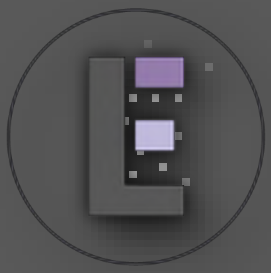

Forest High School

Construction Noise and Vibration Management Sub-Plan

Project No.	P00757
Revision	003
Issued	10 October 2023
Client	ADCO Constructions

E-LAB Consulting

Where science and engineering inspire design.

Document QA and Revisions

ISSUE	DATE	COMMENTS	ENGINEER	REVIEWER
1	08/09/2023	Issue	Teresa D Nguyen	Brandon Notaras
2	25/09/2023	Issue	Teresa D Nguyen	Brandon Notaras
3	06/10/2023	Issue	Teresa D Nguyen	Brandon Notaras
4				

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Authorised by:

E-LAB Consulting

Brandon Notaras | Director

Acoustics & Vibration

Table of Content

1 INTRODUCTION

This Construction Noise and Vibration Management Sub-Plan has been prepared for the Forest High School (the site).

Prior to the commencement of construction of the development, a Construction Noise and Vibration Management Sub-Plan (CNVMSP) is to be prepared to satisfy Development Consent conditions. This CNVMSP has been prepared to address all phases of construction.

This Construction Noise and Vibration Management Plan provides:

- Criteria for the noise and vibration generated during construction
- A quantitative assessment of the airborne and ground-borne noise generated by the work for the proposed development and its impact on nearby receivers
- Strategies to mitigate the noise and vibration generated during the construction works phases
- Complaints handling and community liaison procedures

This assessment discusses the predicted impact of the construction noise and vibration generated by the construction equipment on the nearest most-affected receivers.

This report has been prepared with the following references:

- Noise and Vibration Impact Assessment Report (SSDA Acoustic Report) prepared by Resonate dated 28 October 2022
- Noise and Vibration Impact Assessment Report (SSDA Acoustic Report) prepared by Resonate dated 10 March 2023
- Noise and Vibration Impact Assessment Response to Submissions document prepared by Resonate dated 14 February 2023
- SSD Addendum – Assessment of construction noise and vibration impacts on Arranounbai School letter prepared by Resonate dated 28 April 2023
- Interim Construction Noise Guideline (ICNG), NSW DECC, 2009
- Construction Noise Strategy, Transport for NSW, 2013
- Noise Policy for Industry (NPI), NSW EPA, 2017
- Assessing Vibration: A Technical Guideline, NSW DEC, 2006
- AS 2436:2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*
- British Standard BS 5228: Part 1:1997 *Noise and Vibration Control on Construction and Open Sites*
- British Standard BS 7358:1993 *Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground-borne Vibration*
- German Standard DIN 4150-Part 3 *Structural vibration in buildings – Effects on structures*

This document has been specifically prepared to address Condition B17 of the Development Consent. A summary of the Condition B17 and where all components of this condition are addressed within this report is provided in Table 1.

Table 1: Condition B17 – Location where parts of condition are addressed

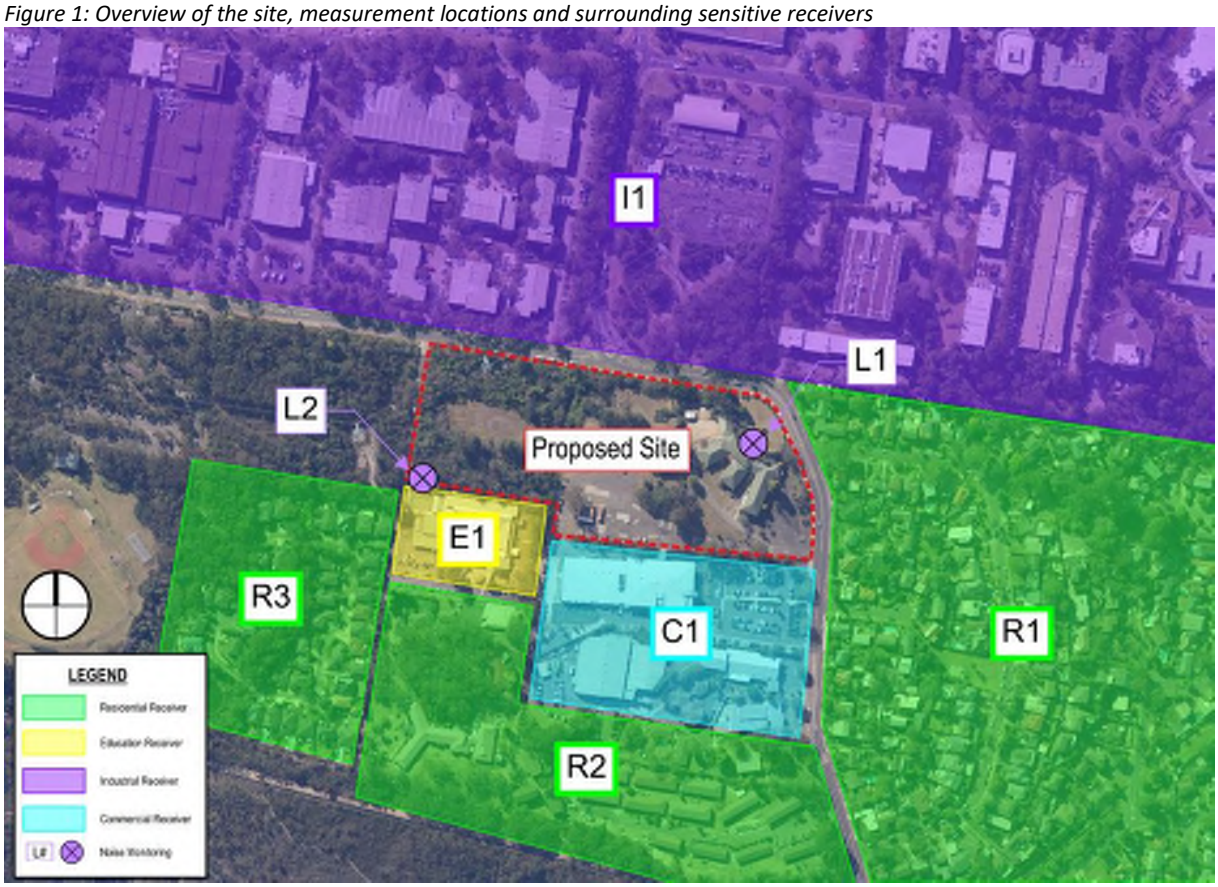
CONDITION B17, PART	SECTION IN THIS REPORT	PAGE IN THIS REPORT
(a) be prepared by a suitably qualified and experienced noise expert;	Brandon Notaras is a Director of the company and an experienced Acoustic Engineer. Brandon has a BEng (Mechanical) and is a member of the Australian Acoustical Society. Teresa D Nguyen is also an experienced Acoustic Engineer, with a BEng (Mechanical) and is a member of the Australian Acoustical Society. The CV's of both Brandon Notaras and Teresa D Nguyen are provided in Appendix B.	
(b) describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);	Section 4	5
(c) describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;	Section 7	15
(d) include strategies that have been developed with the community for managing high noise generating works;	Section 7	15
(e) will include a process for unattended noise monitoring along the northern boundary of the Arranounbai School (i.e. boundary of the formal and informal play areas along the length of the boundary) during the construction works including process for monthly review by the PCG and acute review in the occasion of a complaint;	Section 7.4	23
(f) describe the community consultation undertaken to develop the strategies in condition B17 (d);	Section 7.3	21
(g) include a complaints management system that would be implemented for the duration of the construction; and	Section 7.3	21
(h) include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the management measures in accordance with condition B13.	Section 7.4	23

2 PROJECT DESCRIPTION

2.1 SITE DESCRIPTION AND NOISE & VIBRATION SENSITIVE RECEIVERS

For the purposes of this construction noise and vibration management plan, the site location, measurement positions and surrounding noise and vibration sensitive receivers are shown in Figure 1.

Figure 1: Overview of the site, measurement locations and surrounding sensitive receivers



3 BACKGROUND AND AMBIENT NOISE MONITORING

Long term noise monitoring was previously undertaken for the project site within the SSDA Acoustic Report dated October 2022 (document reference: The Forest High School - Noise and vibration impact assessment Reference S210867RP1 Revision D by Resonate.

Noise monitoring was undertaken at locations shown in Figure 1 to measure the background and ambient noise that is representative of the surrounding noise and vibration sensitive receivers. The noise survey results have been extrapolated from the SSDA Acoustic Report in Table 2 for reference.

Table 2: Summary of long-term background noise monitoring (from SSDA Acoustic Report)

LOCATION	EQUIVALENT CONTINUOUS NOISE LEVEL $L_{Aeq,period}$, dB(A)			BACKGROUND NOISE LEVEL RBL, dB(A)		
	DAY	EVENING	NIGHT	DAY	EVENING	NIGHT
L1	54	54	48	45	41	43
L2	51	45	44	37	32	30

4 PROJECT NOISE AND VIBRATION CRITERIA

4.1 CONSTRUCTION NOISE CRITERIA

The *Interim Construction Noise Guideline* (ICNG) by NSW DECC recommends the following standard hours of construction:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and public holidays: no work

In this report, it is assumed that all works are performed during these standard hours.

Airborne Noise – Residential Receivers

The airborne noise criteria for surrounding residential receivers have been extracted from Table 2 in the ICNG and is presented in Table 3 below.

Table 3: NSW ICNG construction noise criteria for surrounding residential receivers

TIME OF DAY	MANAGEMENT LEVEL, $L_{Aeq,15min}$[1]	HOW TO APPLY
Recommended Standard Hours: Monday – Friday 7am – 6pm Saturday 8am – 1pm No work on Sundays or public holidays	Noise Affected RBL + 10dB	The noise-affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured **$L_{Aeq,15min}$** 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 residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. ▪ Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: – Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) – If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	▪ The proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. ▪ For guidance on negotiating agreements see section 7.2.2 (of ICNG).

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Airborne Noise – Non-Residential Receivers

Table 4 below (extracted from Section 4.1.2 and 4.1.3 of the ICNG) sets out the noise management levels for other land uses. The external noise levels should be assessed at the most affected occupied point for commercial and industrial uses, and at the most affected point within 50 metres of the area boundary for parks.

Table 4: NSW ICNG construction noise criteria for surrounding commercial receivers

RECEIVER TYPE	MANAGEMENT LEVEL (APPLIES WHEN PROPERTIES ARE BEING USED) $L_{Aeq,15min}$, dB(A)
Commercial	70
Industrial	75
Education	45 (Internal) 55 (External)

Based on the criteria in the tables above, the following noise management levels in Table 5 should be applied to the residential and non-residential receivers as identified in Figure 1 when appropriate. Construction during standard hours has been assumed.

Table 5: Project Specific Construction Noise Management Levels

LAND USE	RECEIVER	NOISE MANAGEMENT LEVEL, $L_{Aeq,15min}$	HIGHLY NOISE AFFECTED LEVEL $L_{Aeq,15min}$
Residential	R1	45 dB(A) + 10 dB = 55 dB(A)	75 dB(A)
Residential	R2	37 dB(A) + 10 dB = 47 dB(A)	75 dB(A)
Residential	R3	37 dB(A) + 10 dB = 47 dB(A)	75 dB(A)
Commercial	C1	70 dB	75 dB(A)
Industrial	I1	75 dB	75 dB(A)
Education	E1	45 (Internal) 55 (External)	75 dB(A)

4.2 CONSTRUCTION VIBRATION CRITERIA

4.2.1 Human Comfort

The office of Environment and Heritage (OEH) developed a document, "Assessing vibration: A technical guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels from construction and operation of a development within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

Continuous and Impulsive Vibration

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 6. It should be noted that the human comfort for vibration is more stringent than the building damage criteria.

Table 6: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz

LOCATION	ASSESSMENT PERIOD[1]	PREFERRED VALUES		MAXIMUM VALUES	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night time	0.020	0.014	0.040	0.028
Workshops	Day- or night time	0.04	0.029	0.080	0.058
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night time	0.64	0.46	1.28	0.92
Workshops	Day- or night time	0.64	0.46	1.28	0.92

Note 1: Daytime is 7:00am to 10:00pm and night time is 10:00pm to 7:00am

Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 7: Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

LOCATION	DAYTIME[1]		NIGHT-TIME[1]	
	PREFERRED VALUE	MAXIMUM VALUE	PREFERRED VALUE	MAXIMUM VALUE
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Note 1: Daytime is 7:00am to 10:00pm and night time is 10:00pm to 7:00am

4.2.2 Cosmetic Damage

Structural vibration thresholds are set to minimise the risk of cosmetic surface cracks and lie below the levels that have the potential to cause damage to the main structure. Table 8 presents guide values for building vibration, based on the vibration thresholds above which cosmetic damage has been demonstrated outlined within BS7385-Part 2:1993. These values are evaluated to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as 95% probability of no effect.

Table 8: Transient vibration guide values for cosmetic damage – BS 7385-2:1993

TYPE OF BUILDING	PEAK PARTICLE VELOCITY IN FREQUENCY RANGE OF PREDOMINANT PULSE (PPV)	
	4 Hz TO 15 Hz	15 Hz AND ABOVE
Reinforced or framed structures Industrial or light commercial type buildings	50mm/s	N/A
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s	20mm/s (50mm/s at 40Hz and above)

4.2.3 Structural Damage

Ground vibration criteria is defined in terms of the levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most specified structural vibration levels are defined to minimise the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings". Table 9 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 9: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration – DIN4150-3

LINE	TYPE OF STRUCTURE	VIBRATION VELOCITY, V_i, IN mm/s			
		FOUNDATION			PLANE OF FLOOR OF UPPERMOST FULL STOREY
		AT A FREQUENCY OF			
		LESS THAN 10HZ	10 TO 50HZ	50 TO 100HZ*	ALL FREQUENCIES
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

5 CONSTRUCTION NOISE ASSESSMENT

5.1 CONSTRUCTION ACTIVITIES AND HOURS

In this assessment, the noise impact from all construction works are considered. The works will consist of the following stages:

- Civil works: excavation and foundation of basement of overall site
- Structural works: construction of the new structure including roof and façade

The hours of work are expected to occur during standard daytime hours, as follows:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sunday and public holidays: no work

5.2 EXPECTED CONSTRUCTION EQUIPMENT

The noise sources likely to be associated with the works listed are presented in Table 10. The equipment noise levels have been extracted from AS2436:2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites" and the "Construction Noise Strategy, Transport for NSW, 2013". These equipment noise levels are provided as sound power levels (in-line with the documents referenced above) and are the estimated sound power emitted by the equipment, which differs to the sound pressure level rated for equipment at a particular distance.

Table 10: Construction Equipment Noise Levels

STAGES	EQUIPMENT	SOUND POWER LEVEL dB(A)	USAGE IN 15 MINUTE PERIOD (MINS)	TIME CORRECTED SOUND POWER LEVEL dB(A) $L_{AEQ,\ 15MIN}$
Civil works – Excavation and foundation	Excavator breaker	115	6	111
	Excavator 30 tonne	110	6	106
	Bored piling rig	111	6	107
	Concrete pump	109	7.5	106
	Concrete Truck	108	7.5	105
	Generator	104	3	97
	Mobile crane	110	2.4	102
	General Truck	108	6	104
Structural works - Construction	Powered hand tool	102	7.5	99
	Mobile crane	110	2.4	102
	Generator	104	3	97
	General Truck	108	6	104

5.3 NOISE MODELLING AND ASSUMPTIONS

In order to assess the noise impact from the site during the various construction stages, a desktop noise model was prepared using commercial software SoundPLAN v9.0. The noise model represents the 'reasonable' worst case periods of construction activities, meaning that all the equipment of each stage is operating simultaneously during a 15-minute observation period.

The assumptions that were made within the assessment include the following:

- The predicted noise levels represent the worst-case scenario for each receiver
- The predicted noise levels at the receivers has been assessed at a height of 1.5m above ground level in accordance with the assessment procedures of the ICNG.
- The predicted noise levels at the nearby sensitive receivers have been assessed with the noise mitigation measures provided in Section 7.1 have been implemented. This includes an acoustic barrier option and no barrier option at the site boundary indicated in Appendix A.
- The predicted noise levels at the adjacent Arranounbai School have been assessed with a 5m high noise barrier to be installed by the builder.
- The noise levels have been assessed using neutral weather conditions.

5.4 PREDICTED NOISE LEVELS

The predicted noise levels have been presented in the following table have been assessed to the construction noise criteria established in Section 4.1.

Noise contour maps are provided in Appendix A for reference.

Table 11: Predicted noise levels – civil works: excavation and foundation

ID	RECEIVER TYPE	PREDICTED NOISE LEVEL RANGE, $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL EXCEEDANCE, dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	Residential	50 - 60	55	Up to 5	No
R2	Residential	40 - 45	47	No	No
R3	Residential	45 - 50	47	Up to 3	No
C1	Commercial	60 - 65	70	No	No
I1	Industrial	60 - 65	75	No	No
E1	Education	45 - 50	55	No	No

Table 12: Predicted noise levels – civil works: excavation and foundation (with barrier)

ID	RECEIVER TYPE	PREDICTED NOISE LEVEL RANGE, $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL EXCEEDANCE, dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	Residential	45 - 55	55	No	No
R2	Residential	40 - 45	47	No	No
R3	Residential	45 - 50	47	Up to 3	No
C1	Commercial	55 - 60	70	No	No
I1	Industrial	55 - 60	75	No	No
E1	Education	45 - 50	55	No	No

Table 13 Predicted noise levels – structural works: construction

ID	RECEIVER TYPE	PREDICTED NOISE LEVEL RANGE, $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL EXCEEDANCE, dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	Residential	45 - 50	55	No	No
R2	Residential	< 40	47	No	No
R3	Residential	40 - 45	47	No	No
C1	Commercial	55 -60	70	No	No
I1	Industrial	45 - 50	75	No	No
E1	Education	40 - 45	55	No	No

Table 14 Predicted noise levels – structural works: construction

ID	RECEIVER TYPE	PREDICTED NOISE LEVEL RANGE, $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL $L_{Aeq,15min}$ dB(A)	NOISE MANAGEMENT LEVEL EXCEEDANCE, dB	EXCEEDS HIGHLY NOISE AFFECTED LEVEL (YES/NO)
R1	Residential	45 - 50	55	No	No
R2	Residential	< 40	47	No	No
R3	Residential	< 40	47	No	No
C1	Commercial	50 - 55	70	No	No
I1	Industrial	45 - 50	75	No	No
E1	Education	40 - 45	55	No	No

6 CONSTRUCTION VIBRATION ASSESSMENT

It is expected that the excavation phases of the project to include vibration intensive activities. Activities and machinery that are considered vibration intensive include:

- Piling
- Rock breaking
- Rock sawing

Safe working distances for vibration intensive plant and are quoted for both "cosmetic" damage (in accordance with BS 7385) and human comfort (in accordance with Assessing Vibration – a technical guideline), have been provided, based on the Transport for NSW's "Construction Noise Strategy (2013)". The recommended safe working distances for each of the plant listed above are provided in Table 15.

Table 15: Recommended safe working distances for vibration intensive plant

ACTIVITY	SAFE WORKING DISTANCE (METRES)	
	COSMETIC DAMAGE (BS 7385)	HUMAN RESPONSE (OH&E VIBRATION GUIDELINE)
Piling	2m (nominal)	N/A
Rock Breaking	22m	73m
Rock Sawing	22m	73m

The approximate distances between sensitive receivers (as identified in Figure 1) to the project boundary where vibration intensive plant may be used during construction is provided in Table 16.

Table 16: Receiver distances from construction works

RECEIVER ID	MINIMUM DISTANCE FROM CONSTRUCTION WORKS
R1	28
R2	35
R3	150
C1	11
I1	35
E1	6

The nearest vibration sensitive receiver is the education receiver to the south of the site (E1 receiver as shown in Figure 1) located at approximately 6m from the site boundary.

Residential receivers are located beyond the required minimum safe working distance for cosmetic damage as provided in Table 15, therefore it is unlikely that these receivers will be impacted by vibration. Per the recommendations of the TfNSW CNVS, dilapidation/building condition surveys are not required to assess vibration induced cosmetic damage to surrounding sensitive receivers.

Attended vibration monitoring shall be conducted at the commencement of work in order to verify the safe working distances. If the levels are compliant with the vibration limits as listed in Section 4.2, then work may proceed based on the implementation of the measures detailed in this report. If there are exceedances, reasonable and feasible mitigation measures and additional vibration monitoring should be conducted. Measures to prevent cosmetic damage to surrounding structures are provided in Section 7.

7 NOISE & VIBRATION MANAGEMENT STRATEGIES

7.1 PROJECT SPECIFIC RECOMMENDATIONS

Project specific recommendations and required mitigation methods have been listed below within Section 7.1. For general noise and vibration mitigation and management measures, refer to Section 7.2 of this report.

7.1.1 Noise

The receivers which are considered as most affected is expected to be receivers with close proximity to the site, including:

- Residential Receiver R1

The following noise management strategies is to be implemented by the Builder:

- The use of a standard A-class hoarding of the following materials and construction will suffice to mitigate the impact of the highest predicted noise levels.
  - The A-class hoarding should be impervious of gaps and cracks which would compromise its performance
  - It should be comprised of acoustically suitable materials such as 17 mm plywood
  - Be a minimum of 2.4m high surrounding the site.

  The barrier shall reduce the noise levels experienced at the residential receivers directly adjacent to the project site. Locating site amenities towards the site boundaries further increases the shielding of construction noise.
- At least a one hour respite period, to be offered per day during the most intensive periods of hammering and rock breaking.
- Frequent and proactive communication with the residences to is also encouraged. More details regarding communication with the community can be found in Section 7.3.

7.1.2 Vibration

There may be exceedances of the human comfort criteria due to the proximity of works to the following receivers:

- Receiver Receiver R1 and R2
- Commercial C1
- Education Receiver E2

If vibration intensive activities (as described in Section 6) are to occur on the southern and east boundary, attended vibration measurements is to be conducted to determine if there is an exceedance of the vibration limits set out in Section 4.2.

Upon any exceedances in vibration levels, reasonable and feasible measures should be considered to lessen the impact, such as an alternative method of activity or using machinery with less capacity.

To further diminish the vibration impact, the one-hour respite period, required for noise mitigation shall also apply to vibration.

7.1.3 Arranounbai School Noise & Vibration

Arranounbai School is located approximate 14m south of Forest High School construction boundary. Given the proximity of Arranounbai School to the proposed Forest High school, specific noise and vibration mitigation measure are required to minimise the impacts to Arranounbai School. The noise and vibration mitigation and management measure include the following:

- The barrier is to be erected in location shown in Figure 2.
- 5m high barrier with a minimum acoustic performance of Rw 30. The barrier should be impervious of gaps and cracks which would compromise its performance.
- Respite periods should be implemented when students occupy the northern outdoor play area of the Arranounbai School during recess and lunch time periods
- Unattended noise monitoring along the northern boundary of the Arranounbai School to be carried out during all construction phases by the Contractor. A monthly report is to be provided by the Contractor to present the noise monitoring results recorded during that period and highlight any exceedances (if any)

Figure 2: Arranounbai Acoustic Barrier

7.2 GENERAL ACOUSTIC RECOMMENDATIONS FOR CONSTRUCTION

According to AS 2436 – 2010 "Guide to noise and vibration control on construction, demolition and maintenance sites" the following techniques could be applied to minimise the spread of noise and vibrations to the potential receivers.

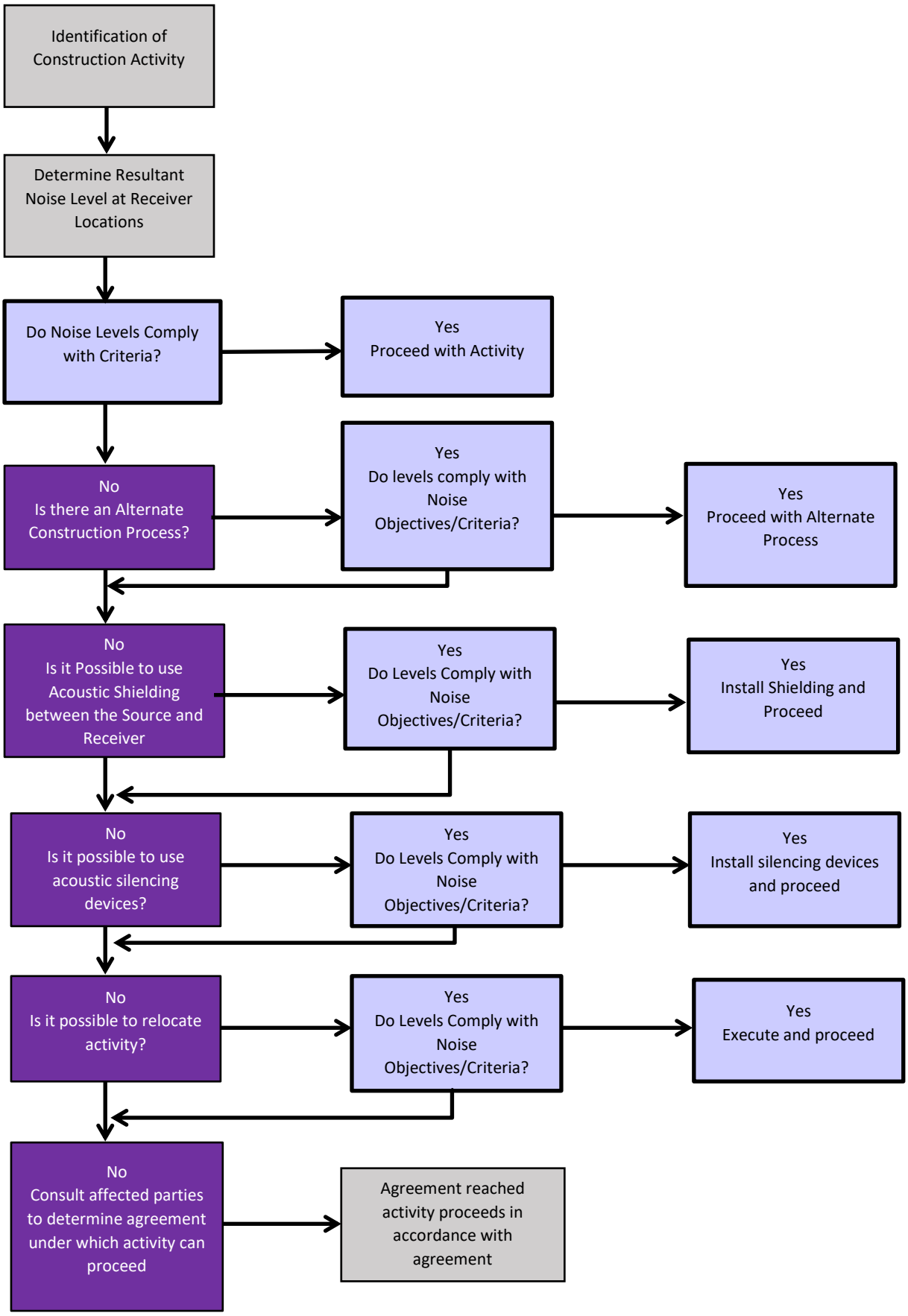
7.2.1 Noise

Figure 3 demonstrates the preferred order of actions taken to mitigate excessive construction noise emissions. If a process that generates significant noise levels cannot be avoided, the amount of noise reaching the receiver should be minimised. Two ways of achieving this are to either increase the distance between the noise source and the receiver or to introduce noise reduction measures such as screens. Practices that will reduce noise from the site include:

- Increasing the distance between noise sources and sensitive receivers.
- Reducing the line-of-sight noise transmission to residences or other sensitive land uses using temporary barriers (stockpiles, shipping containers and site office transportables can be effective barriers).
- Constructing barriers that are part of the project design early in the project to introduce the mitigation of site noise.
- Installing purpose-built noise barriers, acoustic sheds and enclosures.

Physical methods to reduce the transmission of noise between the site works and residences, or other sensitive land uses, are generally suited to works where there is longer-term exposure to the noise. A few of these methods have been introduced below.

Figure 3: Noise mitigation management flow chart



Screening

On sites where distance is limited, screening of noise may be beneficial or even the only way to reduce construction noise impacts on the nearby receivers. Below, screening options for various situations have been introduced. Constructing and utilising these screening methods should be taken into account already during the planning stages.

Temporary buildings: One option to introduce screening is to position structures such as stores, storage piles, site offices and other temporary buildings between the noisiest part of the site and the nearest dwellings. Due to shielding provided by these buildings, some of the noise emission from the site can be reduced. If the buildings are occupied, however, sound insulation measures may be necessary to protect site workers inside the buildings.

Hoarding: Another way of implementing screening is to build hoarding that includes a site office on an elevated structure. This option offers superior noise reduction when compared with a standard, simple hoarding. The acoustic performance is further enhanced when the hoarding is a continuous barrier.

Equipment operating 24h: When it comes to water pumps, fans and other plant equipment that operate on a 24-hour basis, they may not be an irritating source of noise during the day but can be problematic at night. They should therefore be effectively screened by either situating them behind a noise barrier or by being positioned in a trench or a hollow in the ground. Again, generated reverberant noise must be minimised and adequate ventilation should be ensured.

General remarks:

In many cases, it is not practical to screen earthmoving operations effectively, but it may be possible to partially shield a construction plant at the early stages of the project with protective features required to screen traffic noise.

The usefulness of a noise barrier will depend upon its length, its height, its position relative to the source and the receiver, and the material of which it is made. A barrier designed to reduce noise from a moving source should extend beyond the last property to be protected by at least ten times the shortest distance from the said property to the barrier. A barrier designed to reduce noise from a stationary source should, where possible, extend beyond the direct line of sight between the noise source and the receiver by a distance equal to ten times the effective barrier height, which is the height above the direct line between source and receiver.

If the works are already predominantly located within nominally closed structures, careful consideration should be given to reducing noise breakout at any openings.

Cranes

For the early works construction phases, any cranage will be limited to mobile cranes where the engines are typically enclosed in an acoustically treated housing.

Reversing and warning alarms

Community complaints often involve the intrusive noise of alarms commonly used to provide a safe system of work for vehicles operating on a site. Beeper reversing alarm noise is generally tonal and may cause annoyance at significant distances from the work site.

There are alternative warning alarms capable of providing a safe system of work that are equal to or better than the traditional “beeper”, while also reducing environmental noise impacts. The following alternatives should be considered for use on construction sites as appropriate:

- Broadband audible alarms incorporating a wide range of sound frequencies (as opposed to the tonal-frequency ‘beep’) are less intrusive when heard in the neighbourhood.
- Variable-level alarms reduce the emitted noise levels by detecting the background noise level and adjusting the alarm level accordingly.

- Proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.
- Spotters or observers.

The above methods should be combined, where appropriate.

7.2.2 Vibration

Vibration can be more difficult to control than noise, and there are few generalizations that can be made about its control. It should be kept in mind that vibration may cause disturbance by causing structures to vibrate and radiate noise in addition to perceptible movement. Impulsive vibration can, in some cases, provide a trigger mechanism that could result in the failure of building components that had previously been in a stable state.

During the demolition works and the erection of new structures, some vibrations (transmitted through the structure from the demolition sites) are expected, being more of a concern for the surrounding sensitive receivers. Vibrations can also trigger annoyance, which might get elevated into action by occupants of exposed buildings, and should therefore be included in the planning of communication with impacted communities.

It should be remembered that failures, sometimes catastrophic, can occur as a result of conditions not directly connected with the transmission of vibrations, e.g. the removal of supports from retaining structures to facilitate site access. BS 7385-2 provides more information on managing ground-borne vibration and its potential effects on buildings. Where site activities may affect existing structures, a thorough engineering appraisal should be made at the planning stage.

General principles of seeking minimal vibration at receiving structures should be followed in the first instance. Predictions of vibration levels likely to occur at sensitive receivers are recommended when they are relatively close, depending on the magnitude of the source of the vibration or the distance associated. Relatively simple prediction methods are available in textbooks, codes of practice and standards, however, it is preferable to assess site transmission and propagation characteristics between source and receiver locations through measurements.

Guidance for measures available for the mitigation of vibration transmitted can be sought in more detailed standards, such as BS 5228-2 or policy documents, such as the NSW DEC *Assessing Vibration: A technical guideline*. Identifying the strategy best suited to the control of vibration follows a similar approach to that of noise: avoidance, control at the source, control along the propagation path, control at the receiver, or a combination of these. It is noted that vibration sources can include stationary plants (pumps and compressors), portable plants (jackhammers and pavement vibrators), mobile plants, pile-drivers, tunnelling machines and activities, and blasting, amongst others. Unusual ground conditions, such as a high water-table, can also cause a difference to expected or predicted results, especially when considering the noise propagated from piling.

7.3 COMPLAINT HANDLING PROCEDURES AND COMMUNITY LIAISON

7.3.1 Community Consultation to be Undertaken

The builder shall directly contact adjacent noise sensitive receivers and provide them with the following information:

- The contact details for a nominated representative in order to make noise / vibration complaints
- Explain the timeframe for the construction works and the proposed activities, i.e. the proposed start / stop dates of work and a description of the noise producing equipment that will be used
- Notify the noise sensitive receivers and relevant local / state authority in a timely manner should there be any need for an extension to the proposed arrangements
- Provide them with a copy of this report as approved by the relevant local / state authority
- Where noise is demonstrated as being compliant with criteria, this should not limit the proponent in undertaking further additional reasonable and feasible steps to reduce noise emissions.

Further, the Community Consultation Strategy (CCS) document by School Infrastructure NSW (SINSW) provide mechanisms to facilitate communication between the Applicant, the relevant Council and the community during the design and construction of the development.

The builder shall also ensure that community consultant is being undertaken in accordance with the CSS.

7.3.2 Complaint Handling Procedures and Community Liaison

To assist in the management of noise and vibration complaints various procedures are to be followed. These include:

- Clearly visible signage identifying any key personnel along with their contact details to be erected along the perimeter of the building site including:
    - A 24-hour contact name, phone number and email address provided for the resident to address any complaint. The signage will declare; “For any enquiry, complaint or emergency relating to this site at any time please contact…”
- Give complaints a fair hearing
- Relevant local / state authority should be notified of the nature and details of complaints received (time, complainant etc.) and what remedial action has taken place, if any
- Have a documented complaints process, including an escalation procedure so that if a complaint 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
- Implement all feasible and reasonable measures to address the source of the complaint
- A register is to be kept by the contractor to keep a record of complaints and detail any information associated with them. The contents of the register will include:
    - The name and the address of the complainant
    - Time and date of the complaint
    - The nature of the complaint (Noise/Vibration)
    - Subsequent details
    - Remedial action undertaken

The contents of the register will be maintained and updated on a monthly basis with any new complaint without delay. The complaints will be reported to both the relevant local / state authority and the Contractor. The

investigation of the complaint and any remedial actions will be performed by the builder and/or client representative on a monthly basis. In the event of noisy works scheduled, the builder will notify residents 5 business days in advance.

In addition to the above, complaint handling and community liaison shall also be in accordance with the procedures outlined in Section 4.1 and 6.5 within the SINSW CSS.

7.4 NOISE & VIBRATION MONITORING STRATEGY

7.4.1 General Methodology

Noise and vibration levels should be monitored from time to time to ensure that noise generated as a result of remediation and construction activities does not disturb local businesses and residents.

Monitoring may be in the form of regular checks by the builder or indirectly by an acoustic consultant engaged by the builder and in response to any noise or vibration complaints. Where noise and vibration criteria are being exceeded or in response to valid complaints, noise and / or vibration monitoring should be undertaken. This would be performed inside the premises of the affected property and on site adjacent to the affected receivers.

Monitoring is to be undertaken by an experienced noise and vibration monitoring professional or an acoustic consultant. The results of any noise or vibration monitoring are to be provided to the relevant party or person in a timely manner allowing the builder to address the issue and respond to the complaints.

Noise and vibration monitoring can take two forms:

- Short-term monitoring
- Long-term monitoring

Both of these approaches are elaborated below.

7.4.2 Short-term Monitoring

Short-term monitoring consists of attended monitoring when critical stages of the construction are occurring. This normally provides real-time assistance and guidance to the subcontractor on site, telling them when the noise and vibration criteria are exceeded. Thus, the selection of alternative method on construction or equipment selection is allowed in order to minimise noise and vibration impacts.

7.4.3 Long-term Monitoring

Similarly, to short-term monitoring, long-term monitoring provides real-time alerts to the builder / site manager when the noise and vibration criteria are exceeded. Instead of someone being on site measuring, noise and vibration loggers are used.

Typically, the noise and vibration loggers stay on site for a period of several months for the critical construction stages of the project, such as the demolition and excavation phases.

Both methodologies are complementary and normally used simultaneously providing a significant amount of data via the long-term monitoring, but also providing information on the sources of noise and vibration generating exceedances via the short-term or attended monitoring.

7.4.4 Noise & Vibration Monitoring Program

A monitoring programme is proposed in Table 17. The monitoring programme is to be carried out at the nominated receiver locations during the most noise / vibration intensive periods during each construction phase as agreed with the Acoustic Engineer and Contractor. Refer to Figure 4 for the receiver locations corresponding the monitoring locations.

The noise monitoring programme includes unattended noise monitoring along the northern boundary of the Arranounbai School (southern boundary of the site) is to be carried out during all construction phases by the Contractor. A monthly report is to be provided by the Contractor to present the noise monitoring results recorded during that period and highlight any exceedances (if any).

Figure 4: Proposed monitoring locations

Table 17: Noise and vibration monitoring programme

CONSTRUCTION PHASE	LOCATION REFERENCE	MONITORING REQUIRED
Civil works – Excavation and Foundation	R1, R3, E1	Noise
	C1, E1	Vibration
Structural works – Construction	E1	Noise
	N/A	Vibration

8 CONCLUSION

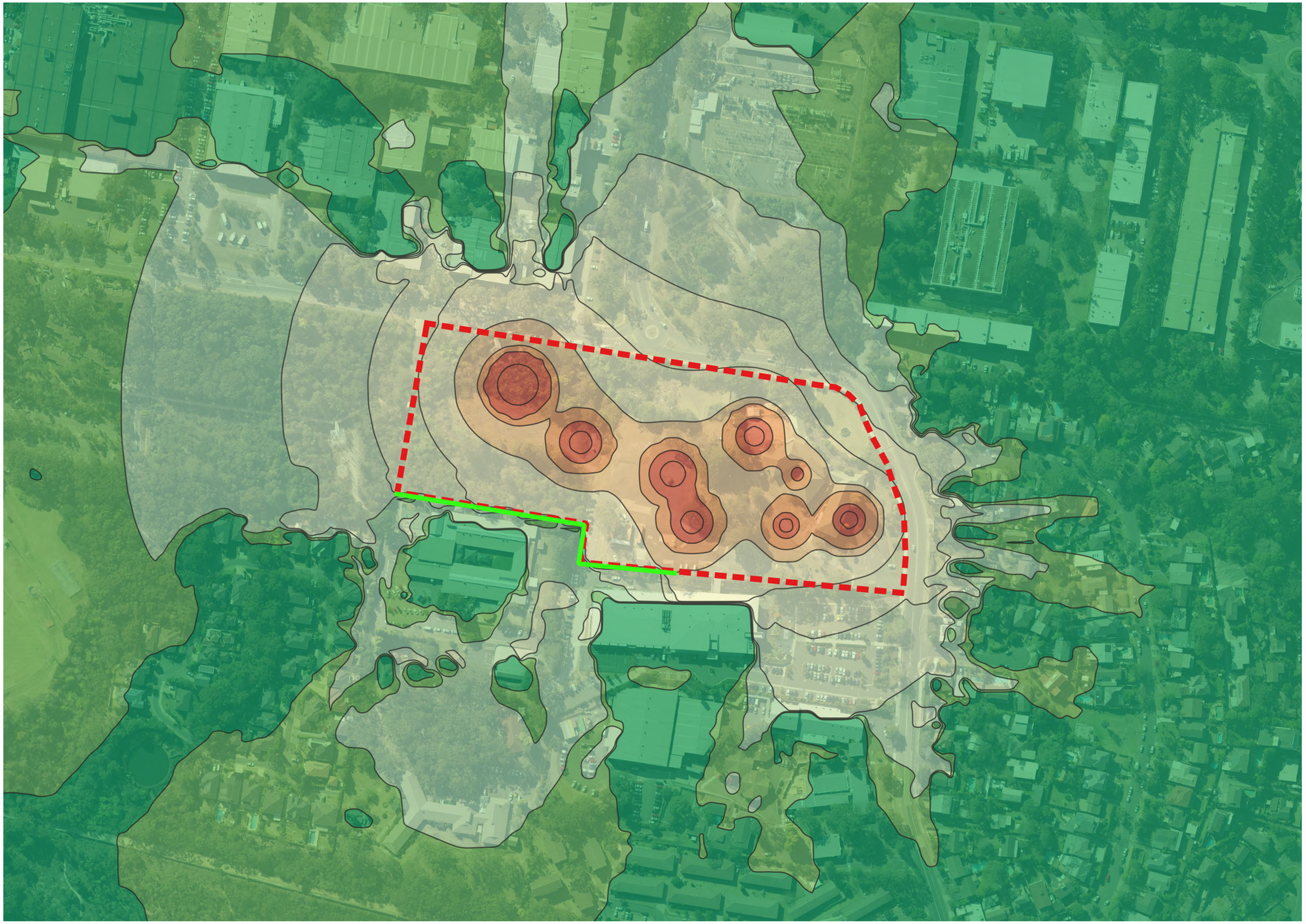
A Construction Noise and Vibration Management Sub-Plan has been provided for the construction works at The Forest High School. This document was prepared in support the Development Consent condition B17 prior to the commencement of construction.

The details of the noise and vibration modelling and assessment undertaken to predict the impacts on sensitive receivers have been presented in Sections 5 and 6.

To reduce the noise and vibration impacts on the sensitive receivers, noise and vibration management strategies have been proposed in Section 7.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to selection of equipment/machinery and modifications to the construction program.

Appendix A **Noise Contour Map**



E-LAB CONSULTING

ISSUE	DATE	STATUS
1	08/04/2022	CNVMSP
2	25/09/2023	CNVMSP

LEGEND

Noise Level, L_{eq} dBA

- < 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- > 75

- Project Site Boundary
- Noise Barrier / Hoarding
- Arranounbai School Noise Barrier

NOTES

PROJECT
THE FOREST HIGH SCHOOL

PROJECT NO.
P00757

ARCHITECT
ARCHITECTUS

CLIENT
ADCO

SCALE
NTS

STATUS
ISSUE FOR CNVMSP

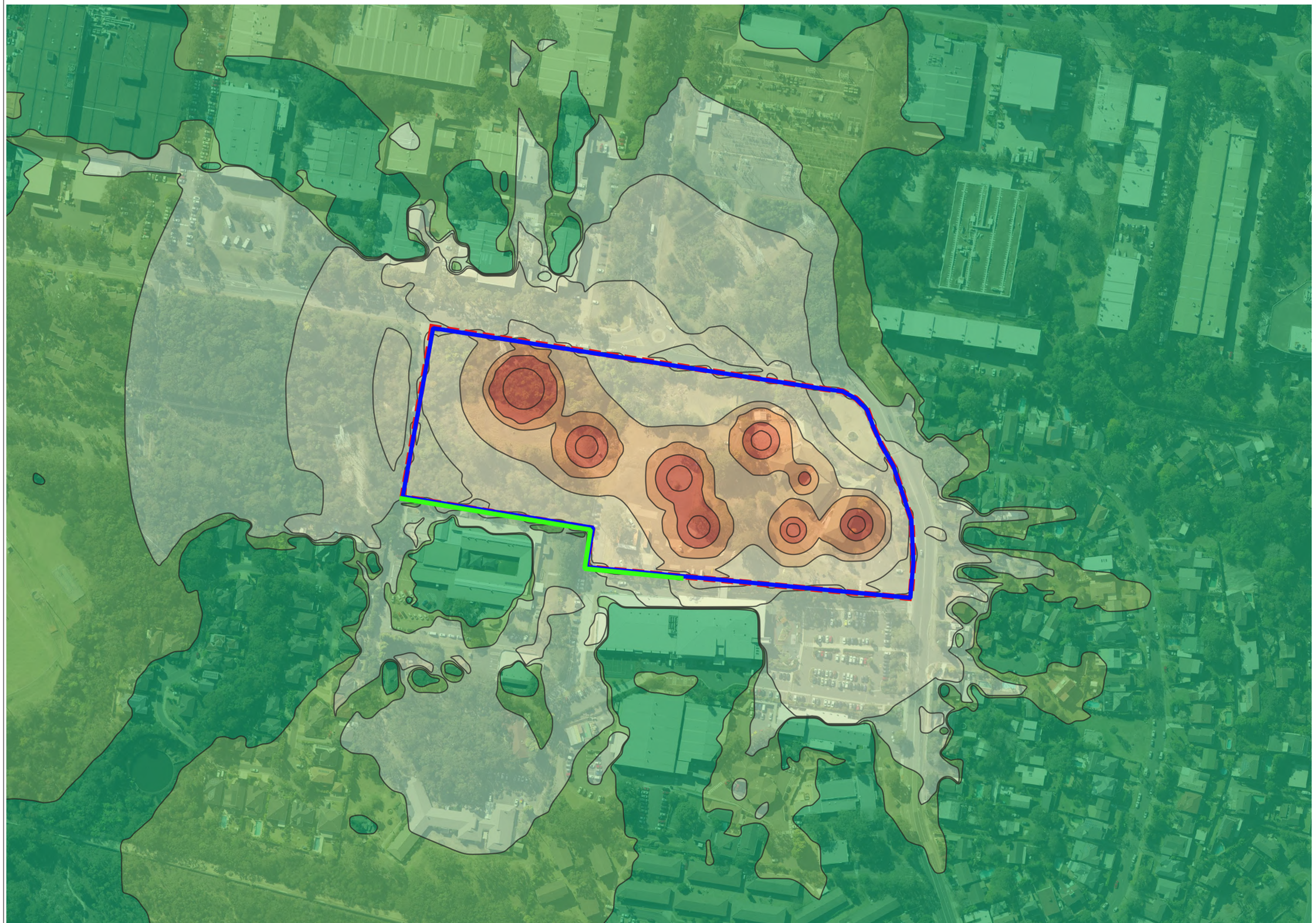
DRAWING
NOISE CONTOUR MAP

CIVIL WORK - EXCAVATION & FOUNDATION (NO BARRIER)

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-100-01-01

REVISION
002



E-LAB CONSULTING

ISSUE	DATE	STATUS
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2	25/09/2023	CNVMSP

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Noise Level, L_{eq} dBA

- < 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- > 75

- Project Site Boundary
- Noise Barrier / Hoarding
- Arranounbai School Noise Barrier

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SCALE
NTS

STATUS
ISSUE FOR CNVMSP

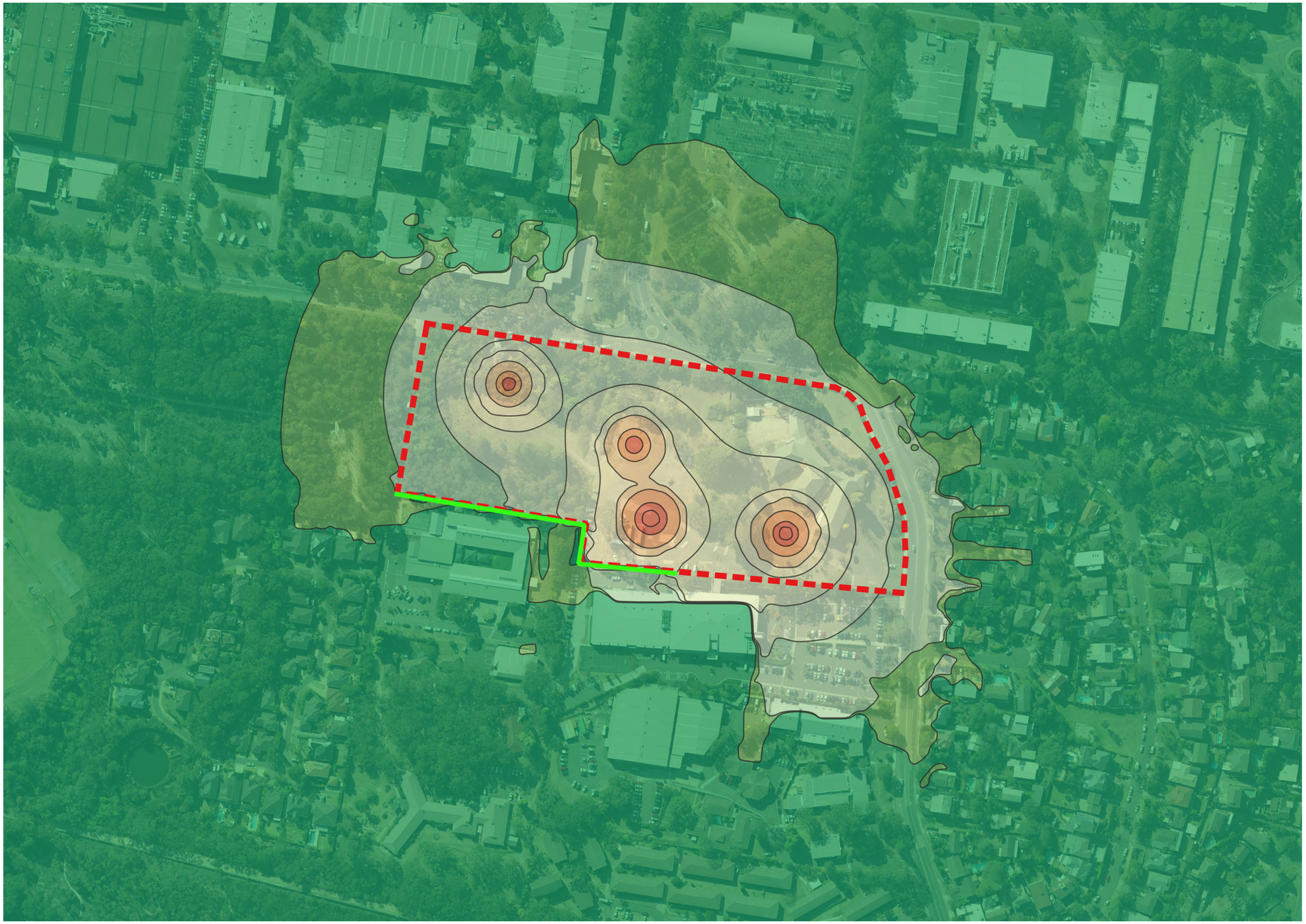
DRAWING
NOISE CONTOUR MAP

CIVIL WORK - EXCAVATION & FOUNDATION (WITH BARRIER)

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-100-01-02

REVISION
002



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- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- > 75

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CLIENT
ADCO

SCALE
NTS

STATUS
ISSUE FOR CNVMSP

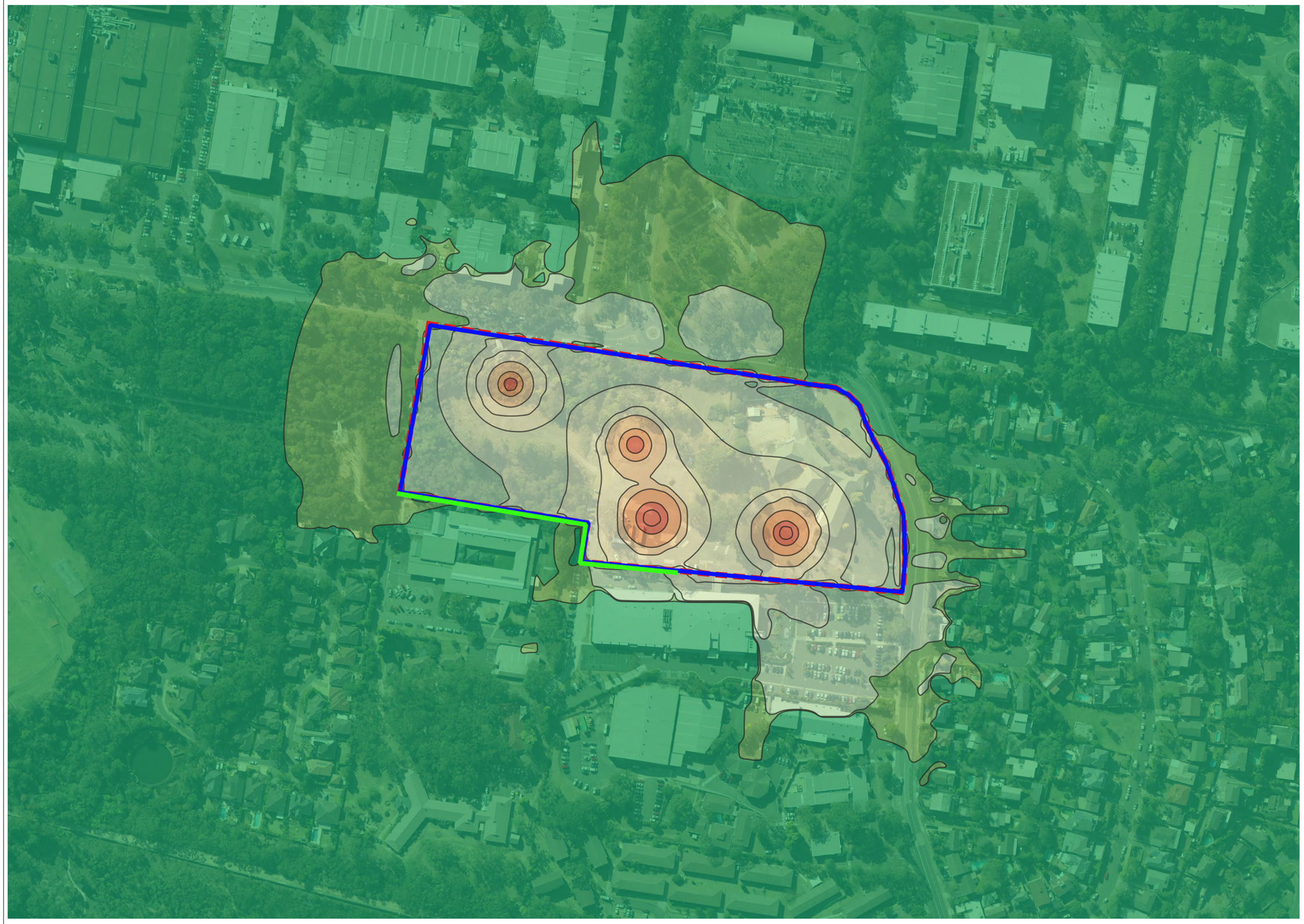
DRAWING
NOISE CONTOUR MAP

STRUCTURAL WORKS - CONSTRUCTION (NO BARRIER)

DISCIPLINE
ACOUSTICS

DRAWING NUMBER
AC-DWG-100-02-01

REVISION
002



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THE FOREST HIGH SCHOOL

PROJECT NO.
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DRAWING
NOISE CONTOUR MAP

STRUCTURAL WORKS - CONSTRUCTION (WITH BARRIER)

DISCIPLINE
ACOUSTICS

DRAWING NUMBER	REVISION
AC-DWG-100-02-02	002

Appendix B Noise and Vibration Consultant CV

"By starting from people-centric designs and building from first principles, a specialist designer is enabled to deliver best-for-project outcomes."

Brandon Notaras | Director Acoustics

BEng, M.AAS

Brandon's technical aptitude for computational modelling combined with his experience in leading large delivery teams has contributed to many of Sydney's thriving built-forms. He is excited by working with teams of engineers and designers on some of the most iconic projects such as Atlassian's tower in Sydney Central's new tech precinct. Specialising in developing and designing buildable technical solutions for complex builds such as Over Station Developments, High-Rise Towers, Mass-Timber (CLT) Buildings, Naturally-Ventilated Noise-Affected Facades and Mixed-Use Interfaces.

Project Highlights

Atlassian Central, Tech Hub
505 George St, Sydney
Waterloo Metro Quarter OSD
Sirius Building Redevelopment
50-52 Phillip St, Sydney
Darling Square Precinct, Haymarket
Greenland Tower, Bathurst St
Sandstone Buildings, Sydney
Fig & Wattle, Pyrmont
Sydney International Convention, Exhibition and Entertainment Precinct
Waverley Bowling Club Precinct
Northpoint Tower, North Sydney
Liverpool Civic Place Precinct
GAIA at Brays Bay – Stage 1
50 Macquarie St, Parramatta
85-97 Macquarie St, Parramatta
Prince St Commercial, Orange

9A & 9B Green Square, Zetland
Rhodes Central – Stage 2
Wentworth Point – Block H
Eden St Precinct, Arncliffe
Voco & Indigio Hotels, Brisbane
338 Botany Road, Alexandria
Westpac 275 Kent St Fitout
ANZ Sydney, 242 Pitt Fitout
NAB Fitout Sydney & Parramatta
QBE Fitout Sydney & Parramatta
Gilbert & Tobin, Barangaroo
Colonial First State, Barangaroo
Department of Industry Fitout
WeWork Fitouts, Sydney
Maitland Hospital
Shellharbour Hospital
Westmead Children's Hospital
Armidale Hospital Redevelopment

Broken Hill Hospital
Bowral Hospital
Healius, Orange & Tweed Heads
Castle Towers, Castle Hill
Gateway Shopping Centre, Darwin
Bloomfield Hospital, Orange
Macquarie Arts Precinct
UoW's Health & Wellbeing Precinct
Fiji National University – Labasa
Marist North Sydney Masterplan
St Josephs College Redevelopment
Blacktown International Sports - ICTE
Parramatta Aquatic Centre
Campbelltown Centre of Excellence
Blacktown Council Sportsgrounds
Sydney T2 Domestic Terminal
Newcastle Airport
Eastern Creek Data Centre Precinct

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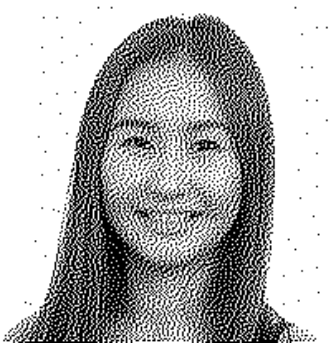

"By driving project teams to fundamentally understand acoustics, I find developments successfully achieve high-performance, low impact and beautiful outcomes"

Teresa D Nguyen | Associate Acoustics

BEng (Mech, Hons), M.AAS

Teresa has been involved in architectural and environmental acoustic projects of all scales, across Australia and New Zealand. Teresa's qualifications include a Bachelor degree in Mechanical Engineering (Hons), from the University of New South Wales.

Teresa specialises in architectural acoustics and brings a broad range of skills to her acoustic approach; including room acoustics, sound insulation and building services noise assessments. She is enthusiastic about Commercial and Residential sectors and understands the importance of transforming these areas into a creation of acoustically comfortable and healthful environment.

Project Highlights

Banksia Mental Health Unit, Tamworth Hospital	Nepean Children and Adolescent Mental Health Service, Kingswood	Royal North Shore Hospital, New Procedure Rooms
Canberra Hospital Electroconvulsive Therpay Suite	Diagnostic Breast and Cardiology, North Shore Hospital, Auckland	Mercy Catheterisation Laboratory, Southern Cross Hospital, Auckland
Lithgow Hospital MRI Suite	Sans Clinic Parkway, Sydney	Icare medical suite fit-out
Axis Sports Medicine, Southern Cross Hospital, Auckland	Special Care Baby Unit (SCBU), Waitakere and North Shore Hospital	CSU Teaching and Learning Refurbishment, Albury/Wagga Wagga
CSU Bathurst Dobbin Building	Mosman High School, Mosman	CSU Orange School of medicine
CSU Wagga Wagga Building 481	CSU Albury 678 Refurbishment	The Shepherd Centre, Sydney
WSU Parramatta Square	Google Majulah, Singapore	EY200, Sydney
Hilton Hotel, Auckland	The Star, Sydney	Beach Road Hotel, Auckland
88 Walker St, North Sydney	77 Market St, Sydney	Aria Bay Retirement Village, Auckland
Summerset Parnell, Auckland	30 Alfred Street, Sydney	Union Green Apartments, Auckland
Dicker Data Distribution Warehouse	EC5 FDM Eastern Creek, Sydney	EC5 Rhino Rack Eastern Creek
Circular Quay Renewal, Sydney	Transport Access Program, Roseville	Pondicherry Redevelopment, Oran Park
Appin Road, Gilead (RMS/Lendlease)	Newell Highway Bypass, Parkes	Sydney Metro North-West SVC Package
Westconnex O'Riordan St Expansion	Archbold Road, Sydney	Inland Rail, Parkes to Narromine

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