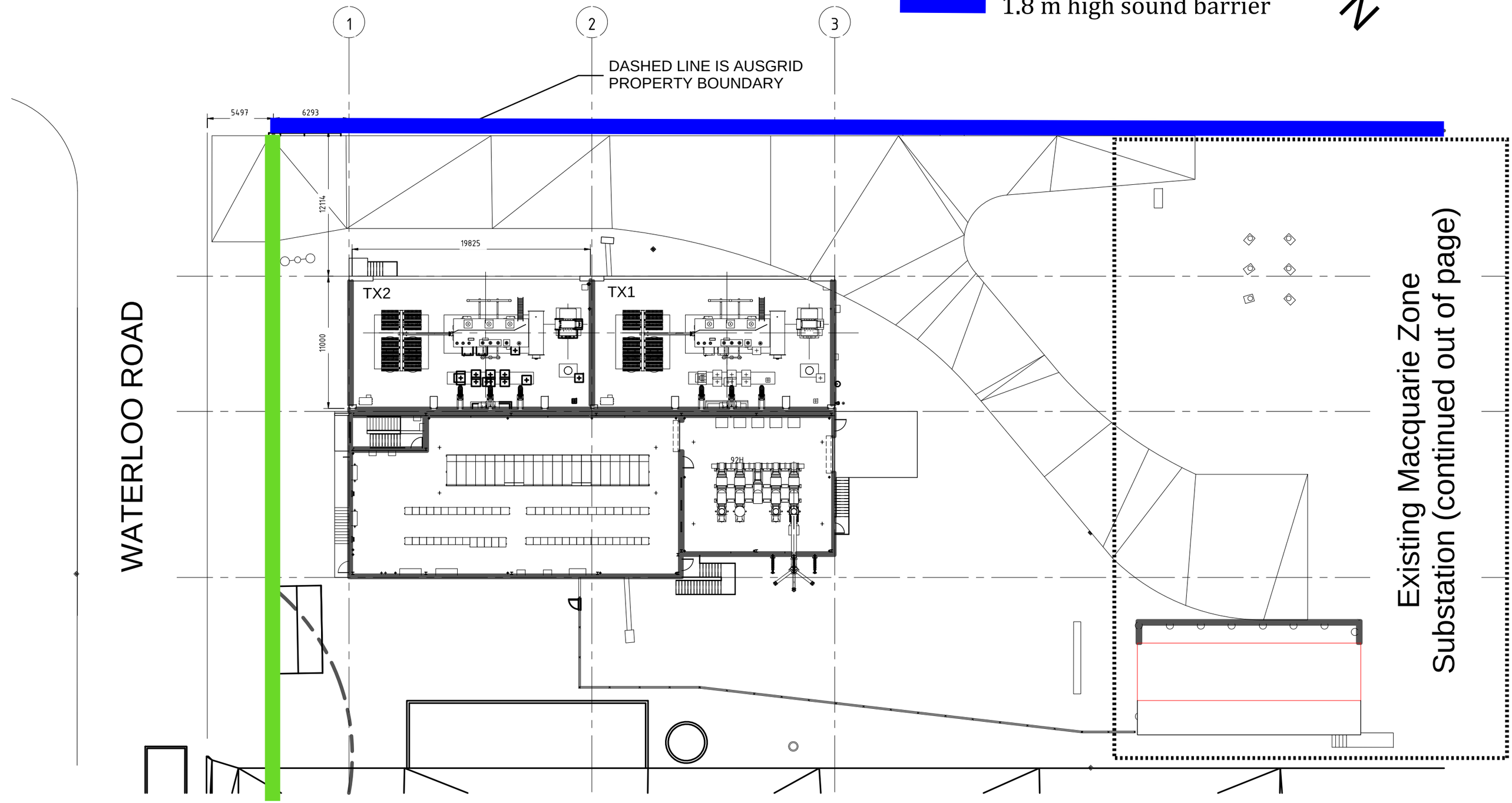
- Appendix A – Ambient Noise Survey
- Appendix B – Site Layout
- Appendix C – Operational Noise Contours
- AC108-1 to 4 – Glossary of Acoustical Terms

Located at 78 Epping Road, Macquarie Park, NSW



Attachment B: Proposed 132/33 kV Subtransisission Substation, Macquarie STS, Site Layout

1.8 m high sound barrier
1.8 m high sound barrier



WORK IN PROGRESS
FOR INFORMATION

Macquarie Park Subtransmission Substation

Noise Level Prediction Contour Map

Appendix C

Noise levels dB(A)

	< 10
10 <=	< 15
15 <=	< 20
20 <=	< 25
25 <=	< 30
30 <=	< 35
35 <=	< 40
40 <=	< 45
45 <=	< 50
50 <=	< 55
55 <=	< 60
60 <=	< 65
65 <=	< 70
70 <=	

Signs and symbols

- Point source
- Plane source
- Residential Building
- Industrial Building
- Noise Barrier Wall

Date: 30 Nov 18

Length Scale 1:2500

0 12.525 50 75 100 m

DAY DESIGN PTY LTD
Suite 17, 808 Forest Road
Peakhurst Sydney NSW 2210
Phone: (02) 9046 3800