15 Noise and vibration

This chapter summarises the noise and vibration impacts of the proposed upgrade, and outlines management measures proposed to address any impacts. *Working Paper 8 – Noise and Vibration Assessment* provides a more detailed assessment of noise and vibration issues.

Environmental assessment requirement	Where addressed
> an assessment of operational road traffic noise impacts including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers;	Section 15.2
> an assessment of construction noise and vibration including construction traffic noise and blasting impacts;	Section 15.3

15.1 Approach and criteria

15.1.1 Noise survey

Ambient noise measurements were conducted over approximately a two-week period in November 2004, and a further two-week period in May 2005. The measurements were undertaken at locations along the existing highway and at other locations within the study area. Unattended noise loggers were used to continuously measure noise at seven different locations. Attended noise measurements were also conducted at a further 32 locations within the study area. A further detailed noise study was undertaken for the Newrybar Public School in February 2007.

15.1.2 Noise modelling

Noise modelling was carried out with noise level predictions made both for daytime (7am - 10pm, 15 hr) and night-time (10pm - 7am, 9 hr) for three base cases;

> 'Future-Existing', i.e. predicted Year 2012 (proposed opening date) traffic flows on the existing road alignment.

> '2012', i.e. predicted Year 2012 traffic flows on the proposed dual carriageway alignment.

> '2022', i.e. predicted Year 2022 traffic flows (10 years after opening) on the proposed dual carriageway alignment.

15.1.3 Road traffic noise criteria

Road traffic noise criteria are provided as guidelines. They provide target noise levels that are desired to be met where it is *feasible and reasonable* to do so.

The basic noise criteria are outlined in the *Environmental Criteria for Road Traffic Noise* (EPA 1999) and shown in **Table 15.1**. The noise criteria are measured at the façade of a building at a height of 1.5 m and are listed in the Noise and Vibration Assessment working paper. In addition, the Environmental Criteria for Road Traffic Noise provides specific criteria for cases with 'extra noise sensitivities', as shown in **Table 15.2**. These criteria are adopted by the RTA in its *Environmental Noise Management Manual (2001)*.

Table 15.1 - Basic noise level criteria for proposed road (from Table 1, EPA Environmental Criteria for Road Traffic Noise

Type of development	Criteria		
	Day (7am -10pm) dB(A)	Night (10pm - 7am) dB(A)	Where criteria are already exceeded
New freeway or arterial road	55 $dBL_{Aeq,15hr}$	50 $dBL_{Aeq,9hr}$	> The new road should be designed so as not to increase existing noise levels by more than 0.5 dB. > Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In some instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.
Redevelopment of existing freeway/arterial road	60 $dBL_{Aeq,15hr}$	55 $dBL_{Aeq,9hr}$	> In all cases, the redevelopment should be designed so as not to increase existing noise levels by more than 2 dB. > Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies such as improved planning, design and construction of adjoining land use developments; reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles; greater use of public transport; and alternative methods of freight haulage.

Table 15.2 - Specific noise level criteria for sensitive land uses

Sensitive land use	Criteria		
	Day (7am -10pm) dB(A)	Night (10pm - 7am) dB(A)	Noise mitigation measures
School classrooms	40 $L_{Aeq,1hr}$	-	> To achieve internal noise criteria in the short term, the most practicable mitigation measures are often related to building or façade treatments. > In the medium to longer term, strategies such as regulation of exhaust noise from in-service vehicles, limitations on exhaust brake use, and restricting access for sensitive areas or during sensitive times to low noise vehicles can be applied to mitigate noise impacts across the road system. Other measures include improved planning, design and construction of sensitive land use developments; reduced new vehicle emission standards; greater use of public transport; and alternative methods of freight haulage. These medium- to long-term strategies apply equally to mitigating internal and external noise levels. > Where existing levels of traffic noise exceed the criteria, all feasible and reasonable noise control measures should be evaluated and applied. Where this has been done and the internal or external criteria (as appropriate) cannot be achieved, the proposed road or land use development should be designed so as not to increase existing road traffic noise levels by more than 0.5 dB(A) for new roads and 2 dB(A) for redeveloped roads or land use development with potential to create additional traffic.

15.1.4 Criteria for construction noise and vibration

The EPA Environmental Noise Control Manual sets out noise criteria for construction projects. The L_{A10} noise parameter is used as the descriptor to assess construction site noise (the noise level that is exceeded for 10 percent of the time, indicative of the *average maximum level*). The relevant criterion depends on the pre-existing L_{A90} noise level (being the noise level that is exceeded for 90 percent of the time, representative of the *background* noise level) and the duration of the construction activity. Construction noise criteria are listed in **Table 15.3.**

Table 15.3 - Summary of construction noise criteria

Construction period	Criteria
4 weeks or less	L_{A10} L_{A90} + 20 dB
4 weeks to 26 weeks	L_{A10} L_{A90} + 10 dB
Greater than 26 weeks	L_{A10} L_{A90} + 5 dB
Tonal or impulsive noise	+5 dB penalty

While the total construction period for the entire project is likely to be greater than 26 weeks, many construction activities would progress along the route during the construction period, and the lowest limit (L_{A10} L_{A90} + 5 dB) would not be appropriate at all locations.

For large construction projects such as the Tintenbar to Ewingsdale upgrade, it is considered appropriate to treat noisy stages of work (such as the earthworks associated with a bridge replacement, for example) as discrete construction periods and assess them against the short and medium term guidelines, provided the cumulative affect of longer-term works is carefully managed.

Where construction noise is audible at residential premises, the EPA guideline recommends that construction should be limited to the following times:

> Monday to Friday, 7am to 6pm, with a maximum of nine hours per day.

> Saturday 7am to 1pm if inaudible on premises, otherwise 8am to 1pm.

> No construction work to occur on Sundays or public holidays.

Due to the nature of highway projects, some construction work may be required to take place outside those preferred hours. The management of these activities would include close liaison with the local community, and the implementation of best practical measures to limit disturbance to the surrounding community.

The Department of Environment and Climate Change has published *Assessing Vibration, a Technical Guideline* (DEC 2006a), which is based on British Standard BS6472 and Chapter 174 of the EPA Environmental Noise Control Manual (ENCM). Australian Standard AS 2670.2-1990 defines limits for both continuous and transient vibration events which are applicable as construction vibration criteria (**Table 15.4**).

Table 15.4 - Multiplying factors to be applied to base curves

Type of building occupancy	Time	Continuous or intermittent vibration	Transient vibration
Critical working areas eg. precision laboratories	Day	1	1
	Night	-	-
Residential	Day	2 to 4	30 to 90
	Night	1.4	1.4 to 20
Office	Day	4	60 to 128
	Night	-	-
Workshop	Day	8	90 to 128
	Night	-	-

Intermittent vibration can be assessed by using vibration dose values calculated according to British Standard BS 6472.1992. **Table 15.5** shows acceptable vibration dose values for intermittent vibration. There is a low probability of adverse comment or disturbance to building occupants at vibration dose values below the preferred values.

Table 15.5 - Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime (0700 – 2200 hrs)		Night-time (2200 – 0700 hrs)	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	0.10	0.20	0.10	0.20
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

With regard to the potential for ground vibration to cause damage to structures, vibration levels may reach much higher values than those applicable to human perception and comfort before the onset of any significant risk. It is proposed to adopt the guidelines and limits in the British Standard BS 7385 as damage criteria for this project, together with a more conservative limit of 5 mm/s in the first instance.

15.1.5 Blasting and vibration exposure

Ground vibration and airblast (also called blast overpressure) are two environmental impacts from blasting. Appendix J of AS2187.2 provides general guidance on appropriate limits for ground vibration and airblast overpressure from blasting.

Recommended limits for the vibration level and blast overpressure from blasting are also found in guidelines from the Australian and New Zealand Environment Conservation Council (ANZECC 1990). These limit blast overpressure to 115 dB (lin, peak) at any residence, and ground vibration to 5 mm/s peak particle velocity. The guidelines also restrict blasting to between 9am and 5pm on weekdays and Saturday, and recommend only one detonation per day.

15.2 Operational road noise assessment

Noise levels have been predicted at over 600 individual residences and other receiver locations along the proposed upgrade. The noise level predictions were made both for daytime (7am - 10pm, 15 hr) and night-time (10pm - 7am, 9 hr) for three base cases described in **Section 15.1.2**.

The 'Future-Existing' noise model assumes a dense graded asphalt (DGA) road surface, while the 'base case' proposed alignment model assumes a concrete road surface with a pavement surface correction of +3 dB(A) relative to DGA. In addition, modelling has also been undertaken for two additional cases with a low-noise pavement (for the purpose of noise modelling stone mastic asphalt has been assumed) in some key sections of the alignment. For this pavement type a correction of -2 dB (relative to DGA) was used. These scenarios are:

> Mitigated situation, '2012', i.e. predicted Year 2012 traffic flows on the proposed dual carriageway alignment.
> Mitigated situation '2022', i.e. predicted Year 2022 traffic flows (10 years after opening) on the proposed dual carriageway alignment.

Noise contour plots for these prediction scenarios are shown in noise contour maps in *Working Paper 8 – Noise and Vibration Assessment.*

For the base case, with a concrete pavement surface and no noise mitigation, 95 residences have predicted noise levels that are above the acute noise level criterion of 60 $dBL_{Aeq,9hr}$ and 65 $dBL_{Aeq,15hr}$ and therefore require noise mitigation. A further 219 residences exceed the base road traffic noise criteria. In total, 314 residences would require noise mitigation.

Noise barriers are not considered reasonable and feasible, except near Clover Hill, since residences near to the route are not typically 'clustered' in close proximity to each other. The low-noise pavement has therefore been examined as a potential noise mitigation measures at key sections of the alignment, including:

> All bridges.
> From about 300 m south of Newrybar (Ch 141750) to Skinners Creek (Ch 143650).
> From south of Bangalow (Ch 145200) to 750 m north of the proposed railway crossing at Bangalow (Ch 147800).
> From the northern portal of the tunnel through to the Ewingsdale interchange.

Noise predictions were also made for the use of a proposed low-noise road surface on these sections of the alignment. In this situation 63 residences are exposed to acute noise levels, and 54 residences exceed the base road traffic noise criteria. In this case, only 117 residences would require noise mitigation when a low-noise pavement is used for the proposed sections of the alignment.

A noise barrier has also been investigated adjacent to Clover Hill (near Bangalow). While the target noise levels are not able to be met with a reasonable and feasible barrier, a 4.5 – 5.5 m high noise barrier may also be considered, since it provides a reasonable level of noise mitigation.

The proposed earthworks adjacent to Ewingsdale generally provide sufficient noise attenuation for the residences at Ewingsdale.

15.3 Construction noise and vibration assessment

15.3.1 Sources of construction noise

General construction activities

The construction of a dual carriageway road generally occurs in three main stages including earthworks, laying of the road-base and final laying of pavement. The duration of the earthworks is likely to be up to six months at some locations and the laying of road base and pavement could also be up to six months at particular locations.

Noise generating activities would include construction of bridges, underpasses, and culverts; earthworks including tunnelling and cutting; paving; and drainage works. These

activities would require the occasional use of rock breakers, jackhammers and concrete saws. Bridge and embankment construction could include piling activities. Blasting is likely to be required for the construction of the St. Helena Hill tunnel (see separate discussion following), and possibly some of the large cuttings.

Batching plants

Asphalt and concrete batching plants would be required at several locations along the construction route for a period of up to 2 years. The number of batching plants and final locations would be chosen by the construction contractor and would be dependent on specific requirements and sequencing. Three preliminary general locations have been identified as potentially suitable for either concrete or ashphalt batching plants:

> On the eastern side of the Ewingsdale interchange.

> On the Bangalow Rd on the eastern side of the proposed upgrade.

> On the north-west side of the proposed Ross Lane interchange.

Noise associated with batching plants would primarily be generated from associated vehicle movements and use of plant and equipment.

Site compound

A site compound would be required to be established for offices, facilities and storage of materials, plant and equipment. A preliminary location has been identified on the eastern side of the proposed upgrade on Bangalow Rd, adjacent to the preliminary batching plant location. Depending on the specific needs of the construction contractor and the sequencing of construction, there may potentially be more than one construction compound. Noise associated with a construction compound would primarily be generated from associated vehicle movements.

Crushing plant

A crushing plant may be required near the St Helena tunnel due to the generation of significant amounts of rock spoil. A preliminary location along the southern side of the proposed tunnel works has been identified. The final location of any crushing plant would be determined by the specific needs of the contractor as well as amenity issues. The crushing plant may need to be relocated several times during construction depending on the volumes of rock spoil generated at particular locations. Noise would be generated by the operation of the crushing plant.

Construction traffic

Construction traffic will generate noise over a relatively wide area and beyond the construction site itself. Routes for construction traffic would be determined during detailed design and construction stages. It would be expected however that traffic noise would be greatest where there is a concentration of vehicle movements, such as at construction compounds, batching plant locations and where construction is occurring at a given time.

Tunnel construction

The proposed tunnel construction would include blasting. Blasting may have impacts in terms of noise, overpressure and vibration. These impacts may occur throughout the period of construction of the tunnel (at least six months).

15.3.2 Sensitive receivers

Sensitive receivers have been identified as having high potential to be impacted during construction of the proposed upgrade at three locations:

> Newrybar Public School.

> Residents at Clover Hill Estate, Bangalow.

> Residents at Ewingsdale.

There are also a number of isolated residences located on rural properties at various points along the proposed route.

15.3.3 Construction noise and vibration impacts

Noise impacts from general construction activities

The actual level of impact from construction noise would depend on the type of plant, equipment and construction methodology chosen by the construction contractor and final location of the work sites and batching plants. However, typical L_{A10} sound power levels can be predicted for a number of activities. Bridgeworks would typically generate sound power levels of 115 dB(A) to 120 dB(A), bored piling 115 dB(A), driven piling 120 dB(A), and paving up to 116 dB(A).

Based on a typical average-maximum construction site sound power level of around 113 dBL_{A10} (re 1 pW), and allowing for distance losses and typical atmospheric and environmental noise attenuation, typical construction noise levels are predicted to be around 70 – 75 dBL_{A10} at a distance of 50 m from construction sites, and 45 – 55 dBL_{A10} at a distance of 150 m. This would apply equally to earthworks and paving stages for construction.

There is the potential for construction noise criteria to be exceeded at times during the construction process where sensitive receivers are in close proximity to construction works. The three locations identified above are the most likely to be impacted by any exceedance of noise criteria. Newrybar Primary School is located 100 m from road acquisition boundary, and at both Clover Hill and Ewingsdale there are a number of sensitive receivers within 100 m of the road boundary.

Noise levels would be expected to be generally consistent along the proposed route. Sensitive receivers at a given location are likely to be exposed to noise for up to six months during the earthworks stage and up to six months during the paving stages. In the case of Newrybar Public School, the bridgeworks associated with the Broken Head Road overpass would generate noise for a period of up to nine months, which would occur after earthworks are complete, but may overlap with the paving stage.

Noise impacts from batching plants

Noise from batching or crushing plants also has the potential to impact sensitive receivers within the vicinity of the plant location. Noise emissions from batching plants arise from the use of plant and equipment and from associated vehicle movements. The preliminary plant locations have been identified in part to minimise the number of sensitive receivers. An indicative radius of 200 m has been identified as an area where construction noise criteria may be exceeded at times. Sensitive receivers within 200 m of the preliminary locations would include:

> A maximum of two residences at Ewingsdale.
> A maximum of one residence at Bangalow Road.
> A maximum of two residences at Ross Lane.

Noise would potentially be generated at these locations at least 18 months.

Noise impacts from construction compounds

An indicative radius of 200 m from construction compounds has been identified as an area where construction noise criteria may be exceeded at times. There would be one residence within 200 m of the preliminary construction compound location. Noise from a construction compound would be likely to be generated for the entire construction period.

Noise from crushing plant

A crushing plant would be likely to generate slightly higher noise levels than other construction activities. For this reason, a 300 m radius from the plant location has been identified as an indicative area which may be subject to exceedances of construction noise criteria. There are seven residences (on St Helena Road) within 300 m of the preliminary crushing plant location on the south side of the proposed tunnel. The location of the plant however would be at the base of the portal cuttings, which would provide some level of noise attenuation.

If a crushing plant is needed at other locations, it would generally be located at the base of a cutting, which would limit its potential noise impacts.

Noise from construction traffic

Noise from construction traffic within the road corridor is taken into account in generally qualitative terms in the relevant discussions above. There would be some noise impacts associated with construction vehicle movements outside the corridor, particularly in terms of any off-site disposal of excess fill. There would be a focus during detailed design, of optimising the cut/fill balance and minimising the volume of material disposed of off-site. The number and location of truck movements may be accurately determined at the completion of detailed design.

Impacts from tunnel construction

Impacts from tunnel construction would primarily be related to noise and vibration from blasting activities, which would occur over a tunnel construction period that would be at least six months. Blasting would generally be managed in accordance with the Australian and New Zealand Environment Council's (ANZECC) guidelines to manage vibration and overpressure from blasting. These guidelines recommend that blasting occurs once per day, and between 9am and 5pm on weekdays and Saturday.

The blasting would generate noise (airblast overpressure) that is likely to be audible to nearby residences. The noise would however occur as short, infrequent events and would be associated with ongoing consultation with potentially affected residents.

Based on the airborne propagation distances and the nature of the geology above the proposed tunnel, the Maximum Instantaneous Charge would be need to be limited to around 4 kg to ensure that the ANZECC overpressure and vibration guidelines are met at the nearest sensitive receivers located on the St Helena ridgeline.

Appropriate monitoring would be undertaken during blasting activities to ensure that this is the case, with blasting methods adapted where reasonable and feasible, if criteria are exceeded.

Vibration impacts

Potential vibration impacts associated with the tunnel construction are described above.

The levels of vibration generated from other construction activities would be site specific, and would be dependant on the ground type, the particular equipment used, and the proximity of the construction activity to the receiver location.

Construction activities associated with general road construction are not generally expected to generate perceptible levels of vibration at nearby residences due to the considerable propagation distances. In some cases, where construction is required near to properties, some vibration may be perceptible, but the works are not predicted to generate levels of vibration that would cause damage.

15.4 Management of impacts

15.4.1 Noise management during operation

Noise management during operation may be undertaken in a number of ways, including the construction of noise barriers, architectural treatment of individual houses, and the use of low noise pavement. Noise management measures are discussed below, with estimates of numbers of residences requiring mitigation being based on the noise modeling undertaken for the current concept design.

For 95 residences along the proposed upgrade, the acute noise level criterion of 60 $dBL_{Aeq,9hr}$ at night time and 65 $dBL_{Aeq,15hr}$ during day time is expected to be exceeded. For these houses noise mitigation is recommended. 219 residences exceed the base traffic noise criteria. Therefore, in total 314 residences would require noise mitigation.

Low-noise pavement surfacing is proposed for some sections of the alignment. Noise predictions are also made for this proposed mitigated situation with low-noise pavement on some sections of the alignment. In this situation 63 residences are exposed to acute noise levels. A further 54 residences exceed the base traffic noise criteria. Therefore, in total 117 residences would require noise mitigation when low-noise pavement is applied to these sections of the alignment.

For the residences at Clover Hill in Bangalow the feasibility of noise mitigation was investigated. For a barrier noise to be considered reasonable and feasible, it must provide at least 10 dB(A) of noise attenuation, in accordance with the RTA's Environmental Noise Management Manual. Barriers investigated in this area do not provide sufficient noise attenuation to be considered reasonable and feasible. However, a noise mound 5.5 m high would decrease noise levels at the most affected resident by approximately 9 dB(A), as well as providing noise reductions for a large number of residences. This is still considered reasonable, since it is anticipated that the earthworks for the project as a whole will result in excess material, which could be effectively reused. This noise mitigation would reduce the number of houses that need architectural treatment.

15.4.2 Noise and vibration management during construction

Management measures to reduce construction noise impacts would include:

> Preconstruction noise monitoring to identify background noise levels at representative noise sensitive locations.

> Adhering to the operating time limits and conditions where possible. And where not possible, consult with the community and obtaining advance agreement with the community and the DECC regarding work to be undertaken outside standard operating limits. Possible works outside standard operating times could include emergency works, safety works, delivery of materials or equipment (eg oversize equipment).

> Keeping the location of the stationary plant (air-compressors, generators, etc.) as far away as possible from residential areas.

> Using natural screening by topography wherever possible to reduce noise impacts.

> Using site sheds and other temporary structures or screens to limit noise exposure where possible.

> Installing operational noise barriers as early as possible to provide ongoing screening from construction activities, where possible.

> Choosing appropriate low-noise construction equipment and/or methods.

> Modifying construction equipment or the construction methodology or programme. This may entail programming activities to occur concurrently where a noisy activity will mask a less noisy activity, or, at different times where more than one noisy activity will significantly increase the noise. The programming would also consider the location of the activities due to occur concurrently.

> Choosing appropriate public consultation tools, which may include, but would not be limited to advance notification to local residents of planned activities and expected disruption/effects and effective monitoring of noise levels around potentially affected dwellings.

Environmental management measures to be adopted for construction stages would incorporate a programme of noise monitoring at sensitive receivers, a community information programme and a complaints hotline.