15. Noise and vibration

15.1 Overview

15.1.1 Noise

Noise is a key consideration for the project as the area contains locations with residential and other noise sensitive uses.

Noise modelling and assessment currently being undertaken will determine the impacts on noise sensitive land uses from the project. It is based on predicted traffic volume data and the concept design.

Traffic noise is modelled and assessed for two scenarios:

- existing road network
- future road network including the duplicated Southern Expressway.

15.1.2 Vibration

The effect of vibration was highlighted by the community as an area of concern especially where rock is likely to be encountered along the alignment. DTEI is committed to minimising the potential for vibration effects on the community.

Sensitive receivers affected by noise and vibration are residential and community (e.g. nursing homes, educational institutions, childcare centres) land uses adjacent to the Southern Expressway corridor.

15.2 Legislative and policy requirements

Table 15.1 summarises key legislation and guidelines relevant to noise and vibration associated with the project.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Description</th>
<th>Relevance to project</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Environment Protection Act 1993 (SA)</em></td>
<td>Deals with protection of the environment and polluting activities; administered and enforced by the SA Environment Protection Authority In relation to noise and vibration Section 25 of the Act states: A person must not undertake an activity which pollutes, or might pollute the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.</td>
<td>Construction and operation of the proposed project must comply with the Act, including Section 25</td>
</tr>
</tbody>
</table>
15.2.1 DTEI Road traffic noise guidelines

The DTEI Road Traffic Noise Guidelines 2007 set criteria for assessing and treating road traffic noise from infrastructure projects for new roads or major upgrade of existing roads.

The road traffic noise level criteria adopted for the project (Table 15.2) are consistent with the target range of outdoor noise levels for noise sensitive properties as described in the guidelines. Generally, where a receiver or group of receivers is not currently exposed to traffic noise, then the lower end of the range is used. For noise sensitive land uses with some exposure to existing traffic noise, an outdoor target is selected according to the level of current exposure. For noise sensitive land uses already exposed to high levels of traffic noise (above the target range), then the higher end of the range is used.

Table 15.2 Adopted road traffic noise level criteria

<table>
<thead>
<tr>
<th></th>
<th>Outdoor noise level target range for 2031 (dB(A))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daytime</strong>&lt;sup&gt;(1)&lt;/sup&gt; ( L_{eq,15h} )</td>
<td>55 to 65</td>
</tr>
<tr>
<td><strong>Night-time</strong>&lt;sup&gt;(2)&lt;/sup&gt; ( L_{eq,9h} )</td>
<td>50 to 60</td>
</tr>
</tbody>
</table>

<sup>(1)</sup> Daytime – the 15 hour period between 7.00am and 10.00pm; <sup>(2)</sup> Night-time – the 9 hour period between 10.00pm and 7.00am

Some examples of typical sound levels in dB(A) are shown in Figure 15.1.
15.2.2 DTEI Management of Noise and Vibration

DTEI Management of Noise and Vibration: Construction and Maintenance activities – Operational Instruction 21.7 establishes a guideline for infrastructure works at night that may impact noise sensitive receivers. Where feasible, these best practice work procedures should be implemented at all times to minimise disturbance from construction activities, but they are particularly important when work is programmed outside of normal construction hours of 7.00 a.m. to 7.00 p.m. Monday to Saturday and 9.00 a.m. to 7.00 p.m. Sunday and public holidays.

The noise level targets for sensitive receivers adopted for this project are from Operational Instruction 21.7 (Table 15.3).
Table 15.3  Construction noise level targets – Operational Instruction 21.7

<table>
<thead>
<tr>
<th>Days</th>
<th>Time period</th>
<th>Short-term works – up to 2 days dB(A)(1)</th>
<th>Medium-term works – 2 to 14 days dB(A)(1)</th>
<th>Long-term works – exceed 14 days dB(A)(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(L_{eq}^{(1)})</td>
<td>(L_{max}^{(1)})</td>
<td>(L_{eq}^{(1)})</td>
</tr>
<tr>
<td>Weekdays</td>
<td>6.00—7.00 a.m.</td>
<td>65</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>7.00 a.m.—7.00 p.m.</td>
<td>All reasonable measures to minimise noise (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.00–10.00 p.m.</td>
<td>75</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>10.00 p.m.—6.00 a.m.</td>
<td>45</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>Saturdays</td>
<td>Midnight—7.00 a.m.</td>
<td>45</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>7.00 a.m.—7.00 p.m.</td>
<td>All reasonable measures to minimise noise (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.00 p.m.—midnight</td>
<td>45</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>Sunday and public holidays</td>
<td>Midnight—7.00 a.m.</td>
<td>45</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>7.00 a.m.—7.00 p.m.</td>
<td>All reasonable efforts to minimise noise (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.00 p.m.—midnight</td>
<td>45</td>
<td>75</td>
<td>45</td>
</tr>
</tbody>
</table>

(1) See glossary for definition; (2) During daytime (7.00 a.m.—7.00 p.m.), all reasonable efforts would be made to minimise noise from construction in accordance with Environmental Protection (Noise) Policy 2007

In this project, construction works would be expected to affect individual receivers for long periods, thus noise level targets for long-term works will be adopted. Night works, when required, should be limited by the number of consecutive nights receivers are impacted, and give respite from sleep disturbance. For example, when sensitive receivers are exposed to noise levels 50–60 dB(A) it may be appropriate to restrict night works to three consecutive nights, followed by four nights respite; night works with noise levels greater than 60 dB(A) should be restricted to two consecutive nights, followed by five nights respite.

In areas where the background noise levels at a sensitive receiver are greater than the noise level targets listed above, the noise level target becomes the background noise level.

15.3 Assessment methodology

15.3.1 Noise

Noise modelling and assessment will be undertaken in accordance to the following methodology:

- **Noise logging.** Noise monitoring was conducted for a minimum period of 7 days at 10 locations along the existing Southern Expressway corridor.

- **Noise modelling of the existing Southern Expressway.** The noise model of the existing Southern Expressway road alignment with its adjoining major roads, currently being created, is based on known traffic volumes and vehicle types.

- **Calibration of the model of the existing Southern Expressway.** The noise model of the existing Southern Expressway will be calibrated with the noise logging results in order to demonstrate the accuracy of the model, and to determine a calibration factor, which will be applied to future noise model predictions and existing noise levels at sensitive receivers along the project corridor.
- **Definition of assessment criteria.** Noise criteria will be established for each sensitive receiver, based on the existing noise levels obtained from the calibrated existing noise model. The policies and guidelines applicable to the project will be used to also determine the noise criteria for construction and operational phases of the project.

- **Noise modelling of the project.** A noise model for the project will be constructed to determine predicted future noise levels from the combined existing and future carriageways until the year 2031 based on projected traffic growth and vehicle type data.

- **Noise assessment.** Predicted operational noise levels from the combined existing and future carriageways will be assessed against the DTEI Road Traffic Noise Guidelines (2007) criteria. Construction noise and vibration effects will also be assessed against relevant criteria.

- **Mitigation measures.** After noise modelling and assessment, potential noise attenuation measures will be developed to control noise and vibration from the duplicated Southern Expressway.

15.3.2 **Construction vibration**

Vibration levels from construction activities will be predicted for the anticipated different types of construction equipment. The estimated vibration levels from these sources will be predicted at the identified distances of the likely receiver buildings.

The predicted vibration levels will be assessed according to the likelihood and magnitude of vibration events while also considering the type of building construction (e.g. brick, timber) and the type of occupancy (e.g. residential, commercial, industrial, heritage structure).

15.4 **Existing environment**

15.4.1 **Road and background noise**

Existing environmental noise levels were measured using noise loggers at 10 locations along the existing expressway from 3 to 14 December 2010. Noise logging determines existing noise levels along the expressway corridor. Noise logging was completed in accordance with the Australian Standard AS1055: Acoustics – Description and Measurement of Environmental Noise.

Noise loggers were located at 1 metre from the most affected façade of the building where possible or completely in the free-field and set to ‘A’ frequency weighting with a ‘Fast’ time setting and recorded over 15-minute time intervals. The ‘A’ frequency weighting approximates the subjective response of normal human hearing, and the ‘Fast’ time constant is commonly used for most environmental noise measurements.

The field equipment was calibrated before placement and again at the end of the collection period. No significant drift in calibration was detected during operation. Approved windshields were installed on all microphones for the duration of the monitoring.

Half-hourly observations of rainfall and wind speed were obtained from the Bureau of Meteorology Automatic Weather Station at Adelaide Airport (site number 023034) from 3 to 5 December 2010. Meteorological data was collected from 5 to 14 December 2010 in a portable weather station located at the Panalatinga Junction in Trott Park. Rainfall data and wind speed data were synchronised with the 15 minute noise logging intervals.
15.4.2 Sensitive locations

The DTEI Road Traffic Noise Guidelines (2007) are applicable to noise sensitive land uses such as:

- existing dwellings in a zone where dwellings are contemplated, as defined by the relevant council development plan
- existing nursing homes
- caravan parks that accommodate existing long-term residential use.

The impact of traffic noise on parks is considered on a case by case basis with protection considered for areas used for passive recreation. The impact of traffic noise on existing educational institutions, childcare centres and kindergartens is assessed on a case by case basis for daytime criteria only.

15.4.3 Road traffic noise modelling results

Noise for the project is currently being modelled. The results of the noise modelling on sensitive receivers, and potential management and mitigation measures, will be discussed in the Supplement Report.

15.5 Effects of the project

15.5.1 Construction

15.5.1.1 Noise

Construction activities likely to produce noise are set out in Table 15.4.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearing</td>
<td>Removal of vegetation includes trees by use of chainsaw, chipping by tub grinder, stump removal, topsoil stripping, loading, tipping and stockpile formation</td>
</tr>
<tr>
<td>Blasting</td>
<td>Blasting and excavation of rock, etc</td>
</tr>
<tr>
<td>Earthworks &amp; drainage</td>
<td>Excavation of soil and rock, hammering/rock breaking, drilling, loading and haulage</td>
</tr>
<tr>
<td>Elevated roadway, bridge &amp; ramp construction</td>
<td>Demolition of existing structures, casting, concrete pours, placement of new pre-cast elements, bored piling, etc</td>
</tr>
</tbody>
</table>

Typical construction noise levels from machinery and equipment are listed in the DTEI Management of Noise and Vibration: Construction and Maintenance activities – Operational Instruction 21.7 (www.dtei.sa.gov.au).

Piling, blasting, rock breaking and major earthworks are typically deemed to be the noisiest construction activity. Potential sensitive receivers (yet to be determined through noise modelling) will be assessed during construction of these elements under a worst case scenario in which all equipment is fully operational.

Potential indicative noise attenuation measures during the construction of the project are discussed in Section 15.6.
15.5.1.2 Vibration

A number of factors can influence the effects of vibration: the magnitude of the vibration source, particular ground conditions between the source and receiver; foundation-to-footing interaction; and the large range of design of structures (e.g. dimensions, materials, type and quality of construction, and footing conditions). The intensity, duration, frequency and number of occurrences of vibration all contribute to annoyance levels caused and strains induced in structures.

The effects of ground vibration are classified into three categories: human comfort/exposure, building contents and structural damage.

**Human comfort**

In general, vibration criteria for human disturbance are more stringent than vibration criteria for effects on building contents and structural damage. Thus compliance with the more stringent limits for human exposure ensures compliance for the other two categories.

The typical human perception of vibration is listed in **Table 15.5**.

<table>
<thead>
<tr>
<th>Approximate vibration level (millimetres per second (mm/s))</th>
<th>Degree of human perception (in range of 8–80 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Not felt</td>
</tr>
<tr>
<td>0.15</td>
<td>Threshold of perception</td>
</tr>
<tr>
<td>0.35</td>
<td>Barely noticeable</td>
</tr>
<tr>
<td>1.0</td>
<td>Noticeable</td>
</tr>
<tr>
<td>2.2</td>
<td>Easily noticeable</td>
</tr>
<tr>
<td>6.0</td>
<td>Strongly noticeable</td>
</tr>
</tbody>
</table>

Source: German Standard DIN4150-3:1999 Structural vibration-Effects of vibration on structures

Residents nearest to road works may perceive vibrations, particularly during vibratory compaction earthworks or blasting of rock. Typically, resident perception of vibration is accompanied by concerns of structural damage thus increasing annoyance levels.

Residents will be informed and consulted to reduce concerns about potential building damage (Section 15.6).

**Structural damage and building contents**

There is no Australian Standard for assessment of building damage caused by vibration energy. In terms of structural damage, the German Standard DIN 4150 3:1999 Structural vibration – Effects of Vibration on Structures provide guidelines for allowable levels (or ‘safe limits’) of vibration for building structures (Table 15.6). Exposure to vibration has the potential to lead to damage to building structures and should be kept within allowable limits.
Table 15.6  Structural damage allowable levels for building vibration

<table>
<thead>
<tr>
<th>Group</th>
<th>Type of structure</th>
<th>Vibration velocity in mm/s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At foundation at a frequency of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;10 Hz</td>
</tr>
<tr>
<td>1</td>
<td>Commercial, industrial or similar buildings</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Dwellings &amp; buildings of similar design and/or use</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Structures that, because of their particular sensitivity to vibration, do not correspond to 1 or 2 and have intrinsic value (e.g. heritage buildings)</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: For frequencies above 100 Hz, use the higher values in the 50–100 Hz column. Where the dynamic loading caused by continuous vibration gives rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in this table may need to be reduced by up to 50%.

The highest levels of vibrations are typically generated by compactors, vibratory rollers, pile drivers and blasting activities. In most cases, vibration levels are too low in magnitude to cause structural damage to buildings located more than 25 metres from the construction activity. Heritage listed buildings within 50 metres of construction activities are considered for structural damage.

With regard to vibration resulting from blasting of rock, blasting will be done in accordance with the Australian Standard 2187.2-2006 Explosives – Storage, Transport and Use – Use of Explosives.

Residents nearest to road works may perceive vibrations, particularly during vibratory compaction earthworks or blasting of rock. It is not expected that properties will experience adverse impacts through blasting operations. Nonetheless, as a precaution, buildings located within 25 metres, and in the case of heritage-listed buildings, within 50 metres of the blasting activities, will be inspected. The building inspections condition reports before blasting provide an assessment of pre-existing structural conditions as a reference for any potential claims of damage from blasting that may be lodged.

15.5.2 Operation

15.5.2.1 Noise

The noise modelling and assessment will be provided in the Supplement Report.

15.5.2.2 Vibration

Vibration generated from construction activities is characteristically greater in magnitude than from an operational road. This is particularly the case with a road surface in good condition where there are no potholes or significant irregularities in the surface. Ground-borne vibration from traffic on arterial roads is not normally of a level that affects residents or buildings and is commonly confused with high levels of low frequency airborne noise.
15.6 Principles and measures to minimise effects during planning and design

15.6.1 Construction noise

The contractor will develop a noise and vibration management plan (NVMP), as part of the construction environmental management plan (CEMP), that incorporates the noise management and mitigation measures of:

- notifying the community near the works before construction activities begin
- providing a 24 hour contact phone number for a construction officer who has the authority to stop or alter works being undertaken if the complaint is justified
- using pro-active noise control strategies such as temporary acoustic barriers, enclosures or substitution of alternative construction processes as required to comply with noise goals
- avoiding truck movements on residential streets where possible
- shutting down, or throttling down to a minimum, machines that are used intermittently in periods between works
- shielding for compressors, power generators and other fixed plant at ground level
- ensuring all equipment has quality mufflers installed and is well maintained
- scheduling night works that create the most noise early in the night where possible
- where practicable, building respite periods into night works schedules where residents are likely to be disturbed for multiple nights
- utilising, where possible, natural noise screening from cuttings and mounds
- monitoring noise and vibration levels on site to ensure compliance with agreed criteria.

15.6.2 Construction vibration

The contractor will be required to develop an NVMP, as part of the CEMP for the whole project, that includes the vibration management and mitigation measures of:

- vibration monitoring at selected structures within 25 metres and heritage listed structures within 50 metres of construction activities that are known to generate high ground vibration levels
- regular community updates advising when and where construction activities may generate perceptible levels of vibration
- minimising vibration energy (i.e. reduced piling hammer drop distance or compactor displacement setting) as necessary depending on receiver distance.

Building condition inspections may be undertaken before construction for buildings close to construction activities that create vibration (e.g. pile driving, dynamic compaction, demolition of structures, blasting). The locations of potential building condition inspections will be determined during the detailed design phase.

15.6.3 Operation noise

The most effective way of minimising noise from road traffic is to control vehicle noise at the source and, where feasible, introduce the following:

- Quieter vehicles. DTEI supports the national processes for developing transport, vehicle or infrastructure noise standard or guidelines particularly motor vehicle noise standards.

- Installing ‘low noise’ road surfaces. The type of road surface can have a significant impact on traffic noise generated by pavement surface/tyre interactions. Road tyre noise appears to
dominate at around 70 kph which means that in areas with posted speeds of 70 kph or more, road tyre noise can be reduced by installing low noise road surfaces.

- **Modifying road gradient.** A reduced road gradient can have a positive effect on road traffic noise levels by reducing acceleration noise and engine/exhaust brake noise.

- **Roadside noise barriers and mounds.** Acoustic barriers are the most popular way of controlling noise levels in close proximity to roadways as they immediately reduce road noise. Where applicable, earth mounding with vegetation will be used to reduce the visual effects of built form structures in the landscape.

Approaches to the acoustic treatment of areas of sensitive receivers are dependent on expected noise levels and eligibility for treatment. Further noise attenuation measures will then be considered and discussed in the Supplement Report.

### 15.7 Conclusion

It is expected road traffic noise will increase for properties closer to the west of the alignment. Road noise on alternate routes is likely to decrease. The existing noise environment is currently being determined through noise logging and noise modelling of the existing road network. Noise level predictions of the project for the year 2031 are being calibrated by using noise logging locations. Noise modelling will evaluate the potential impact on sensitive receivers and identify locations where criteria are exceeded. Noise attenuation measures will depend on the amount of noise reduction required to achieve stipulated noise criteria.

Construction noise and vibration will be managed through the development of the NVMP as part of the contractor’s CEMP.