12. Noise and vibration

This Chapter summarises the potential noise and vibration impacts of the SWRL project, based on the findings of Technical Paper 5 in Volume 3 of this report. The existing noise environment is described in Section 5.1.3.

12.1 Assessment approach and criteria

12.1.1 Construction noise

Construction noise modelling scenarios were developed for those SWRL construction phases that are considered to be representative of the highest potential noise impacts (see Section 8.6 of Technical Paper 5). Predicted noise levels were calculated for both 'typical' construction activities and 'worst case' activities, assuming plant would be operating in the area closest to the respective receivers. Unattended background noise monitoring was undertaken during April and July 2006 at seven locations in the vicinity of the proposed construction works between Glenfield and Rossmore. Results are described in Section 5.1.3.

The main noise metrics used to describe construction noise emissions in the modelling and assessments are:

- $L_{A1(60\ second)}$ — the 'typical maximum noise level' for an event, used in the assessment of potential sleep disturbance during night-time periods
- $L_{A10(15\ minute)}$ — the 'average maximum noise level' during construction activities, used to assess the potential construction noise impacts
- L_{A90} — the 'background noise level' in the absence of construction activities. (This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. $L_{A10(15\ minute)}$ construction noise goals are based on the L_{A90} background noise levels. Daytime, evening and night-time periods are defined as 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm Saturdays; 6.00pm to 10.00pm; and 10.00pm to 7.00am respectively.)

Based on the Department of Environment and Conservation's (DEC's) *Environmental Noise Control Manual*, as the overall duration of the proposed construction program is greater than 26 weeks, the L_{A90} background + 5 dBA noise goal is applicable to residential and other noise sensitive receiver locations (e.g. schools, hospitals, nursing homes) along the SWRL corridor. The $L_{A10\ (15\ minute)}$ construction noise goal is based on the local L_{A90} background noise level during the relevant time period (day, evening or night). For retail and commercial buildings, it is generally accepted that receivers are 5 dBA to 10 dBA less sensitive to noise emissions than residential receivers. For these receivers, an L_{A10} noise objective of L_{A90} background + 10 dBA has been conservatively applied. The noise objectives for each of the nearby receiver groups are detailed in Table 14 of Technical Paper 5 (Volume 3).

As the existing background noise levels adjacent to the proposed SWRL may increase by up to 5 dBA as a result of the proposed change in land use from rural to suburban, the current assessment is considered to be conservative and is likely to have over-estimated the potential noise exposure at nearby residential receiver locations. At the proposed time of construction, some of the areas adjacent to the construction sites would have undergone

development, for example, Edmondson Park and Ingleburn Gardens. These new noise sensitive receivers would also be subject to potential noise impacts. As the precise timing of the development is not known at this stage, the potential future dwellings were not included in the assessment. The assessment of construction noise impacts will be reviewed following concept approval (and additional information available would be included at this stage).

12.1.2 Construction vibration

The standards normally used as a basis for assessing the risk of vibration damage to structures are German Standard DIN 4150 Part 3 1999 and British Standard BS 7385 Part 2 1993. The 'safe limits' for short-term building vibration are summarised in Section 9.2 of Technical Paper 5 (Volume 3). Safe limits are limits up to which no damage due to vibration effects would be observed for a particular class of building. Human comfort is normally assessed with reference to British Standard BS 6472 1992 or Australian Standard AS 2670.2 1990. For daytime activities, the limiting objective for continuous vibration at residential or commercial receivers is a V_{rms} (root mean squared vibration velocity) of 0.4 millimetres per second. The DEC document, *Assessing vibration: a technical guidelines*, is based on the guidelines contained in BS 6472-1992, and the acceptable values for continuous and intermittent vibration are the same.

Indicative safe working distances for typical items of vibration intensive plant are listed in Table 12-1 below. The safe working distances apply to structural damage of typical buildings and with typical geotechnical conditions. They do not address heritage structures. Vibration monitoring would need to be undertaken to confirm the safe working distances at specific sites.

Table 12-1 Recommended safe working distances for vibration intensive plant

Plant item	Rating/description	Safe working distance	
		Cosmetic damage (DIN 4150)	Human response (BS 6472)
Vibratory roller	< 50 kN (typically 1-2 tonnes)	5 metres	15 to 20 metres
	< 100 kN (typically 2-4 tonnes)	6 metres	20 metres
	< 200 kN (typically 4-6 tonnes)	12 metres	40 metres
	< 300 kN (typically 7-13 tonnes)	15 metres	100 metres
	> 300 kN (typically 13-18 tonnes)	20 metres	100 metres
	> 300 kN (> 18 tonnes)	25 metres	100 metres
Vibratory pile driver	Sheet piles	2 to 20 metres	20 metres
Pile boring	≤ 800 millimetres	2 metres (nominal)	N/A
Jackhammer	Hand held	1 metre (nominal)	Avoid contact with structure

Source: Technical Paper 5

Note: kN = kilo Newtons a measure of force

12.1.3 Operational noise (running trains)

The three primary noise metrics used to describe railway noise emissions in the modelling and assessments are:

- **L_{Amax}** — the 'maximum noise level' occurring during a train passby noise event

- **$L_{Aeq(24\ hour)}$** — the 'equivalent continuous noise level', sometimes also described as the 'energy-averaged noise level'
- **L_{AE}** — the 'sound exposure level', which is used to indicate the total acoustic energy of an individual noise event. (This parameter is used in the calculation of $L_{Aeq(24\ hour)}$ values from individual noise events.)

Pending further design development of Stage B of the SWRL project, preliminary (rather than detailed), noise modelling has been undertaken. It is proposed that detailed assessment of appropriate noise mitigation measures for the rail operations — such as the potential source controls, the location and height of noise barriers or bund walls, and building treatments — will be undertaken as part of the next stage of the assessment process. Therefore, assessment of potential mitigation methods was limited to typical measures that may be required, subject to determining future criteria and consideration of the feasibility and reasonableness of the proposed mitigation measures.

For the assessment, the predicted future noise levels were compared with the DEC's 'planning noise levels' (from Chapter 163 of its *Environmental Noise Control Manual*) in order to determine the likely noise impacts. The DEC's planning levels for residential buildings are:

- $L_{Aeq(24\ hour)}$ 55 dBA
- L_{Amax} 80 dBA.

The design goals presented in this Environmental Assessment should be regarded as indicative only and are subject to change during the assessment process. Higher or lower noise goals may be applied in further assessments, particularly in areas with existing rail operations (for example, near Glenfield). In the section of the track near Glenfield, there are both existing and proposed freight operations on the Main South Line and the Southern Sydney Freight Line. As the Freight Line is expected to be completed by 2009, it was included in this assessment, with data drawn from the *Southern Sydney Freight Line Environmental Assessment* (Australian Rail Track Corporation 2006). No noise barriers are proposed for the Freight Line within the area assessed for the SWRL.

For the purpose of this assessment, noise emissions from freight and passenger trains were modelled separately, as the noise mitigation requirements for these sources usually differ.

Computer noise modelling was undertaken for the future SWRL operations (Year 2017) on both new and upgraded sections of the track. The future noise levels were modelled for four scenarios: a 'no barrier' scenario and three barrier scenarios (with noise barriers of 2, 3 and 4 metres in height). Operational noise was calculated from midway between the two rails of the nearest track, referred to below as the track centreline.

12.1.4 Train stabling operations

The proposed stabling yard is a fixed facility and, therefore, all operational noise emissions, including train movements, were assessed in accordance with the DEC's *Industrial Noise Policy*. This Policy sets both 'intrusive' 'amenity' noise criteria. Sleep disturbance also requires assessment because of the 24 hour operations of the facility. The noise criteria are expressed in the assessment as a 5 dBA range, allowing for an increase in the background noise environment over time. Stabling facilities also have specific noise sources such as air conditioning noise, train horn operations and brake testing. Therefore, computer noise

modelling was undertaken for the daytime scenario and three night-time scenarios (representing continuous noise emissions, and brake and horn testing).

12.1.5 Operational vibration

The operational vibration criteria used for the assessment are based on the vibration dose values for human comfort nominated in BS 6472, and the DEC's *Assessing vibration: a technical guideline*. Vibration levels above the continuous vibration levels nominated in AS 2670 (106 dB for daytime, 103 dB for night-time) may be perceptible and could result in adverse comment from sensitive receivers; consequently, these vibration contours were also included in the results.

Some 'non-stopping trains' (i.e. trains that do not stop at either Leppington or Edmondson Park Stations) may run along the SWRL from the stabling facility in the future. For this reason, operational vibration predictions were conservatively based on the 'non-stopping' train speeds. The actual location of the vibration compliance contour would be somewhere between the 'stopping' and 'non-stopping' contours, and would be determined at a later stage when the operational characteristics are finalised.

12.2 Construction noise and vibration impacts

Other than the works within the existing rail corridor at Glenfield Junction and some works at road crossings, the SWRL would generally be constructed during standard hours of construction, namely 7.00am to 6.00pm Monday to Friday and 8.00am to 1.00pm on Saturdays.

12.2.1 Construction noise

Bridge and station construction

Indicative construction noise levels at sensitive receiver locations in the vicinity of bridge and station works are summarised in Table 12-2. The different scenarios are based on different assumed construction methods/equipment, as explained in Section 8.6 of Technical Paper 5. At the majority of locations, the predicted L_{A10} construction noise levels would exceed the noise goals, if no noise measures are applied, when plant and equipment are located close to residential and commercial receiver locations. This is primarily because of the small offset distances involved between construction plant and the nearest receivers, especially at construction sites near Glenfield. The highest potential impacts are predicted to occur adjacent to residential locations where rock breaking or vibratory pile driving may be required (at bridge locations and possibly some other earthworks locations). It is anticipated that rock-breakers and vibratory piling rigs would be used for only relatively short periods of time, with lower construction noise levels observed for the majority of the works.

Table 12-2 Predicted L_{A10} construction noise levels - bridge and station works (without mitigation)

Construction site	Typical receiver location		LA10 daytime 1 construction noise objectives (dBA)	Predicted LA10 construction noise levels (dBA) - Scenario2			
				1	2	3	4
Glenfield North	Glenfield Road (100 metres)	Residential	46	74	63	65	60

Construction site	Typical receiver location	LA10 daytime 1 construction noise objectives (dBA)	Predicted LA10 construction noise levels (dBA) - Scenario2			
			1	2	3	4
Junction	Foreman Street Residential (100 metres)		53	35	39	65
	Slessor Road Residential (160 metres)		72	56	60	53
Glenfield Station	Railway Parade Residential (100 metres)	52	59	67	-	-
	Hurlstone Agricultural High School (45 metres)		46	61	-	-
Glenfield South Junction	Newtown Road Residential (130 metres)	52	50	73	60	-
Hume Highway crossing	Quarter Sessions Road Residential (420 metres)	43	55	-	-	-
Campbelltown Road overbridge	Croatia Avenue Residential (600 metres)	43	44	-	-	-
	Lawson Road Residential (500 metres)		42	-	-	-
Edmondson Park Station	Croatia Avenue Residential (250 metres)	43	56	-	-	-
	Lawson Road Residential (40 metres)		70	-	-	-
Cabramatta Creek culvert	Jardine Drive Residential (130 metres)	41	62	-	-	-
	Culverston Avenue Residential (180 metres)		60	-	-	-
Camden Valley Way overbridge	Camden Valley Way Residential (30 metres)	41	82	-	-	-
	Bringelly Road Residential (270 metres)		53	-	-	-
	Forest Lawn Cemetery (150 metres)		58	-	-	-
Cowpasture Road overbridge	Cowpasture Road (West Side) Residential (50 metres)	48	67	-	-	-
	Cowpasture Road (East Side) Residential (220 metres)		57	-	-	-
Leppington Station and Rickard Road flyover	Rickard Road (North) Residential (50 metres)	39	71	-	-	-
	Rickard Road (South) Residential (80 metres)		65	-	-	-
	Leppington Primary School (320 metres)		53	-	-	-
Dickson Road flyover	Dickson Road (South) Residential (40 metres)	39	70	-	-	-
	Dickson Road (North) Residential (80 metres)		66	-	-	-
Stabling facility area	Bringelly Road Residential (240 metres)	48	57	-	-	-

Construction site	Typical receiver location		LA10 daytime 1 construction noise objectives (dBA)	Predicted LA10 construction noise levels (dBA) - Scenario2			
				1	2	3	4
	McCann Road (110 metres)	Residential	39	68	-	-	-

Note 1 Daytime construction noise objectives are presented in this table as most works would occur during this time period. Night-time noise objectives are typically 10 dBA lower than the daytime objectives.

Note 2 Shaded cells indicate a significant increase of 20 dBA or more above the daytime LA10 construction noise goal, for receivers surrounding each work site.

Corridor earthworks and track works

Noise emissions from the proposed track works, including earthworks, overhead wiring, signalling and track-laying, would move progressively along the railway corridor in stages, such that most residential receivers would not be exposed to high levels of construction noise for periods of longer than one month at a time. The predicted noise levels during these works are summarised in Table 17 of Technical Paper 5 (Volume 3). For short periods of time, criterion exceedances of over 25 dBA and up to 40 dBA are likely at the nearest receivers, with track-laying causing the greatest exceedances. Noise levels during other activities are predicted to be 5 dBA to 10 dBA lower, but may occur over longer time periods than track works. In all cases, the predicted noise levels would not be sustained.

Construction traffic noise

On local roads immediately adjacent to construction sites, the community may associate truck movements with the construction works. Once the trucks move onto collector and arterial roads, the truck noise is likely to be perceived as part of the general road traffic.

Access to construction sites is proposed via easements and other suitable locations along the corridor, resulting in numerous access points. Truck noise levels in the busiest anticipated periods are calculated to be $L_{Aeq(1hour)}$ 56 dBA to 58 dBA at receivers within 10 metres. Whilst individual truck noise events would be clearly perceptible, the L_{Aeq} assessment indicates that they would be unlikely to have a major impact on the acoustic amenity of the area.

Predicted noise levels for construction traffic lie within the DEC's noise criteria for permanent daytime road traffic noise on collector and arterial roads, which range from 55 dBA to 60 dBA. Therefore the predicted noise levels are considered to be tolerable for short to medium term construction activities. Noise from idling trucks near construction sites could also affect amenity. As such, it is recommended that queuing of trucks awaiting entry to sites outside of normal construction hours is restricted to locations away from residences. Should trucks have to queue in residential areas during construction hours, engines would be shut down.

12.2.2 Construction vibration

General

Construction activities would be managed to avoid structural damage due to vibration. In order to achieve this, the recommended safe working distances for typical structures in typical geo-technical conditions prescribed in Table 12-1 would need to be observed. If work within these zones is necessary, vibration monitoring would be undertaken.

The potential impacts of vibration during construction relate mostly to human response, which is sensitive to lower levels of vibration than that resulting in building damage. Based on data from recent projects, vibration from vibratory rollers would be clearly perceptible, but would not be expected to cause damage to buildings. The vibration from such equipment is likely to exceed the continuous vibration criterion of 0.4 millimetres per second. This could be managed by selection of rollers to minimise vibration as much as practicable (without compromising the ability to complete the required task) and that monitoring is carried out on commencement of vibratory rolling to determine an acceptable duration consistent with BS 6472.

Ground vibration levels for vibratory sheet piling are typically less than 2 millimetres per second at 10 metres distance, and are expected to comply with human comfort criteria at distances greater than 20 metres. Vibration levels would vary considerably with ground conditions, and vibratory piles can sometimes be used at closer distances without potentially significant vibration impact. As such, vibration emissions from such activities would need to be assessed on a case-by-case basis.

Sydney Water Supply Canal

The Sydney Water Supply Canal and its associated structures are potentially classed as Group 3 structures under German Standard DIN 4150 Part 3 1999, meaning they would be subject to the strictest vibration criteria because of their potential sensitivity to vibration and their intrinsic value (being heritage listed items). During vibration-intensive construction works in proximity to the Canal and its associated structures, safe working distances twice those specified in Table 12-1 would need to be observed. If work is proposed within the safe working distances, specific measurements and assessment would be required to ensure that do damage is sustained. In addition, vibration monitoring would need to be carried out at all times during vibration-intensive construction works in proximity to the Canal and its associated structures.

Vibration emissions from impact piling activities, if they are required, would need to be assessed on a case-by-case basis.

12.3 Operational noise and vibration impacts

12.3.1 Rail operational noise

The results of the computer noise modelling are presented in the form of (L_{Amax} and $L_{Aeq(24\ hour)}$) noise contour plots in Figures 10 to 17 and Appendix E of Technical Paper 5. The noise level contours represent building façade corrected values that correspond to the DEC's planning noise levels, with and without noise barriers. Noise barriers of various heights were included in the modelling for the purpose of testing the likely effectiveness of noise barriers at particular locations. This does not mean that noise barriers would be proposed in all the locations considered. This approach was taken as the project is currently at a preliminary stage of design development and the predicted changes in land uses over time mean that the details of the proposed mitigation cannot be resolved at this time.

Areas within the boundary of the contours are predicted to have noise levels above the current DEC planning levels. They include both existing buildings and the planned future land use zones and provide an indication of the noise reductions that may be achieved for various height noise barriers (i.e. they indicate the likely effectiveness of noise barriers at particular locations). The track centreline was used as the noise source in the calculations.

Table 12-3 provides a summary of predicted operational noise impacts by assessment zone. These assessment zones are indicated graphically on Figure 5-2 in this document.

Table 12-3 Summary of operational noise impacts by assessment zone

Assessment zone (refer Figure 5-2)	Summary of potential impact
A and B - east and west of the Main South Line (Glenfield)	Electric passenger train services on SWRL and existing tracks (i.e. potential cumulative noise impacts): ▪ Predicted exceedance of DEC planning levels at a large number of dwellings (see Figures 10 and 11 in Technical Paper 5) without noise barriers and significantly reduced number of exceedances with 3 metre noise barriers ▪ similar potential impacts predicted for proposed and existing residential developments in Zone A ▪ noise barriers on the eastern side of the corridor near Glenfield Station may not be practicable due to requirements for pedestrian access and visual amenity; impacts would be offset by shielding from station buildings ▪ large noise reductions possible in Zone B on the grade-separated flyover if low level parapets are used Freight train services (on SSFL and Main South Line): ▪ large number of dwellings in Zone A expected to experience exceedances without noise mitigation; 3 metre barriers would create a significant reduction in the number of affected dwellings (but less than for electric passenger trains) ▪ most existing residences (on eastern side of corridor) would benefit from the additional distance to the future Southern Sydney Freight Line tracks (on western side), but future residential development on western side would need to be considered in later design stages ▪ future residential dwellings in Zone B would generally be a significant distance from diesel freight operations, and are unlikely to be impacted significantly.
C and D - between Hume Highway and Culverston Avenue (includes Edmondson Park town centre)	Electric passenger train services on SWRL: ▪ in Zone C, without noise barriers, the planning level noise contours extend 100–140 metres either side of the Up and Down tracks (nearest track centreline) ▪ the only significant noise in these zones is the wheel/rail interface, so noise barriers are a potentially effective mitigation measure; 3 metre noise barriers would reduce the planning level exceedance zone to about 40 metres (from the nearest track) ▪ predicted noise levels at existing residences in Zone D comply with noise goals (no barrier scenario) with the exception of the closest four dwellings; in the area zoned for residential development (northern side of corridor), the exceedance zone without a barrier varies from 80 metres (eastern end) to 130 metres (western end), due in part to the change in train speed and vertical alignment; a 3 metre noise barrier would reduce the planning level exceedance zone to about 35 metres ▪ similar noise reductions could be achieved with smaller barriers/mounds if used in conjunction with land use measures (larger setbacks and rezoning)
E - Culverston Avenue (Denham Court)	Electric passenger train services on SWRL: ▪ without noise barriers, several existing residences would experience exceedances; noise barriers would provide mitigation to ensure no existing dwellings would experience noise goal exceedances ▪ the cutting through part of this zone would act as a natural barrier to noise

Assessment zone (refer Figure 5-2)	Summary of potential impact
	▪ operational rail noise would be unlikely to exceed noise goals in the area likely to be developed for residential zones in the future (given implementation of mitigation, including noise barriers)
F and G - Culverston Avenue to Cowpasture Road (includes Forest Memorial Gardens Cemetery and Western Sydney Parklands)	Electric passenger train services on SWRL: ▪ in areas on embankment through this section, without barriers, the contours extend up to 300 metres from the track; noise barriers would effectively mitigate noise in these locations to limit the area of potential exceedances; however, as the base of the modelled barrier was at track height, additional earthworks could be necessary to bring the ground height at the rail corridor up to the necessary level for sections of track on embankment ▪ in the only planned residential areas (the south-eastern side of Zone F and the extreme western end of Zone G), without noise barriers, there is a large distance (200–300 metres) to the planning level exceedance contours and the nearest track centreline; significant acoustic benefits are predicted under the 3 metre noise barrier scenario ▪ currently there are no noise criteria for cemeteries or other passive recreation areas; however, potential impacts on the Forest Memorial Gardens Cemetery are to be assessed in more detail as the design develops
H and J - Cowpasture Road to Dickson Road (Leppington)	Electric passenger train services on SWRL: ▪ some existing residential dwellings are located close to the proposed corridor; a combination of topographical and operational factors mean that large areas of these zones are potentially subject to exceedances of planning levels ▪ in the eastern section of these zones, without barriers in place, the contours extend up to 300 metres either side of the SWRL tracks, but substantial reductions are predicted with 3 metre noise barriers ▪ the cutting in the western half of the area (including Leppington Station) reduces the distance between the planning level exceedance contour and the nearest track centreline ▪ the potential acoustic impact on residential receivers around the town centre cannot be confirmed until land uses are finalised.
K - Dickson Road to Mark Road (Leppington)	Electric passenger train services on SWRL: ▪ potential noise impacts in this zone are less than in the proposed Leppington town centre due to lower train speeds and the topography of the area ▪ under the 'no barrier' scenario, the distance between the planning level contours and the nearest track centreline is between 100–160 metres, with several existing dwellings falling within this predicted exceedance zone; 3 metre barriers would significantly reduce the number of exceedances with mitigation ▪ it is likely that any decisions to provide commercial/light industrial areas along the proposed SWRL in this zone would produce a buffering effect to any residential development without the need for noise barriers or other measures ▪ should multi-storey residential development be approved alongside the proposed SWRL, noise barriers would be relatively ineffective for potential noise impacts for residents above the first or second floor

In summary, the preliminary noise modelling indicates that without mitigation measures, such as noise barriers or bund walls, there is potential for a significant number of exceedances of the DEC's planning levels under the Year 2017 scenario. For the new sections of track, most of the exceedances could be significantly reduced through the use of noise barriers of approximately 3 metres in height. On upgraded sections of the track (near

Glenfield), compliance with the planning levels may be harder to achieve due to the restrictions on barrier locations, and the source height of diesel locomotive noise emissions.

For most of the project area, it is anticipated that significant noise reductions can be achieved by using low-level noise barriers/mounds in conjunction with land use measures such as setbacks and appropriate zoning. The noise assessment was based on a preliminary design. There would be opportunity for further noise mitigation to be implemented via track infrastructure design measures.

Glenfield early works – Stage A

In regard to the Glenfield early works proposed as Stage A of the project, the existing and future noise levels exceed the DEC's 'planning levels' at a large number of residential receiver locations.

In this section of track, a new line is proposed on the Down (eastern) side of the railway corridor. At this location, Railway Parade is located between the railway corridor and the nearest residential receiver locations. On the basis of the proposed track layout and number of train movements, the L_{Amax} noise levels would increase by approximately 2 dBA and the L_{Aeq} noise levels would increase by approximately 3 dBA.

Given that the increase in L_{Aeq} noise levels would be greater than 2 dBA as a result of the project (including future traffic growth), and that the future noise levels would also exceed the noise goals, it is considered likely that noise mitigation would need to be considered as part of the project for receiver locations on the Down side of the railway corridor. The feasibility and reasonableness of constructing a noise barrier on the Down (eastern) side of the corridor would be considered in further detail; however, a noise barrier at this location may not be practical due to requirements for pedestrian access and visual amenity.

On the Up (western) side of the railway corridor, the predicted increase in L_{Amax} and L_{Aeq} noise levels are anticipated to be less than 2 dBA with the nearest receiver locations being located further from the railway corridor. It is considered unlikely that a requirement for noise mitigation would be triggered on this side of the railway corridor.

12.3.2 Stabling facility noise

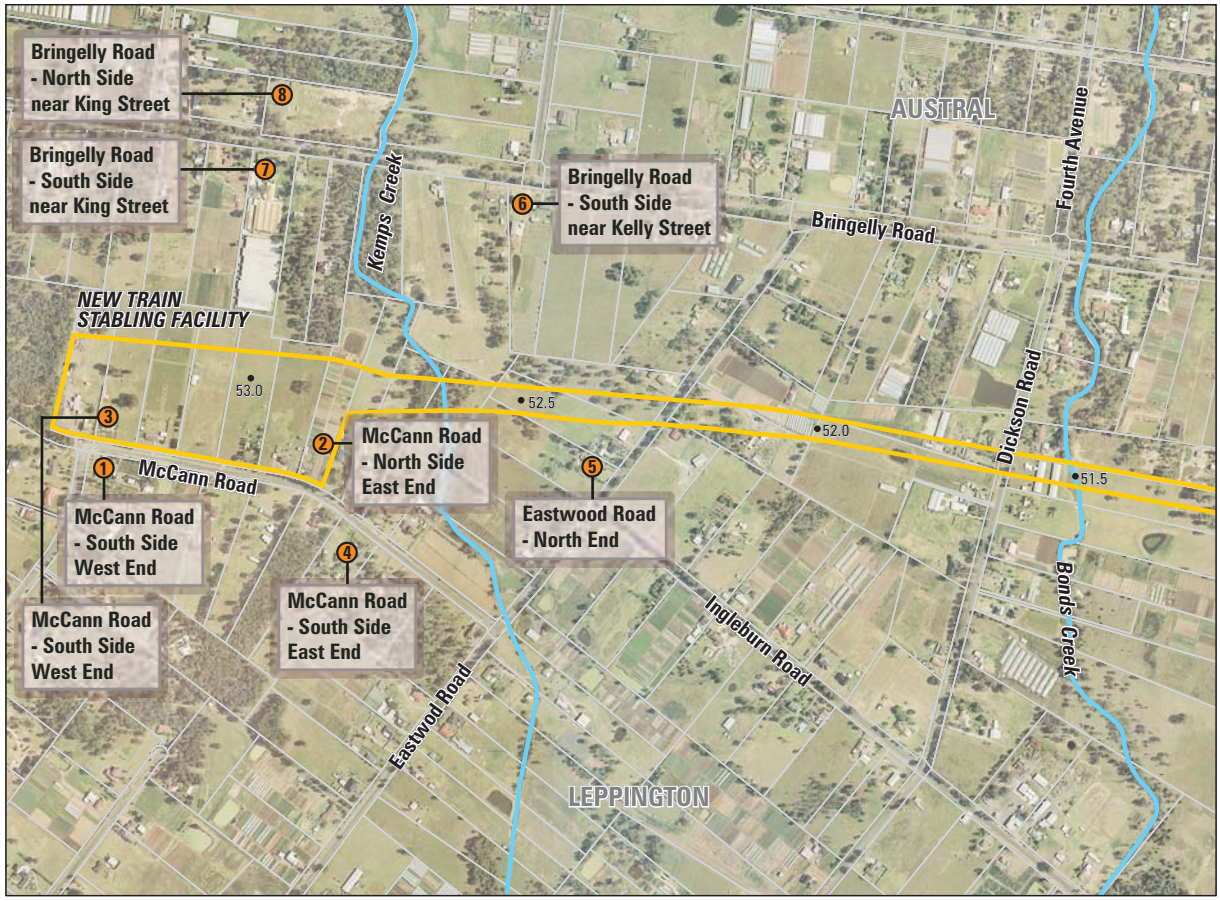
$L_{Aeq(15\ minute)}$ noise levels

Figure 12-1 summarises predicted $L_{Aeq(15\ minute)}$ noise levels at representative receiver locations near the proposed train stabling facility during the daytime and night-time. For the proposed daytime and night-time stabling operations, the highest source of noise emission (aside from horn testing discussed below) would be generated under the carriage in association with compressed air cycle and brake tests. The highest noise levels are predicted to occur at existing residential locations to the south of the stabling facility. Without noise mitigation, continuous noise emissions from the stabling facility would exceed the relevant noise goals at existing nearby residential receiver locations as indicated on Figure 12-1.

Buffer distances of up to 200 metres would be required (without noise mitigation) to achieve compliance with the upper $L_{Aeq(15\ minute)}$ noise goals. Without noise mitigation, the $L_{A1(60\ second)}$ noise levels during night-time periods would also significantly exceed the DEC's background + 5 dBA sleep disturbance screening criterion. The addition of noise barriers around the perimeter of the stabling area could be employed to reduce potential noise impacts of the proposed facility for existing receivers and decrease the extent of any buffer zones required to meet relevant noise criteria for future residential/urban development.

Representative receiver locations	$L_{Aeq(15\ minute)}$ daytime noise goal (dBA)	Predicted $L_{Aeq(15\ minute)}$ noise level daytime			$L_{Aeq(15\ minute)}$ night time noise goal (dBA)	Predicted $L_{Aeq(15\ minute)}$ noise level night-time		
		No mitigation	With 3m noise barriers	With 6m noise barriers		No mitigation	With 3m noise barriers	With 6m noise barriers
1	39 to 44	40 to 48	40 to 45	36 to 42	35 to 40	36 to 43	36 to 40	34 to 37
2	39 to 44	33 to 38	32 to 37	32 to 36	35 to 40	28 to 33	29 to 33	29 to 32
3	39 to 44	52 to 55	48 to 49	43 to 44	35 to 40	48 to 50	44 to 45	38 to 39
4	39 to 44	39 to 53	39 to 53	38 to 45	35 to 40	35 to 49	35 to 49	35 to 40
5	39 to 44	31 to 33	31 to 33	31 to 33	35 to 40	27 to 29	27 to 29	27 to 30
6	48 to 53	33 to 36	33 to 36	33 to 35	35 to 40	28 to 32	28 to 32	30 to 32
7	48 to 53	37 to 46	34 to 46	31 to 38	35 to 40	32 to 41	30 to 41	27 to 33
8	48 to 53	35 to 36	33 to 35	31 to 32	35 to 40	30 to 31	29 to 30	27 to 28

Note: Shaded cells indicate exceedances of the relevant upper noise goal by more than 3dBA



Source: Based on Technical Paper 5 - Noise and Vibration

Figure 12-1 Stabling facility representative receiver locations and predicted $L_{Aeq(15\ minutes)}$ operational noise levels

Night-time $L_{A1(60\ second)}$ noise levels - horn testing

Drivers are required to operate the train horn when preparing a stabled train for service, and it is normal practice to operate the horn immediately before moving the train. Train horns represent the greatest potential source of potential noise impact associated with the operation of the proposed stabling facility. Noise levels (without mitigation) would typically be 11 dBA to 33 dBA higher than the screening criterion of 45 to 50 dBA at the nearest existing residential receiver locations. Noise levels with 6 metre high noise barriers are also predicted to be up to 22 dBA higher than the screening criterion at the nearest residential receiver locations. Therefore, with 6 metre high noise barriers, horn noise may potentially cause sleep disturbance at residential receiver locations adjacent to or in the direct line of sight of the front or end of trains.

RailCorp is currently investigating the feasibility of a low level horn test for trains. If this proves to be feasible, the predicted noise levels could be up to 30 dBA quieter than predicted and compliance with the noise goals may be possible at most nearby residential receiver locations. If a low level horn test mode is not available, other forms of mitigation would need to be considered.

Other stabling noise sources

Train movements within the stabling facility would occur at low speed, such that $L_{Aeq(15\ minute)}$ noise levels would be controlled by noise sources other than wheel-rail noise. Train arrivals and departures would include intermittent noise from air brake valves, similar to that included above for brake tests. Train cleaning would not involve external noise sources and would not contribute significantly to noise emissions from the site. Emergency maintenance could become necessary at any point on the network, but it is unlikely to be sufficiently frequent or definable for inclusion in this assessment.

12.3.3 Operational vibration

The results of the vibration modelling are presented in the form of vibration velocity (dB re 10^{-9} metres per second) contour plots in Appendix F of Technical Paper 5 (Volume 3). The modelling results based on worst case 'non-stopping' trains indicate that none of the existing dwellings lie inside the building damage criterion contour. The 106 dB (daytime 'perceptible' zone) and 103 dB (night-time 'perceptible' zone) contours extend out to a maximum offset distance of 30 and 41 metres (from the nearest track centreline) respectively. At some locations then, the offset distance is greater than the proposed SWRL corridor width. Some of the existing dwellings lie inside these zones. On this basis it is predicted that vibration levels would be perceptible at some of the existing and proposed residential locations; however the levels would be well below the damage criterion.

Near to the stations, most trains would be operating at significantly lower speeds than the non-stopping services and, therefore, the conservative approach used in the modelling would have overestimated the potential vibration impact.

Near to, and within the proposed train stabling facility, operational train speeds would be much lower than those on the main section of the line. Due to the lower speed, and the increased setback to all but the outermost two tracks, the vibration levels are not expected to exceed the criteria (or be perceptible) at the nearest existing residential receiver locations.

12.4 Recommendations for further assessment and mitigation

12.4.1 Further assessment

In regard to operational noise, it is recommended that:

- operational noise impacts are assessed in more detail as part of the design development
- acoustic mitigation measures are provided to meet, where reasonable and feasible, the design goals (in situations where land use planning and consent condition measures do not provide adequate protection)
- the feasibility and reasonableness of providing noise barriers on the Down side of the railway corridor near Glenfield is investigated as part of the early works package
- the proponent undertakes to work with the relevant authorities (such as local Councils and the Growth Centres Commission) regarding land use decisions
- the proponent undertakes to work with local government to set acoustic standards in the consent conditions for new noise-sensitive buildings.

In regard to train stabling operational noise, it is recommended that:

- the extent of physical noise mitigation measures is determined as part of the design development and in consultation with existing land owners, the Growth Centres Commission, Camden Council and RailCorp
- new developments in addressing horn noise as a result of RailCorp's investigations regarding the feasibility of implementing a low volume horn test are investigated at a later stage in the design process.

In regard to operational vibration, no further assessment is recommended unless proposed buildings are located within approximately 30 metres of the nearest track centreline.

12.4.2 Construction management/mitigation recommendations

Recommended mitigation measures for construction noise and vibration include the following:

- Noise intensive construction works should be carried out during normal construction hours wherever practicable. Where works involving the operating line need to be carried out during weekend possessions, noise intensive activities should be scheduled to occur during the daytime where possible.
- Quietest available plant suitable for the relevant tasks should be used.
- Where feasible and reasonable, site hoardings or temporary noise barriers should be used to provide acoustic shielding of noise intensive activities. In order to be effective, these must at least break the line of sight between the receiver and the source of noise emission.
- Rock breakers should be of the 'vibro-silenced' or 'city' type, where feasible and reasonable.

- Activities resulting in highly impulsive or tonal noise emission (e.g. rock breaking) should be limited to 8.00am to 12.00pm Monday to Saturday and 2.00pm to 5.00pm Monday to Friday (except where essential during track possessions).
- Noise awareness training should be included in inductions for site staff and contractors.
- Noise generating plant should be oriented away from sensitive receivers, where possible.
- Notification should be provided to residents advising of the nature and timing of works, contact number and complaint procedures.
- Noise monitoring should be carried out to confirm that noise levels do not significantly exceed the predictions and that noise levels of individual plant items do not significantly exceed the levels shown in Table 15 of Technical Paper 5 (Volume 3).
- Deliveries should be carried out within standard construction hours, except as directed by the NSWPolice or the Roads and Traffic Authority.
- Non-tonal reversing beepers or equivalent should be fitted and used on all construction vehicles and mobile plant regularly used on-site and on other vehicles where possible.
- Trucking routes should be via major roads, where possible.
- Trucks should not be permitted to queue near residential dwellings with engines running.
- Buffer zones should be established and work within these zones limited to activities that have been assessed as safe or to activities undertaken in conjunction with strict vibration monitoring.
- The smallest suitable size of vibratory roller should be selected when working close to occupied and heritage buildings to minimise potential vibration impacts.

12.4.3 Operational noise and vibration management/mitigation recommendations

Due to the preliminary nature of the assessment, the specific details of operational mitigation have not been determined. Technical Paper 5 (Section 5.4) includes detailed discussion of mitigation options to manage potential operational noise impacts of the SWRL. Further assessment is required to confirm the potential impacts and, therefore, the appropriate combination of mitigation required. Typical measures that may be required, subject to determining future criteria and the outcome of the assessment of the methods feasibility and reasonableness include the following:

- The proposed tracks should be located in cuttings where feasible and reasonable to reduce the potential extent of noise barriers.
- Ballasted concrete bridges with side screens should be provided for the new sections of track where feasible and reasonable.
- Low level parapets should be used (where feasible and reasonable) on bridges and grade separated flyovers.
- Station public address systems (if required) should be designed to avoid excessive noise.

No mitigation measures for operational vibration are recommended at this stage. As discussed above, potential operational vibration impacts would be reassessed at a later stage in the design process if proposed buildings are located within the vibration buffer zones described in the preliminary noise assessment.