

Bankstown North Public School

Construction Noise and Vibration Management

Patterson Building Group

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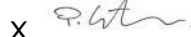
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1.0

Introduction

1.0 Introduction

Cundall has been engaged by Patterson Building Group to prepare a Construction Noise and Vibration Management Plan (CNVMP) for the construction stage of the proposed development at Bankstown North Public School, Bankstown NSW.

The Crown Certificate Requirements (CCR) for the project requires the following:

B16

The Construction Noise and Vibration Management Sub-Plan must:

- (a) Be prepared by a suitably qualified and experienced noise experts;*
- (b) Describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);*
- (c) Describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;*
- (d) Include strategies that have been developed with the community for managing high noise generating works;*
- (e) Describe the community consultation undertaken to develop the strategies in B16(d);*
- (f) Include a complaints management system that would be implemented for duration of the construction; and*
- (g) Include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the implemented management measures in accordance with the requirements of condition B13.*

We note that Clause B13 appears to have been deleted from the CCR. Recommendations for noise monitoring methodology has been provided, should it be required.

An explanation of common acoustic terminology used in this report is provided in Appendix A.

1.1 CNVMP Objectives

The objectives of this CNVMP are as follows:

- Planning Secretary's environmental assessment requirements (SEARs)(SSD 10290)
- BCA Crown Certificate Requirements
- Manage all construction related activities to minimise the noise and vibration impact to an acceptable level.
- Limit and reduce noise or vibration impacts at sensitive receivers or affect building integrity.
- Work to a target of not receiving any noise complaints.
- Ensure all noise mitigation infrastructure is maintained and effective.

2.0

Description of the existing environment

2.0 Description of the existing environment

2.1 Project site and surrounds

The existing Bankstown North Public school is surrounded by Stacy street to the north, Beresford Avenue to the east with residential receivers directly to the west of the school and south, past the Hume Highway.

Roads with significant contribution to the proposal within the school has been identified as Stacey Street and Hume Highway. Rookwood Road is approximately 112m away from the nearest façade of the project site without direct line of sight but may have contributions to the ambient noise.

The closest residential receiver to the nearest façade of the school is approximately 30m.

Figure 1 indicates the site and the immediate surrounds of the school, an indicative location of the proposed new building and noise monitoring locations.

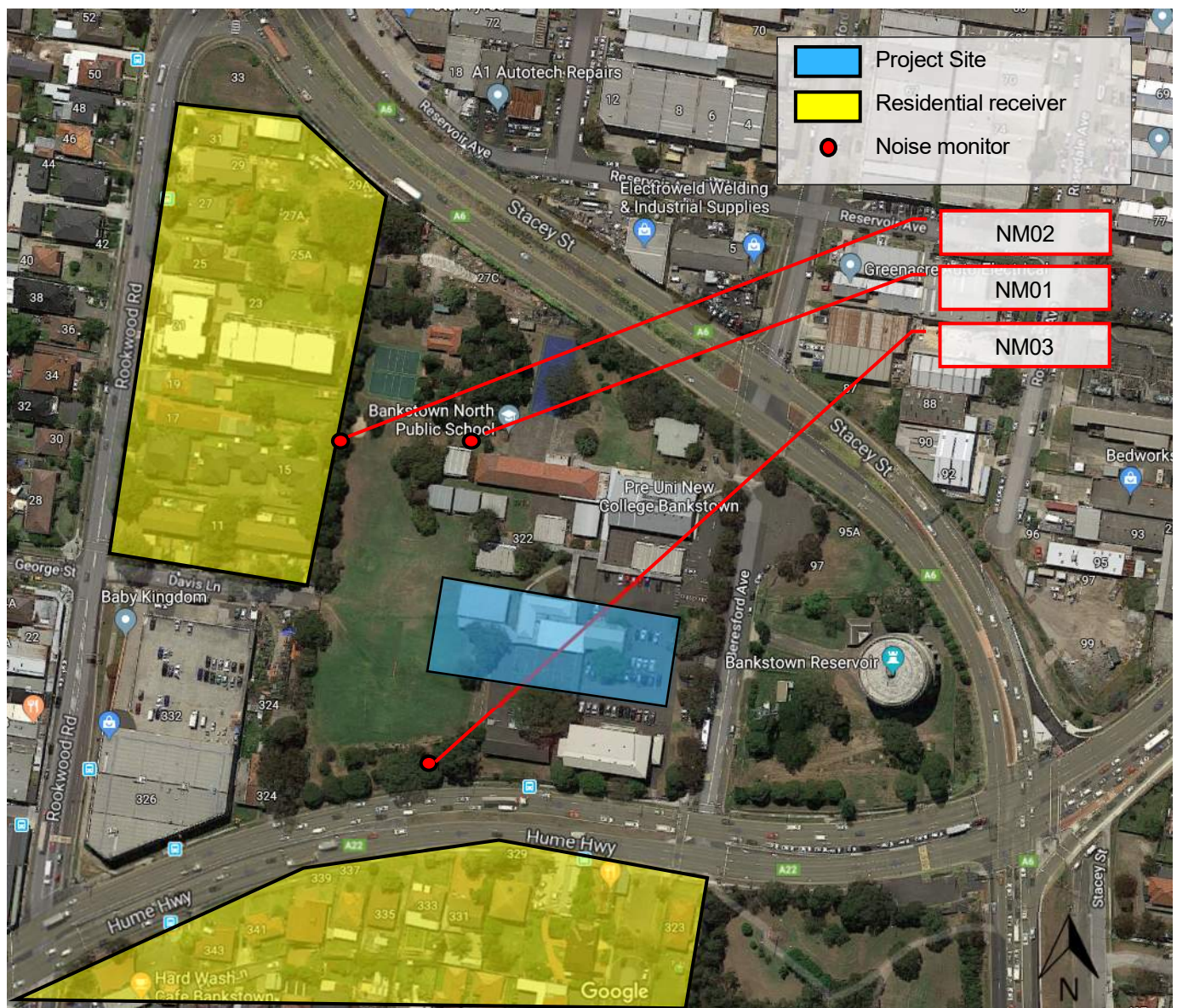


Figure 1 Existing site location and surroundings (Google Maps)

2.2 Measured background noise levels

Detail of the noise monitoring procedures and processes are outlined within *1019593-LET-AS01 BNPS existing acoustic conditions*, prepared by Cundall dated 20 November 2018. The logger locations were considered appropriate to represent the noise climate at adjacent noise sensitive properties

A brief description of the three noise monitoring locations is presented in Table 1.

Table 1 Description of noise monitoring location

Monitoring location	Description
NM01 (North)	Along the northern façade of the school with exposure to Stacey St.
NM02 (West)	West of the school set close to the boundary of the nearest residents.
NM03 (South)	Near the southern façade of the school capturing representative traffic noise of Hume Highway.

The average measured background noise levels are summarised in Table 2.

Table 2 Summary of measured Road traffic noise levels

Measurement location	Measured Ambient Noise Level (dB, L _{Aeq})			Measured Background Noise Level (dB, L _{A90})		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
NM01	57	53	51	47	46	42
NM02	56	50	49	45	43	39
NM03	66	64	63	51	50	45

2.3 Sensitive receivers

Residences are located directly West of the school and South across the Hume Highway. For assessment purposes, the Project area has been divided into four Noise Catchment Areas (NCAs). The NCAs have been used to represent the different noise environments in area of the Project.

A summary of the identified sensitive receivers is presented in Table 3.

Table 3 Identified sensitive receivers

NCA	Noise logger reference	Receiver Type	Address / Description	Approximate Horizontal Distance from nearest construction footprint (m) ¹	
				Zone A	Zone B
NCA01	NM01	Residential	Residential receivers North west to the school grounds including residence across Rookwood Road	65	50
NCA02	NM02	Residential	Residential receivers West of the school including residence across Rookwood Road	70	20
NCA03	NM03	Residential	Residential receivers South of the school across Hume Highway	145	90
NCA04	NM01	Existing school	Other buildings within the Bankstown North PS campus	15	15

Note 1: Approximate minimum horizontal distance to nearest receiver boundary (receiver of any type), where the horizontal distance is measured from the boundary of the early works construction to the near point of the Project footprint.

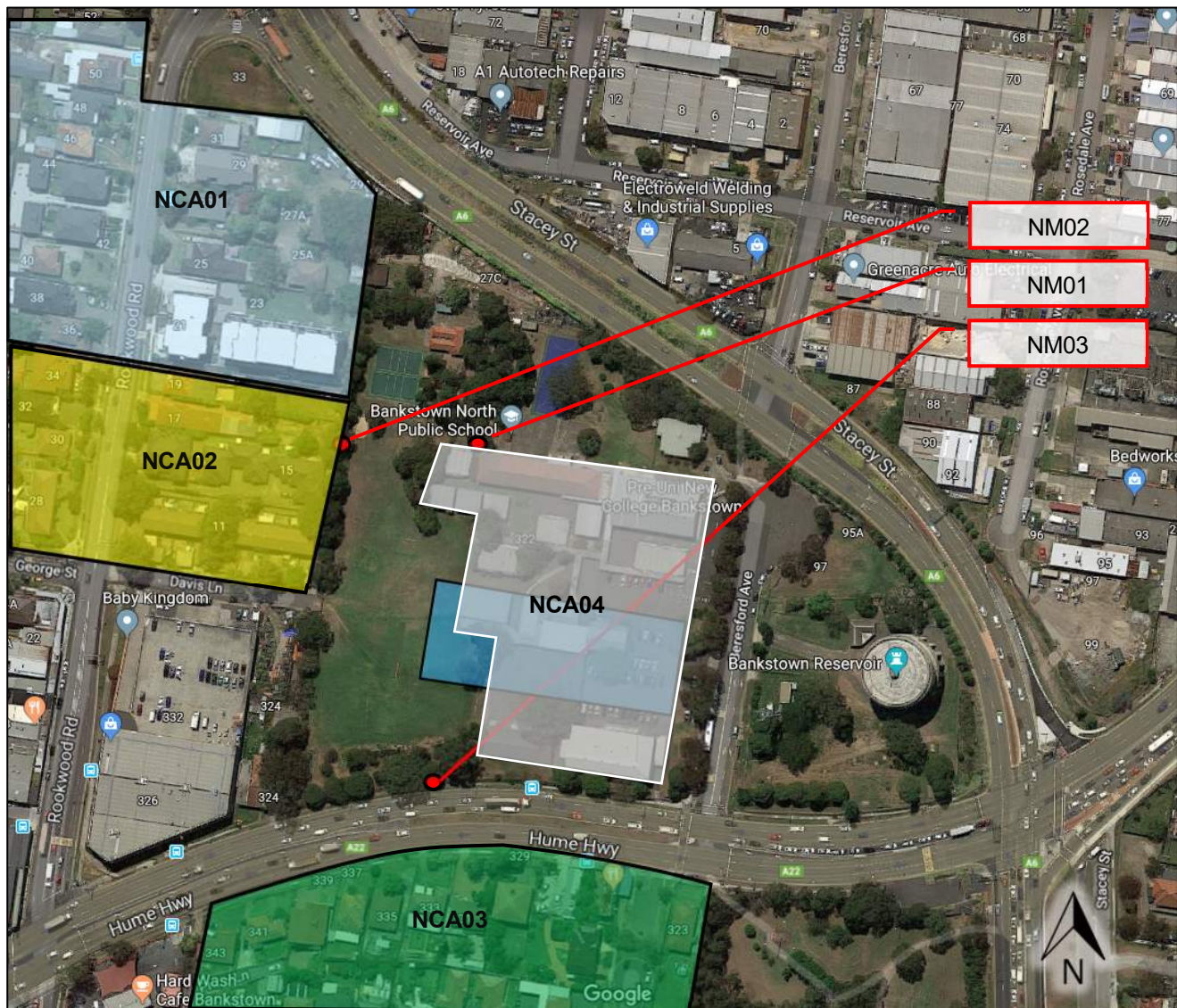


Figure 2 Sensitive receiver and Noise Catchment Area

Typical operating periods corresponding to the identified sensitive receivers above have been assumed at this stage of the Plan and are outlined in Table 4. The actual operating time are to be confirmed with the receivers prior to construction and the Plan to be updated correspondingly.

Table 4 Sensitive Receivers – Assumed typical operating hours

Receiver Type	Operating time
Residential	24 hours
Education Institutions	7:00 am to 4:00 pm ¹
Active recreational area (school grounds)	7:00 am to 6:00 pm ¹

Note 1: Assumed operating hours. To be confirmed with the relevant operator prior to construction.

3.0

Proposed construction activities

3.0 Proposed construction activities

The two main construction footprints within Stage 1A and 2 have been proposed. The two new blocks are located near the centre of the school with a new outdoor sports court west on the site. New Carpark located north of the school grounds with a kiss and drop trailing to the west. Temporary demountables are located where the proposed sports court is, near the western residents.

The development plan and layouts are presented in Figure 3.



Figure 3 Proposed site plan (JDH Architects, drawing number SD-003 Rev 7, dated 7 April 2021)

3.1 Construction methodology

It is assumed that construction works for all stages will be carried out simultaneously. Indicative construction methodology, discussions with the contractor and timelines from similar projects provides guidance of the proposed works.

Table 5 Construction works

Proposed works	Timeline	Assumed plant equipment ¹
Civil works	2 months	Concrete supply truck Dump truck Excavator (tracked) + hydraulic hammer 20t Excavator (tracked) 20t Front end loader 23t Pile driver (auger) Roller 5t Skid steer Truck – road truck
Structure works	4 months	Concrete supply truck Dump truck Excavator (tracked) 20t Front end loader 23t Hand tools/Power tools Tower crane 22t Pile driver (auger)
Fitout and finishes	5 months	Forklift Hand tools/Power tools Hiab trucks Truck – road truck

Note 1: Construction equipment adopted from similar construction activities provided within Table F1 of Roads and Maritime Services Construction Noise and Vibration Guideline (2016).

3.2 Construction Traffic

Additional road traffic generated on existing roads due to construction phase of the proposal may have the potential to cause adverse road noise impacts at receivers. The additional road traffic generated by vehicles accessing the construction site locations are to be assessed in accordance with the NSW EPA Road Noise Policy (RNP).

At this time, no information regarding the increase in traffic has been made available for review. We understand however, that the majority of demolition traffic will access the site via Beresford Avenue, which is unlikely to result in adverse impact upon residential receivers on the opposite side of the site.

4.0

Construction noise and vibration requirements

4.0 Construction noise and vibration requirements

4.1 Legislative and Other requirements

4.1.1 Relevant Legislation and Guidelines

In preparation of this report, the review of construction noise and vibration impacts has been carried out with in accordance with SEARs SSD 10290 dated 2 May 2019 (NSW Department of Planning and Environment):

- NSW Noise Policy for Industry 2017 (EPA)
- NSW Interim Construction Noise Guideline (ICNG) (EPA, 2009)
- NSW Road Noise Policy (RNP) (EPA, 2011)

Guidelines and standards relating to the management of noise and vibration during construction include:

- Australian / New Zealand Standard AS/NZS 2107:2016 *Recommended Design Sound Levels and Reverberation Times for Building Interiors* (Standards Australia, 2016)
- Australian Standard AS 1055.1-1997 *Acoustics - Description and Measurement of Environmental Noise - General Procedures* (Standards Australia, 1997)
- German Standard DIN 4150: Part 3 - 1999 *Structural Vibration - Effects of Vibration on Structures* (German Institute of Standardisation, 1999)
- British Standard BS 7385 Part 2. *Evaluation and measurement for vibration in buildings Part 2* (British Standards Institution, 1993)
- Environmental Noise Management - *Assessing Vibration: a technical guideline* (EPA, 2006)
- Australian Standard AS2436 *Guide to noise and vibration control on construction, demolition and maintenance sites*
- UK's Department of Environment, Food and Rural Affairs *Noise Database for Prediction of Noise on Construction and Open Sites* (DEFRA, 2006)
- Transport for NSW *Construction Noise Strategy* (CNS) (TfNSW 2012),
- Roads and Maritime's guidelines *Guideline* (CNVG) (Roads and Maritime, 2016)
- British Standard BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites*

5.0

Construction noise and vibration

5.0 Construction noise and vibration criteria

5.1 Construction hours

The approved construction hours are outlined within Table 6.

Table 6 Approved construction hours

Day	Approved construction hours
Monday to Friday	7:00 am to 6:00 pm
Saturday	7:00 am to 1:00 pm
Sunday and public holidays	No construction

Based on the proposed program (Section 3.1), it is noted that the construction works may be required during the school exams. Coordination with the school to manage potential disruptions caused by noise and vibration from construction activities.

Out of hours works are possible with appropriate permit for works requiring special condition, such as oversized trucks and/or cranes that are restricted by Roads and Maritime Services from travelling during daylight hours, or emergency works. Application for out of hours works permit requires approval by the Department. Surrounding residents nearby the project site are to be notified in advance of the out of hours works.

5.2 Construction noise and vibration criteria

5.2.1 Construction Noise Management Levels

Noise levels arising from a construction project, measured within an area of sensitive receiver premises (i.e. at boundary or within 30 m of the residence, whichever is the lesser), should not exceed the established Noise Management Levels (NMLs) in line with the ICNG. The established NMLs in accordance with the ICNG are indicated in Table 7.

Table 7 Construction Noise Management Levels

	Time of day	Hours	Construction Noise Management Levels, dB, $L_{Aeq}(15\text{minute})$				
			ICNG	NCA01	NCA02	NCA03	NCA04
Residences affected by construction works	Recommended Standard Hours / Approved construction hours	Monday to Friday 7:00 am to 6:00 pm	Noise affected ¹ RBL ² + 10 dBA	57	55	61	-
		Saturday 8:00 am to 1:00 pm	Highly Noise affected ³ 75 dBA	75	75	75	-
	Outside Recommended Standard Hours		Noise affected ¹ RBL + 5 dBA				
	Daytime (out of hours)	Saturday 7:00 am to 8:00 am 1:00 pm to 6:00 pm		52	50	56	-
	Evening	6:00 pm to 10:00 pm		No construction works			
	Night-time ³	10:00 pm to 7:00 am		No construction works			

	Time of day	Hours	Construction Noise Management Levels, dB, $L_{Aeq(15minute)}$				
			ICNG	NCA01	NCA02	NCA03	NCA04
Noise at Sensitive Land Uses (other than residences)	Classrooms at schools and other educational institutions	7:00 am to 4:00 pm ⁴		-	-	-	55
	Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	7:00 pm to 6:00 pm ⁴		-	-	-	65

Note 1: The noise affected level represents the point above which there may be some community reaction to noise.

Note 2: dB, L_{A90} - The "background noise level" or "Rating Background Level" (RBL) in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The dB, $L_{Aeq(15minute)}$ construction noise management levels are based on the RBLs.

Note 3: Additional assessment of sleep disturbance is to be completed should the Project requires to undertake construction works during the night-time period.

Note 4: Assumed operating hours. To be confirmed with the relevant operator prior to construction.

Note 5: Based on assumed partially open window reduction of 10 dB and to the internal Construction Noise Management Level of 45 dB, $L_{Aeq(15minute)}$

In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

5.2.2 Construction vibration criteria – Surface structure

Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks and are set well below the levels that have potential to cause damage to the main structure. Example of these vibration level limits are nominated within the BBS7385: Part 2.

The criteria specified within DIN 4150 are design for controls of continuous long-term vibration or repetitive vibration with the potential to cause fatigue effects to structure.

The following Peak Particle Velocity (PPV) values are specified within DIN 4150 as safe limits, below which even superficial cosmetic damage is not to be expected:

- 10 mm/s for commercial buildings and buildings of similar design.
- 5 mm/s for dwellings and buildings of similar design.
- 2.5 mm/s for buildings of great intrinsic value (e.g. heritage listed buildings).

For short-term vibration events (i.e. those unlikely to cause resonance or fatigue), DIN 4150 offers the criteria shown in

Table 8. These are maximum levels measured in any direction at the foundation or in the horizontal axes in the plane of the uppermost floor.

Table 8 DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration

Group	Type of Structure	Peak Particle Velocity, (mm/s) ¹		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz ²
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 at 10 Hz increasing to 40 at 50 Hz	40 at 50 Hz increasing to 50 at 100 Hz
2	Dwellings and buildings of similar design and/or use	5	5 at 10 Hz increasing to 15 at 50 Hz	15 at 50 Hz increasing to 20 at 100 Hz
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 at 10 Hz increasing to 8 at 50 Hz	8 at 50 Hz increasing to 10 at 100 Hz

Note 1: Unless specified, vibration levels are measured at foundation of the structure

Note 2: For frequencies above 100 Hz the upper value in this column should be used

The “safe limits” given in DIN 4150 are the levels up to which no damage due to vibration effects has been observed for the particular class of building. The definition of “damage” is described by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

5.2.3 Construction vibration criteria – Human comfort

For most construction activities that generate perceptible vibration by occupants in nearby buildings (e.g. earth works and excavation works), the character of the vibration emissions is considered to be intermittent in nature. As a guide, the BS5228-2:2009 provide effects of perceived vibration level in terms of peak particle velocity (PPV, mm/s).

Table 9 Guidance on effects of vibration levels (BS 5228-2: 2009)

Vibration level (mm/s)	Effect
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments.
1.0	It is likely that vibration of this level in residential environment will cause complaint, but can be tolerated if prior warning and explaining has been given to residents.
10.0	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Table 9 suggests that people will be able to detect vibration at levels of about 0.15 mm/s and that the motion becomes “noticeable” at a level of approximately 1 mm/s.

The EPA *Assessing Vibration: a technical guideline* nominates preferred and maximum vibration goals for critical areas, residences and other sensitive receivers (related to the Project) are shown in

Table 10 for intermittent vibration and Table 11 for continuous vibration. The guideline advises a low probability of adverse comment or disturbance to building occupants would be expected at or below the preferred values.

The applicable human comfort vibration goal for intermittent vibration source is defined in terms of Vibration Dose Values (VDVs) where the permissible vibration level corresponding to the VDV varies according to the duration of exposure.

Table 10 Preferred and Maximum Vibration Dose Values for Intermittent Vibration (EPA, 2006)

Building Type	Preferred Vibration Dose Value (m/s ^{1.75})	Maximum Vibration Dose Value (m/s ^{1.75})
Residential Daytime	0.20	0.40
Residential Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80

Note: Daytime is 7:00 am to 10:00 pm and Night-time is 10:00 pm to 7:00 am

Table 11 Preferred and Maximum Vibration Dose Values for Continuous Vibration (EPA, 2006)

Building Type	Preferred Vibration Dose Value (m/s ^{1.75})	Maximum Vibration Dose Value (m/s ^{1.75})
Residential Daytime	0.20	0.40
Residential Night-time	0.14	0.28
Offices, schools, educational institutions and places of worship	0.40	0.80

Note: Daytime is 7:00 am to 10:00 pm and Night-time is 10:00 pm to 7:00 am

In applying the preferred and maximum VDV the guidelines states that:

'Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. An example is a construction or excavation Project.'

The guideline also advises that:

'Where all feasible and reasonable measures have been applied to control potential ground vibration levels the maximum values may be used. For values above the maximum value the proponent should negotiate directly with the affected community.'

When short-term works such as piling, demolition or compaction give rise to impulsive vibrations, it should be noted that undue restriction on vibration levels can significantly prolong the construction process and may result in greater annoyance overall.

5.3 Nominated site control vibration targets

Based on the vibration criteria detailed above, the site-specific controls to reduce risk of cosmetic damage as per DIN 4150 are outlined below in Table 12.

Table 12 Nominated site control vibration targets (warning and stop levels)

Structure	Site Control vibration Criteria ¹ (Peak Particle Velocity, PPV) in any Orthogonal Direction	
	Warning Level	Stop Level
Residential buildings	4 mm/s	5 mm/s
Commercial Buildings (school building)	10 mm/s	20 mm/s

Note 1: Vibration levels measured at the base of the building

5.4 Construction related traffic noise

As stated in the RNP application notes, the consideration of mitigation would only be required where additional traffic on existing roads creates an increase of more than 2 dB L_{Aeq} (Daytime, Night-time) at existing sensitive receivers. This typically corresponds to a traffic volume increase of minimum 60 percent, provided the mix of light and heavy vehicle traffic is comparable.

6.0

Consideration of construction noise and vibration

6.0 Consideration of construction noise and vibration

6.1 Construction Noise

The project-specific construction airborne noise management levels (NMLs) for approved daytime hours are outlined in Table 6. Where NMLs cannot be achieved, the construction contractor will use all reasonable and feasible noise mitigation and management measures to reduce noise generation and impacts.

6.2 Typical plant sound power level

The recommended noise levels for construction plant in Table 13 are referenced from various sources as a guide for the Project.

All plant and equipment used for construction must have operating Sound Power or Sound Pressure Levels below or equal to the allowable noise levels in or if not listed below, shall achieve compliance to the most applicable equipment listed in the following document:

- Transport for NSW *Construction Noise and Vibration Strategy* (CNVS, 2018); or
- Australian Standard AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites; or
- UK's Department of Environment, Food and Rural Affairs Noise Database for Prediction of Noise on Construction and Open Sites (DEFRA, 2006); or
- British Standard BS 5228-1 *Code of practice for noise and vibration control on construction and open sites*.

Table 13 Maximum allowable noise levels for construction equipment

Plant item	Reference	Individual Item SWL
Concrete truck	RMS CNVG	109
Dump truck	TfNSW CNVS (2018)	110
Excavator (tracked) 20t	TfNSW CNVS (2018)	105
Excavator (tracked) 20t + Hydraulic hammer ¹	TfNSW CNVS (2018)	122
Forklift	AS 2436	106
Front end loader 23t	RMS CNVG	112
Hand tools/ Power tools	AS 2436	102
Hiab trucks	TfNSW CNVS (2018)	108
Pile driver (auger)	RMS CNVG	112
Roller 5t	RMS CNVG	109
Skid steer	TfNSW CNVS (2005)	110
Tower crane 22t	DEFRA	104
Truck – road truck	RMS CNVG	108

Note 1: Equipment with special audible characteristics.

6.3 Vibration compliance

The construction contractor will, if required, ensure compliance with the nominated site control vibration targets as outlined in Table 12.

Details of monitoring requirements are outline within Section 7.2.

Vibration monitoring is required as per Condition B13 in the BCA Crown Certificate Requirements to confirm compliance with the nominated vibration criteria of the proposed plant equipment used within 30 m of identified sensitive structure.

6.4 Vibration damage

Disturbance to building occupants can potentially occur at much lower vibration levels than the safe limits relating to cosmetic or structural damage of the building.

The risk of exceeding the recommended building damage criteria should be managed by carrying out vibration measurements during piling, excavation, demolition and compaction works in order to establish satisfactory buffer zones.

Details of monitoring requirements are outline within Section 7.2.

6.5 Recommended minimum working distances for vibration intensive plant

The propagation of vibration emitted from a source is site-specific. The level of vibration potentially experienced at a by the occupant of a building structure is dependent upon the vibration energy generated by the source, the frequency content of vibration, the localised geotechnical conditions and the interaction of structures and features which can dampen or enhanced vibration.

The recommended minimum working distances for construction plant in Table 14 are referenced from the Transport for NSW *Construction Noise and Vibration Strategy, April 2018* as a guide for the Project.

The nominated distances outlined below assumed propagation on particular ground condition and the recommendations are for the practical management of potential vibration to minimise disturbance or annoyance to surrounding receivers. The human comfort minimum working distances are conservative, developed with reference to the more stringent objectives for continuous vibration for typical residential building constructions.

Table 14 Recommended safe working distances for vibration intensive plant (TFNSW CNVS, 2018)

Plant Item	Approx. Size/ Weight/ Model	Minimum Distance – Human Response (EPA Vibration Guideline)
Vibratory Roller	1-2 tonne	15 m to 20 m
	2-4 tonne	20 m
	4-6 tonne	40 m
	7-13 tonne	100 m
	13-18 tonne	100 m
	> 18 tonne	100 m
Small Hydraulic Hammer	300 kg (5 to 12t excavator)	7 m
Medium Hydraulic Hammer	900 kg (12 to 18t excavator)	23 m
Large Hydraulic Hammer	1600 kg (18 to 34t excavator)	73 m
Pile Driver – Vibratory	Sheet piles	20 m
Piling Rig – Bored	≤ 800 mm	N/A
Piling Rig – Hammer	12 t down force	50 m
Jackhammer	Hand held	Avoid contact with structure

A vibration trial to assess the ground vibration from ground compacting equipment (e.g. vibratory roller) which may potentially impact the adjacent school buildings is recommended. The vibration trial is to be conducted to develop a site-

specific vibration propagation characteristic and determining safe operational distances for plant equipment on the Project site.

Continuous vibration monitoring is to be carried out throughout the activity when vibration intensive plant equipment's are in use. Continuous vibration monitoring will also be carried out during all works with potential to generate vibration.

6.6 Construction generated road traffic noise

The additional traffic generated due to construction travelling along Cumberland Highway is considered to be negligible. The existing traffic volumes on the local roads are not available at the time of assessment however, it is likely to comprise predominately of light vehicles. The noise from additional construction traffic utilising the local roads would likely to be noticeable due to increase in heavy vehicle volumes.

Recommendations for control of construction vehicles and traffic are provided within Section 7.1.

7.0

Recommended mitigation measures and work practices

7.0 Recommended mitigation measures and work practices

7.1 General noise and vibration mitigation measures

As the details of the construction and operational methodology to carry out the Project has not been confirmed, specific mitigation measure, such as noise barrier, have not been specified.

The general mitigation measures provided in the Plan and the commitments made by Lahey Constructions (Construction Contractor) should be referenced and revised to ensure applicability once the construction and operational methodology is finalised. Typical noise management procedures are as follows:

General

- Where feasible and reasonable, construction should be carried out during the approved standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
- Where activities identified by the Development consent as generating high noise and vibration are expected, scheduling of respite period as per the approved hours outlined in Table 6 is required;
- Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers (both noise and vibration generating activity).
- The contractor will take all reasonable and feasible measures to mitigate noise effects;
- The contractor will take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers;
- Minimise plant and vehicles idling when not in use;
- All plant and equipment should be maintained in a proper and efficient manner to minimise noise emissions, including the replacement of engine covers, repair of defective silencing equipment, tightening of rattling components and the repair of leakages in air lines;
- Notification of occupant's adjacent to the site of when these activities occur; and
- Implementing an effective community consultation and complaints management.

Noise

- Provision of localised treatment such as temporary barriers, shrouds and the like around fixed plant such as pumps, generators and groundwater extraction plant during use and by "stepping down" the plant settings out of construction hours or turned off completely where able. The detailed design of acoustic treatments will be undertaken during the detailed design phase; and
- Maximising the offset distance between noisy plant items and nearby noise sensitive receivers;
- Where practicable, provision of additional respite from noise producing activities during extended hours operations;
- Use of broadband alarm in place of tonal alarm where practicable;
- Selection and maintenance of "quiet" type equipment where practicable;
- Minimise consecutive works in the same locality (if applicable);
- Minimising consecutive works in the same locality;
- Silenced air compressors, fitted with noise labels indicating a maximum (L_{Amax}) sound pressure level of not more than 75 dBA at 7 m is to be used on site. The sound pressure level of noise emitted from a compressor used is to comply with noise label requirements;
- Orienting equipment away from noise sensitive areas; and
- Carrying out loading and unloading away from noise sensitive areas.

Vibration

- Selection and maintenance of low vibration equipment where practicable;

- Use only dampened rockbreakers and/or “city” rockbreakers to minimise the impacts associated with rockbreaking works;
- Trial testing of vibration levels is to be conducted where equipment identified as having the potential to exceed the human comfort criteria or where the vibration intensive plant or equipment is required to operate in close proximity (30 m or less) to sensitive structure exceeding the nominated minimum working distances;
- Trial vibration monitoring to determine appropriate work distances of proposed vibration intensive activities; and
- Utilise the smallest practicable size of plant equipment when in close proximity to the sensitive structure (e.g. small vibratory roller).

Construction traffic

- Where practicable, site should be arranged to provide one-way traffic movement minimise reversing of vehicles onsite;
- Utilising main road networks to access site and where practicable;
- Provide instructions for heavy vehicles operators regarding minimising noise when entering and leaving the construction sites;
- Delivery truck should be scheduled to arrive on site within the approved construction hours;
- Queuing of trucks are to be minimise as far as practicable and located away from residences and operating school buildings in order to reduce noise impacts due to trucks idling; and
- Where practicable, heavy vehicles should be switched off while queuing or not in use.

7.2 Noise monitoring

As part of site management for noise emissions, Construction Contractor would undertake a daily log of construction activities kept onsite by the site manager.

In addition, where required, noise monitoring would be conducted at the nearest residential receiver to the construction works being undertaken for:

The beginning of the proposed construction activity (refer to

- Table 5);
- Whenever an item of “noise intensive” plant or equipment is brought onto site for the first time. For the purpose of internal noise audits, any item of plant or equipment with Sound Power Level (SWL) greater than or equal to 110 dBA as presented in Table 3.3 would be considered to be potentially “noise intensive”; and
- In response to complaints, once differentiation between site related construction noise sources and other sources has been established.

7.2.1 Noise auditing

The results of all noise audits and monitoring would be submitted to an environmental representative of Construction Contractor who would compile progressive impact assessments as work progresses. Submission of the internal noise auditing report to relevant authorities and/ or stakeholders may be applicable on an as per requested basis.

Site noise emissions requiring monitoring (e.g. following a complaint) would be undertaken in accordance with procedures outlined within the Construction Environmental Management Plan and would be carried out on the property of an affected receiver or at the boundary of the receiver (whichever is most affected).

The noise audits reporting would include the following information as a minimum during construction works:

Noise auditing reporting items

- Work activity.
- Name of auditor and site manager.
- Details of the instrument used for the measurement including make, model, serial number and last calibration date.
- Date and time of test.
- Weather condition during test, including air temperature, wind speed, wind direction and details of rain/wet conditions if applicable.
- Plant and equipment operating at the time of measurement.
- Noise measurement recorded for each activity as follows:
- Concurrent construction occurring (not associated with Ex-Situ works) and other background noise sources.

General noise auditing requirement:

- Measured 15 minute noise level at both the site boundary and nearest affected receiver, including A weighted, fast time-weighting L_{min} , L_{90} , L_{10} , L_1 , L_{max} and L_{eq} statistical parameters.
- Provide comparison of the measured noise levels with the predicted noise levels from the proposed activity.

Plant and equipment noise auditing requirement:

- A weighted, fast time-weighted L_{eq} and L_{max} noise level measured at a distance of 7 metres from the item of plant or equipment during normal operation.
- Provide comparison of the measured noise levels with the predicted noise levels from the proposed plant equipment.

Noise auditing in response to complaints:

- The name and contact details of the person making the complaint.
- Time of the complaint.
- Any other specific details relating to the complaint.
- GPS location of the measurement location
- Distance from the source activity to the measurement location.
- Measured 15 minute noise level at the boundary of the affected receiver A weighted, fast time-weighting L_{min} , L_{90} , L_{10} , L_1 , L_{max} and L_{eq} statistical parameters.
- Levels and description of other noise sources observed during the measurement period.

7.3 Vibration monitoring

As part of site management for vibration emissions, Construction Contractor would undertake a daily log of construction activities that would be kept onsite by the site manager. In addition, informal vibration audits would be conducted at the nearest affected receiver or relevant structure for:

- Prevention of structural damage; and
- In response to complaints.

7.3.1 Vibration auditing

The results of all vibration audits and monitoring would be submitted to an environmental representative of Construction Contractor who would compile progressive impact assessments as work progresses. Submission of the internal noise auditing report to relevant authorities and/ or stakeholders may be applicable on an as per requested basis.

Site vibration emissions requiring monitoring (e.g. following a complaint) would be undertaken in accordance with procedures outlined within the Construction Environmental Management Plan and would be carried out at the structure of the receiver building.

The mounting location of the vibration monitors must be on a stiff part of the structure either rigidly attached to or representative of the structure (at the foundations) on the side of the structures adjacent to the subject excavation works, in accordance with BS 7385 Part 2: 1993. The transducer must be positioned with the indicator arrow on top of the transducers pointing in the direction of the vibration source.

The vibration audits reporting would include the following information as a minimum during construction works:

Vibration auditing reporting items

- Work activity.
- Name of auditor and site manager.
- Details of the instrument used for the measurement including make, model, serial number and last calibration date.
- Date and time of test.
- Photograph of transducer and description of mounting location.
- Plant and equipment operating at the time of measurement.
- Description of other vibration source(s) (non-site related) and level if measurable.

Vibration auditing for building cosmetic damage prevention

Where it has been determined that continuous vibration monitoring is required to prevent risk of cosmetic damage to the structure, the vibration measurements are to be carried out with reference to the following standards:

- BS 7385-1; and
- DIN 4150-3

The frequency of reporting will be as agreed with relevant authorities in consultation with the Construction Contractor.

The vibration logger(s) will be set up to record time histogram during the proposed work hours and days. The loggers will include a real time monitoring and provide alerts for whenever the vibration levels reached the warning or stop levels as outlined in Table 12.

All units may also be set up to provide email or SMS alerts distributed to the nominated recipients when an event is triggered.

In the case of the vibration level exceeding the nominated Warning Level, construction activity does not need to cease immediately, but rather alerts the Site Manager to proceed with caution at reduced force or load.

In the case of the vibration level exceeding the nominated Stop Level, the equipment operator would be required to stop work immediately. Following the Stop Level exceedance, Project Manager is required to implement an alternative

construction technique pending further analysis of the vibration frequency content in order to determine any potential exceedance of the criteria presented in

Table 8. This include either:

- Reduce the number of vibration-generating plant/equipment items; or
- Cease operation, pending further analysis of the potential for building damage. A specialist acceptable to the construction contractor must endorse the conclusions of such an investigation.

Work must not resume until an alternative construction technique can be adopted. If it is not considered feasible or reasonable to adopt alternative construction methods, an operator-attended vibration monitoring would be conducted by a suitable qualified acoustic consultant for real-time assessment and works may proceed with caution under their strict instruction.

Documentation outlining the causation of the exceedance and control measures adopted is to be prepared and kept on site.

Vibration auditing in response to complaints (exceedance of human comfort criteria):

A vibration monitoring to address complaints may be carried out as a per request basis by Lendlease in the event where source of complaints have been identified as relating to the proposed works. Any engagement with the stakeholders should be carried out in accordance with Lendlease's stakeholder engagement procedures. The operator attended vibration survey would include the following items:

- The name and contact details of the person making the complaint.
- Time of the complaint and work associated with the complaint.
- Any other specific details relating to the complaint.
- Distance to the activity under assessment
- Measurements are to be conducted at the location inside the property of the complainant as advised by the complainant to have felt the vibration the most.
- Measured and recorded vibration level and frequency (PPV, mm/s and Hz) of the activity.
- Determine and confirm that source of vibration is related to the project activity.
- Conduct assessment of vibration emissions against the nominated human comfort criteria and provide a revised safety distances for the works.

Site noise and vibration management measures described in Section 7.1, in particular the scheduling of works and placement of plant and equipment would also provide benefits with reference to human response to vibration.

7.4 Community consultation

Community consultation will, if required, be undertaken via the construction contractor, including:

- Advising the community of work to be undertaken.
- Recording and managing any complaints.

These and other elements of the community consultation will be addressed under the relevant procedures for the subject works.

7.5 Complaints handling

This protocol is intended to provide framework relating to complaint as a result of the proposed work, and application of appropriate corrective action is identified and implemented as necessary:

- All complaints (verbal, telephone or in writing) are to be recorded and forwarded to the Project Manager, together with details of the circumstance leading to the complaint, work activity at relating to the complaint and all subsequent actions taken.
- The Project Manager shall investigate the complaint in order to determine whether work practices have been carried out with reasonable and feasible to minimise noise.
- Where excessive noise has been caused and identified as related to the work corrective action will be planned and implemented by the construction contractor

- Project Manager shall inform the complainants regarding their complaints including:
 - Outcome of the investigation; and
 - Corrective action taken (if applicable).
- Follow up monitoring or other investigations will be carried out by the Project Manager and the construction contractor to confirm the effectiveness of the corrective action.

All stakeholders must be provided with a complaint response form, with the following details:

- Name and mobile phone number of a nominated contact for the Contractor, available during all construction operations;
- Details of the relevant Council Authority for noise complaint;
- Facility to record time, source, and duration of disturbance;
- A postal address for issuing written complaint.

An example Noise Complaint Form, to be provided to residents, is provided in Appendix B.

In the event of a complaint, the Contractor must:

- Investigate the complaint immediately;
- Take any necessary remedial action;
- Report to the Council on the results of that investigation.

It is also recommended that the Contractor maintain a complaint register to allow for an assessment of the overall performance of the Plan. This register should include a record of the above actions. An example Noise Complaint Register form is provided in Appendix C.

Appendices

Appendix A Acoustic terminology

ASSESSMENT BACKGROUND LEVEL (ABL)

A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background LA90 noise levels – i.e. the measured background noise is above the ABL 90% of the time.

'A'-WEIGHTED SOUND LEVEL dBA

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dBA. An A-weighting network can be built into a sound level measuring instrument such that sound levels in dBA can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. An increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise. A change of 2 to 3 dB is subjectively barely perceptible.

DECIBEL

The ratio of sound pressures which we can hear is a ratio of $10^6:1$ (one million : one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound level' (L) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

Some typical noise levels are given below:

Noise Level dBA	Example
130	Threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside disco
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 1m
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

EQUIVALENT CONTINUOUS SOUND LEVEL (L_{Aeq})

Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq} . This is a notional steady level, which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

FREQUENCY

The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kilohertz (kHz), e.g. 2 kHz = 2000 Hz. Human hearing ranges from approximately 20 Hz to 20 kHz. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. For more detailed analysis, each octave band may be split into three one-third octave bands or, in some cases, narrow frequency bands.

RATING BACKGROUND LEVEL (RBL)

A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.

SOUND POWER AND SOUND PRESSURE

The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of distance from a source. However, the sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.

STATISTICAL NOISE LEVELS

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index that allows for this variation. 'A'-weighted statistical noise levels are denoted L_{A10} , dB_{LA90} etc. The reference time period (T) is normally included, eg. $dB_{LA10, 5min}$ or $dB_{LA90, 8hr}$.

L_{A90} (T)

Refers to the sound pressure level measured in dBA, exceeded for 90% of the time interval (T) –i.e. measured noise levels were greater than this value for 90% of the time interval. This is also often referred to the background noise level.

L_{A10} (T)

Refers to the sound pressure level measured in dBA, exceeded for 10% of the time interval (T). This is often referred to as the average maximum noise level and is frequently used to describe traffic noise.

L_{A1} (T)

Refers to the sound pressure level measured in dBA, exceeded for 1% of the time interval (T). This is often used to represent the maximum noise level from a period of measurement.

L_{Amax}

The maximum measured noise level measured in dBA.

VIBRATION

Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure borne noise or human comfort issues respectively. Vibration amplitude may be quantified as a peak value, or as a root mean squared (rms) value.

Vibration amplitude can be expressed as an engineering unit value e.g. 1mm s^{-1} or as a ratio on a logarithmic scale in decibels:

Vibration velocity level, L_v (dB) = $20 \log (V/V_{ref})$,

(where the preferred reference level, V_{ref} , for vibration velocity = 10^{-9} m/s).

The decibel approach has advantages for manipulation and comparison of data.

Appendix B Noise Complaint form

Noise Complaint Form		
If you have any queries regarding excessive noise or wish to make a complaint, please contact: Builder Contact: Address: Mobile Phone:		
Council contact number: (8.30 am to 5.00 pm)		
If, for any reason, you are not able to raise the above person, please make a note of the time and type of noise in the space provided below and send to the address detailed above.		
Your name:		Date:
Location:		
Start time	Type of noise (please be as specific as possible)	Duration of noise
Other Comments		

Appendix C Noise incident register

[illegible]