Project No: 232253R

Construction Noise and Vibration Assessment
Proposed Road Upgrade
Governor Macquarie Drive (Alfred Rd. to Childs Rd.)
Chipping Norton, NSW

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1.0 - INTRODUCTION

This construction noise assessment has been undertaken in relation to the proposed upgrade of Governor Macquarie Drive, between Alfred Road and Childs Road, Chipping Norton, NSW. The approximate location of the works is shown in **Figure 1**.

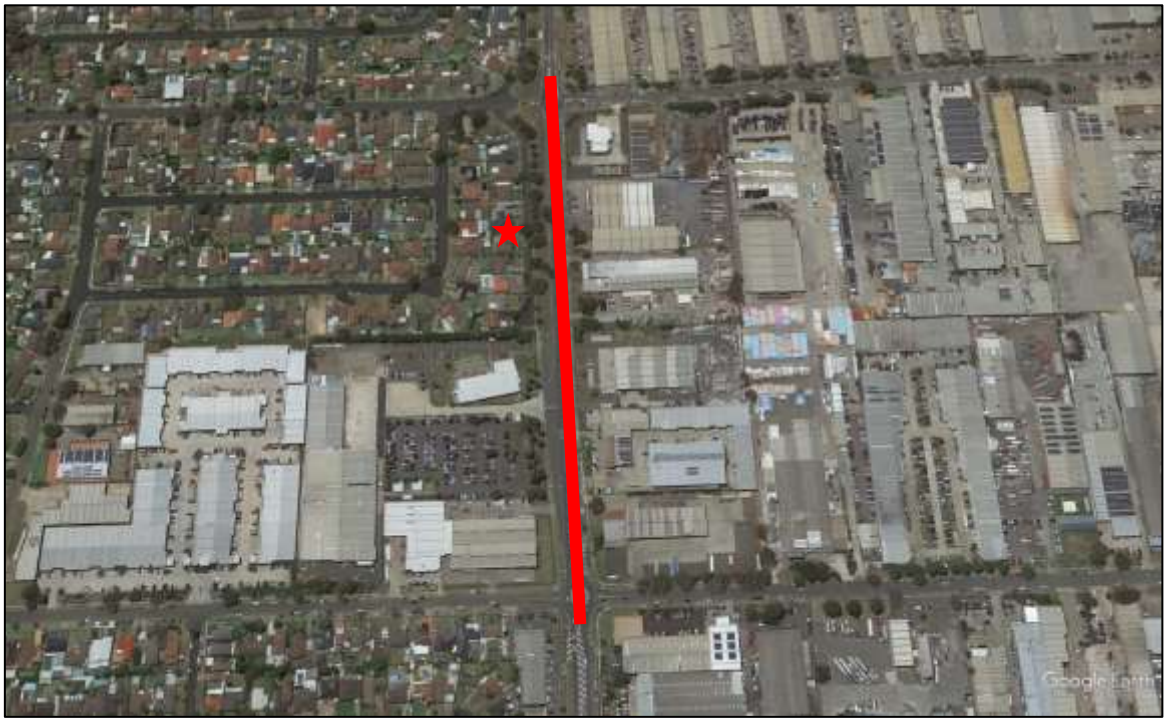

Figure 1 – Road Works Site

The proposed works will involve upgrading the existing road and include construction of sections of new pavement and the overlay of other pavement sections, turning lanes, a central median island, and the upgrade to shared paths.

The assessment of potential construction noise impacts is undertaken in accordance with the *Interim Construction Noise Guideline* (ICNG, 2009) and *Assessing Vibration: A Technical Guideline* (AVTG, 2006). These guidelines are non-mandatory but are usually referred to by local councils and the NSW Department of Planning and Infrastructure (DP&I) when construction/demolition works require development approval.

The criteria in the ICNG cover all activities and machinery associated with construction on the site including, but not limited to, site preparation and any excavation work. It is designed to ensure noise emissions resulting from the construction are maintained to minimise potential impacts to nearby receivers.

2.0 - TERMS AND DEFINITIONS

Table 1 contains the definitions of commonly used acoustical terms and is presented as an aid to understanding this report.

TABLE 1
DEFINITION OF ACOUSTICAL TERMS

Term	Definition
dB(A)	The quantitative measure of sound heard by the human ear, measured by the A-Scale Weighting Network of a sound level meter expressed in decibels (dB).
SPL	Sound Pressure Level. The incremental variation of sound pressure above and below atmospheric pressure and expressed in decibels. The human ear responds to pressure fluctuations, resulting in sound being heard.
STL	Sound Transmission Loss. The ability of a partition to attenuate sound, in dB.
Lw	Sound Power Level radiated by a noise source per unit time re 1pW.
Leq	Equivalent Continuous Noise Level - taking into account the fluctuations of noise over time. The time-varying level is computed to give an equivalent dB(A) level that is equal to the energy content and time period.
L1	Average Peak Noise Level - the level exceeded for 1% of the monitoring period.
L10	Average Maximum Noise Level - the level exceeded for 10% of the monitoring period.
L90	Average Minimum Noise Level - the level exceeded for 90% of the monitoring period and recognised as the Background Noise Level. In this instance, the L90 percentile level is representative of the noise level generated by the surrounds of the residential area.

3.0 – APPLYING THE GUIDELINE

Section 1.5 of the ICNG outlines the steps for management of construction noise impacts as follows:

1. **identify sensitive land uses** that may be affected.
2. **identify hours** for the proposed construction works.
3. **identify impacts** at sensitive land uses.
4. **select and apply the best work practices** to minimise noise impacts.

Each of the above four points is assessed in detail in the following sections.

3.1. Surrounding Land Uses

The subject site is in an area of mixed residential and commercial activity. There are residential receivers along the north western end of the proposed works and commercial/semi industrial receivers along the south western and eastern side of the road.

Potential construction noise impacts at all of these receivers will require assessment.

3.2. Operating Hours

The recommended standard hours for construction works are shown in **Table 2** which is a reproduction of Table 1, section 2.2 of the ICNG.

TABLE 2 STANDARD CONSTRUCTION HOURS	
Work Type	Recommended standard hours of work[1]
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays
Blasting	Monday to Friday 9 am to 5 pm Saturday 9 am to 1 pm No blasting on Sundays or public holidays

1 The relevant authority (consent, determining or regulatory) may impose more or less stringent construction hours

Construction work outside the hours in Table 2 is normally only permissible for delivery of oversized structures, emergency works, public infrastructure works that are supported by the affected community or where the proponent demonstrates and justifies a need to work outside the recommended standard hours (ICNG, p9).

3.3. Impacts at Sensitive Land Uses

The ICNG provides two assessment methodologies for construction noise impacts: a 'qualitative' assessment where works occur for less than three weeks and a 'quantitative' assessment for works of longer duration. As construction work will take longer than three weeks, the quantitative methodology is applicable.

Noise management Levels

Table 3 sets out noise management levels for construction works, (as reproduced from section 2.2 of the ICNG).

TABLE 3 NOISE AT RESIDENCES USING QUANTITATIVE ASSESSMENT		
Time of day	Management level Leq (15 min)	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise level 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, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

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

The ICNG also details the construction noise management levels at other potentially sensitive land uses. At industrial premises, the external noise management level is 75 dB(A) Leq (15 min). At offices and retail outlets the external noise management level is 70 dB(A) Leq (15 min).

Unattended noise logging was undertaken to quantify the existing acoustic environment of the area. A Rion NL-42 sound level meter set up as an environmental noise logger was installed in the front yard of

the residence at number 11 Ledbury Place, Chipping Norton (adjacent to Governor Macquarie Drive) between 15th and 22nd February, 2023, as shown indicatively with a star on Figure 1.

Noise levels were measured at 15 minute statistical intervals with all measurements done in accordance with relevant OEH guidelines and AS 1055-2018 "Acoustics – Description and Measurement of Environmental Noise". The noise logger used complies with the requirements of AS 1259.2-1990 "Acoustics – Sound Level Meters", and has current NATA calibration certification.

The logger was programmed to continuously register environmental noise levels over the 15 minute intervals, with internal software calculating and storing Ln percentile noise levels for each sampling period. Calibration of the logger was performed as part of the instrument's initialisation procedures, with calibration results being within the allowable ± 0.5 dB(A) range.

The logger data shows that ambient noise levels increase from early morning and stay elevated until early evening indicating the acoustic environment is dominated by noise from traffic on Governor Macquarie Drive and the nearby commercial activities.

Ambient Leq and background noise levels, obtained from the logger, are summarised in **Table 4** and shown graphically in **Appendix I**.

TABLE 4
MEASURED AMBIENT NOISE LEVELS dB(A)
11 LEDBURY DRIVE

Period	L90	Leq (15 min)
Day	52	62
Evening	43	57
Night	35	54

Based on the daytime background noise level (RBL) of 52 dB(A),L90 the daytime construction noise management level is **62 dB(A),Leq (15 min)**, at residential receivers along the roadside, in accordance with Table 2.

The ICNG details the construction noise management levels at potentially sensitive land uses other than residential. Noise management levels for such construction works are detailed in section 4.1.3 of the ICNG.

At industrial premises, the external noise management level is 75 dB(A) Leq (15 min). At offices and retail outlets the external noise management level is 70 dB(A) Leq (15 min).

3.4 Work Practises and Noise Sources

Based on typical construction scenarios for similar type projects it is envisaged that the construction works would progress along the entire length of the road upgrade in sections.

Where full depth of new pavement is to be constructed there would be a requirement for initial excavation stage followed by preparation and repaving of the road surface. Other sections will be repaved only. Shared pathways will require ground preparation and formwork.

It is envisaged that the that the plant and equipment to be used on site will include;

- Rollers,
- Vibratory rollers,
- Compactors,
- Pavement mill,
- Asphalt paver,
- Excavator,
- Concrete trucks,
- Concrete pumps, and
- Dump truck.

Appendix B of the ICNG provides references for published databases of noise levels for construction equipment. Data for maximum noise emissions from the equipment typical of that to be used on site were provided in the *Roadway construction noise model user's guide*, Federal Highway Administration (FHWA), US Department of Transport, 2006 and the NSW RTA's Environmental Noise Management Manual (ENMM). Calculated Leq (15 min) sound power levels (Lw, dB(A)) based on the FHWA and ENMM data are summarised in **Table 5**.

Additional information has also been taken from the Spectrum Acoustics technical database which has been referenced to determine the sound power level most applicable to the actual operation of the equipment proposed to be used on the site. This level is also shown in Table 5.

During a full 15 minute period the machinery items to be used on site would operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels whilst carrying out activities not requiring full power.

In addition to this, mobile machinery would likely move about during the 15 minutes, variously altering the distance from, and directivity of, the noise source with respect to individual receivers.

TABLE 5 MEASURED EQUIPMENT NOISE LEVELS dB(A) Leq			
Equipment	Range of Indicative Lw dB(A)	Range of Indicative Lp @ 10m dB(A)	Lw for Assessment as Leq (15 min)
Roller	98 - 107	70 - 79	104
Vibratory Roller	102 - 110	74 - 82	107
Compactor	91 - 106	63 - 78	103
Pavement Mill	110	82	110
Asphalt Paver	103 - 112	75 - 84	110
Excavator	97 - 117	69 - 89	102
Concrete Agitator	99 - 104	71 - 76	104
Concrete Pump	103 - 108	75 - 80	106
Dump Truck	112	84	103

The logistics of typical road construction work would mean that all of the plant items shown in Table 5 will not operate at the same time. To give a conservative (i.e. worst case) estimate of typical construction noise various configurations of machinery were considered.

For the initial phases of construction such as for new sections pavement, up to four plant items (e.g., a vibratory roller, roller, concrete agitator and dump truck) were considered to be working in close proximity. Such a configuration of machinery would result in sound pressure levels of about 83 dB(A) at 10m (i.e. a combined sound power level of approximately 111 dB(A) at the acoustic centre).

To calculate indicative potential impacts, construction noise levels have been predicted at a number of representative distances from the centre of the assessed road works.

Due to the relatively short distance between the noise sources and receivers, the influence of differing meteorological conditions was not considered in the calculations. The calculations also do not take into account the variable screening effects of intervening structures (e.g., shed buildings etc.) between the construction noise sources and any individual receiver.

Table 6 show the results of a sample calculation of potential noise impacts at representative receiver distances from the site of works, as a result of the assessed, typical, road construction operations taking place at various locations relative to the receivers.

TABLE 6 ROAD CONSTRUCTION NOISE as dB(A) Leq (15 min)				
	@25m	@ 40 m	@ 100 m	@ 250 m
Road Works Noise	111	111	111	111
Distance Loss to Receiver	36	40	48	56
Received Noise	75	71	63	55
Criterion (Management level)	62	62	62	69
Impact	13	9	0	0

The results in Table 6 show that, during the day, for the assessed initial phase of works the construction noise management level would be exceeded at residential receiver locations that are close the site of the works.

The predicted noise levels show that any residences which were within 25m of the centre of the works may be in the “highly affected” zone, that is, levels exceeding 75 dB(A) Leq (15 min). The closest parts of the construction works will be over 30m from the facade of the nearest residences (as scaled from Google Earth using the ruler function, not surveyed). There will, therefore, be no residences in the highly affected category.

All of the commercial premises along the road are set back from the edge of the pavement and, in many instances separated by car parking areas. The nearest facades are approximately 30m from the closest parts of the construction work.

The results in Table 6 also show that, compared to the most stringent noise management level for offices and retail outlets (i.e., 70 dB(A) Leq (15 min)), the theoretically predicted construction noise levels may exceed the adopted criterion at the most exposed facade of offices or commercial locations that are within 40m of the centre of the construction works.

Under such circumstances noise management practices should be implemented, as detailed in Section 4 of this report.

4.0 - NOISE MANAGEMENT

The mechanisms available for control of construction noise are limited due to the necessary and mostly unchangeable location of the works and the size and type of plant and machinery which, by necessity, must be used.

Noise control, planning and management options are discussed below and applicable recommendations are included.

4.1 Noise Control

The best ways to minimise construction noise impacts are to employ quiet work practices and use the quietest available construction equipment.

There are four main methods of controlling noise. These are;

1. Controlling noise at the source. Examples are; sound proof covers, sound reducing mufflers on plant etc. Also included here is the substitution of processes or equipment with less noisy items,

2. Controlling the transmission of noise in its path. Examples are noise barriers (such as appropriate fencing) or portable barriers which may be used around static equipment like generators,

3. Controlling noise at the receiver. Examples are insulation on buildings and thicker glazing, and

4. In addition to the above noise mitigation can involve scheduling of the more noisy activities to less sensitive periods of the day or times of the year.

For the current construction works there is little scope for the feasible and reasonable application of methods in items 2 and 3.

In relation to item 3, though, it is noted that Governor Macquarie Drive in this vicinity is relatively busy and carries a high percentage of heavy vehicles, particularly during the day. As such, it is reasonable to assume that the commercial premises with frontage to Governor Macquarie Drive have incorporated some forms of noise control in their construction in order to mitigate the potential traffic noise impacts. That is, for example, the inclusion of thicker than standard glazing, in solid frames.

This would also act to reduce any construction noise impacts.

With regard to item 1 several recommendations are made in **Section 4.3** of this report. In addition to this, **Section 4.2** details noise planning and management procedures to enable identification of particularly noise sensitive times.

4.2 Noise Planning

The proponent should undertake noise control planning as part of project pre-planning. This will identify potential noise problems and eliminate them in the planning phase prior to site works commencing.

Occupants of the nearby residences and commercial premises, with acoustic line of sight to the road, adjacent to the construction site should be notified of the project. This would, typically, be done by a letterbox drop. Included in the notification should be a description of proposed works and an outline of the proposed time frame for the various stages of the works.

The letterbox drop should include, as a minimum, all receivers within the area marked in red on **Figure 2**, and listed in **Table 7**.

TABLE 7
LETTERBOX DROP RECIPIENTS

Street Name	Street Numbers
Ledbury Place	1 to 19
Aylesbury Crescent	2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Childs Road	33, 35
Derby Crescent	2, 4, 6, 8
Governor Macquarie Drive	Commercial premises within 40m as marked on Figure 2

The letterbox drop should include, as a minimum, all receivers within the area marked in red on **Figure 2**, and (i.e., residences 1 to 19 Ledbury Place, even numbered residences between numbers 2 and 20 Aylesbury Crescent, 33 and 35 Childs Road and 2, 4, 6 and 8 Derby Crescent. It should also include commercial premises within 40m of Governor Macquarie Drive).

Figure 2 – Letterbox Drop Locations

The contact name and phone number of a responsible person should be given out so that owners/occupants may comment on the works and indicate any particularly significant noise sensitive times.

The advice should also give the name and phone number of the person responsible for accepting and dealing with complaints. All complaints or communications should be answered promptly and a record kept of all complaints, responses and actions.

The main contractor should plan to co-ordinate subcontractors so that there are no unnecessary cumulative impacts arising from the simultaneous activities of more than one subcontractor. That is, planning to avoid, if practical, having more than one noisy activity taking place in close proximity. It is good practice to appoint a single co-ordinator to oversee all significant noise producing activities.

4.3 Noise Management

All personnel working on the job including subcontractors and their employees must be made aware of their obligations and responsibilities with regard to minimising noise emissions.

Site inductions and toolbox meetings to all employees and subcontractors must include information about the need to minimise noise impacts to surrounding areas.

Contractors should familiarise themselves with methods of controlling noisy machines and alternative construction procedures. These are explained in AS2436-1981 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.

Any activities identified in in the risk assessment phase, that are known or have the potential to create excessive noise should, where possible, be scheduled to occur at times to cause least annoyance to the community. This includes start up and idling etc. of heavy machinery prior to commencement of work.

Mechanical plant should be silenced using best available control technology. Noise suppression devices should be maintained to manufacturer’s specifications.

All equipment used on the site shall have exhaust systems that have been recommended by the manufacturer as having the lowest associated noise for that machine.

Machines which are used intermittently such as rollers or other earthmoving machinery should either be shut down in the intervening periods between use or throttled down to a minimum.

Any portable equipment with the potential to create high levels of noise e.g. compressors, generators etc. should only be selected for use if it incorporates effective noise control. This equipment should be located where practical so that site sheds, or previously erected structures are between it and the nearest potentially affected receivers. Where no such barriers are present this machinery should be located behind a portable screen or enclosure.

The effectiveness of a noise barrier or screen depends on its length, height and its position relative to the source and the receiver. A screen designed to reduce noise from a stationary source should, where possible, extend a distance of twice the length of the noise source beyond the direct line of sight between the source and the receiver.
Plant known to emit noise strongly in one direction, such as a concrete agitator, should, where possible, be oriented such that the noise is directed away from the closest or the most noise sensitive receivers.

Regular and effective maintenance of all equipment including vehicles moving on and off the site should be conducted. Prompt attention must be given to repair of loose or rattling parts and broken equipment. All maintenance work should only be carried out by qualified persons.

When selecting contractors and/or equipment for the job, preference must be given to those with capacities best suited to the task at hand. That is the use of larger machines with excess capacity should be avoided unless these can be shown to be quieter than smaller capacity machines.

Site access should be designed such that delivery vehicles, and other heavy vehicles moving through the site can do so with minimum need to reverse.

Where possible, loading and unloading of plant and materials should be carried out away from potentially affected receivers.

Care should be taken not to drop materials from height either into, or out of trucks or other rigid surfaces. The surface to which the materials are being moved should be covered by some resilient material. Particular care should be taken during the loading or unloading of any scaffolding.

5.0 - ADMINSITRATIVE PROCEDURES

5.1 Subcontractor Management

It is the responsibility of the main contractor to ensure that all subcontractors comply with site requirements as well as statutory requirements. No subcontractor should be allowed on site without being

able to prove duty of care for the safety of their employees and bystanders with regard to noise emissions.

No subcontractor should be allowed on site without being able to provide adherence to the noise control measures that are relevant to their respective operations.

5.2 Action Plan

The main contractor should develop an Action Plan. This would be a document that will state responsibilities, actions, due dates and specific controls to be implemented.

6.0 – CONSTRUCTION VIBRATION

6.1 Vibration Criteria

Vibration from construction works, including continuous, intermittent or impulsive vibration from construction, but excluding blasting, is to be assessed in accordance with section 2.5 Short term works in the AVTG.

The AVTG defines the vibration associated with events such as road construction works as Intermittent.

The AVTG indicates that the assessment of intermittent vibration should be done using a vibration dose value (VDV), which is defines as the fourth root interval with respect to time of the acceleration after it has been weighted. The VDV is fully described in British Standard BS 6472: 1992 "*Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*".

Table 8 shows the acceptable VDV's for intermittent vibration taken from Table 2.4 of the AVTG.

TABLE 8
ACCEPTABLE VDV's FOR INTERMITTENT VIBRATION ($m/s^{1.75}$)

Area, Time	Preferred Value	Maximum Value
Residential – Day[1]	0.20	0.40
Residential – Night	0.13	0.26
Offices	0.40	0.80
Workshops	0.80	1.60

1. Day time is regarded as being between 7am and 10pm

The calculation of the individual vibration dose values (VDVi) is based on the equations detailed in Section 2.4.1 of the technical guideline. The calculations take into account vibration level and duration.

There are a number of Standards designed for the assessment of damage to building structures. One that is most frequently referred to is German Standard DIN 4150: Part 3-1986 *Structural Vibration in Buildings – Effects on Structures*.

DIN 4150 presents a series of "safe limit" values below which no damage due to vibration has been observed. Damage is specifically defined as including minor superficial cracking, the enlargement of existing cracks in cement render and the separation of partitions from load bearing walls.

A summary of the relevant sections from DIN 4150 is shown below in **Table 9**.

TABLE 9
STRUCTURAL DAMAGE - SAFETY LIMITS FOR BUILDING VIBRATION

Group	Type of Source	Vibration Velocity in mm/s			
		At Foundations		Plane of Floor of Uppermost Story	
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Freqs
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 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 1, or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

A more recent standard than DIN 4150 for assessing building damage is British Standard BS 7385: Part 2 – 1993 *Evaluation and Measurement of Vibration in Building part 2*. This standard was developed following a full review of available data, including other international standards, publications, and a review of UK data. The standard concludes by providing guidance for threshold values corresponding to the minimum risk of cosmetic damage from vibration.

A summary of the relevant sections from BS 7385 is shown below in **Table 10**.

TABLE 10 TRANSIENT VIBRATION LEVELS FOR COSMETIC DAMAGE			
Line	Type of Building	Peak Particle Velocity	
		4 Hz to 15 Hz	Greater than 15 Hz
1	Reinforced or framed structures. Industrial or heavy commercial buildings	50 mm/s	50 mm/s
2	Un-reinforced or light framed commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard specifically notes:

- Historic buildings should not to be assumed to be more sensitive to vibration (unless structurally unsound); and
- Structures below ground are known to sustain higher levels of vibration and are very resistant to damage, unless in poor condition.

6.2 Vibration Impacts

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The attenuation of vibration through the ground is dependent upon site specific factors relating to the strata between the vibration source and receivers. In obtaining an initial indication of likely vibration levels, it can be assumed that the vibration level is inversely proportional to distance. That is, at double the distance from the source the vibration level will be halved.

Due to the above factors, there is inherent variability in ground vibration predictions without site-specific measurement data. The NSW Roads and Traffic Authority (RTA) *Environmental Noise Management Manual* (RTA 2001). provides typical construction equipment ground vibration levels at 10m. Typical vibration levels of construction plant items are detailed in **Table 11**. These levels have been used to determine potential impacts at nearby residential and commercial receivers.

TABLE 11 TYPICAL VIBRATION LEVELS – CONSTRUCTION EQUIPMENT	
Item	Peak Particle Velocity at 10m (mm/sec)*
Vibratory Roller	7-8
Roller	5-6
Excavator	2-4

A worst case scenario was considered where a vibratory roller was working at approximately 30m from a residence or commercial premises

for a period of 10m. The total vibration dose from this activity would be 0.7.

This indicates that, under the assessed conditions, the vibration dose may exceed the acceptable level at some residential receivers that are close to the site of the activity, but would be below the acceptable level at commercial receivers.

As the vibration dose criteria are based on human comfort, they are only applicable when the residents are at home whilst the works are taking place.

Based on the typical vibration levels shown in Table 9 received vibration levels would be less than a peak particle velocity of 5 mm/s at distances of approximately 15m from a vibratory roller and less than 10m from a roller.

Based on the most stringent building damage criterion detailed in Table 9 (Group 1), this shows that there is little likelihood of damage to any buildings due to the proposed construction works.

APPENDIX I
NOISE LOGGER CHARTS