RAIL TRAFFIC NOISE ASSESSMENT FOR PROPOSED MIXED USE DEVELOPMENT

73-79 Railway Lane, Wickham

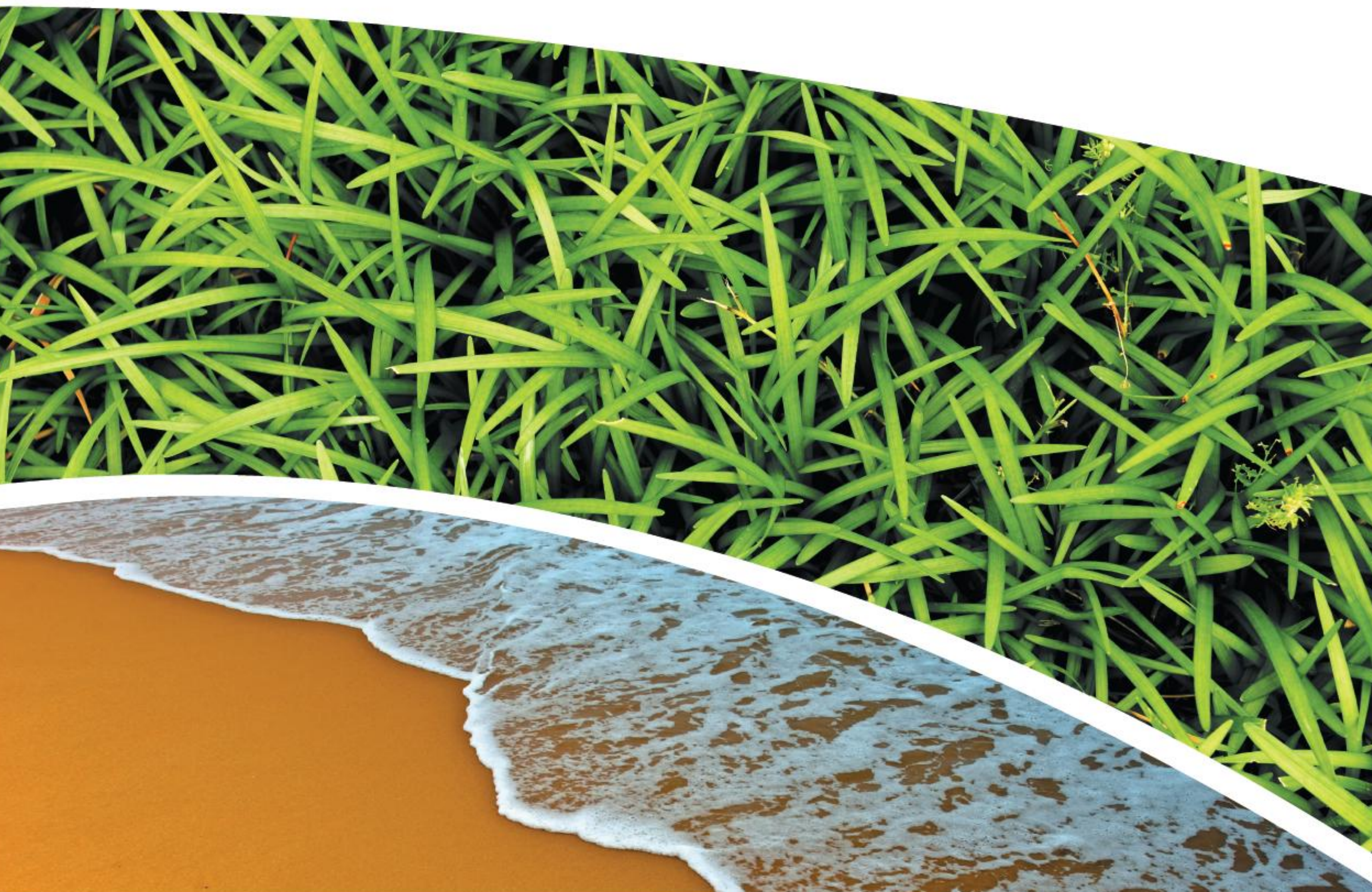
Prepared for EJE Architecture

Prepared by RCA Australia

RCA ref 12101-402/1

April 2016

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL



RCA AUSTRALIA
ABN 53 063 515 711

92 Hill Street, CARRINGTON NSW 2294

Telephone: +61 2 4902 9200
Facsimile: +61 2 4902 9299
Email: administrator@rca.com.au
Internet: www.rca.com.au

DOCUMENT STATUS

Rev No	Comment	Author	Reviewer	Approved for Issue (Project Manager)		
				Name	Signature	Date
/0	Draft	M Bain	G Mason	M Bain		01.04.16
/1	Final	M Bain	G Mason	M Bain	M.B	05.04.16

DOCUMENT DISTRIBUTION

Rev No	Copies	Format	Issued to	Date
/0	1	Electronic (email)	EJE Architecture – Patrick Bless - pbless@eje.com.au	01.04.16
/1	1	Electronic (email)	EJE Architecture – Patrick Bless - pbless@eje.com.au	05.04.16
/1	1	Electronic report	RCA – job archive	05.04.16

Contents

5 April 2016

EJE Architecture
412 King St,
Newcastle NSW 2300

Attention: Barney Collins

RAIL TRAFFIC NOISE ASSESSMENT
FOR PROPOSED MIXED USE DEVELOPMENT
73-79 RAILWAY LANE, WICKHAM

1 INTRODUCTION

RCA Acoustics has been engaged by EJE Architecture (the Client) to conduct an assessment of the impact of rail traffic noise on a proposed mixed use development to be located at 73-79 Railway Lane, Wickham, New South Wales (NSW). The proposed development is a 15 level mixed use development consisting of one level of commercial/residential use, 14 levels of residential apartments in various configurations and two levels of basement parking.

The proposed development is described in drawings by EJE Architecture, Project 10670, and dated February 2016.

This report assesses the impact of rail traffic noise from the currently unused Great Northern Rail line and the proposed Wickham Interchange on the proposed development in accordance with relevant Australian Standards and the NSW regulatory guidelines.

2 ACOUSTIC ISSUES

The proposed development has the potential to be affected by rail noise from the adjacent rail corridor and the proposed Wickham interchange, therefore suitable protective measures need to be put in place to protect the acoustic amenity of the occupants of the proposed development.

The rail corridor adjacent to the proposed development is unused at present after the closure of the rail line at Hannell Street in December 2014. The future development of the area includes a proposed transport interchange which will reopen the currently unused rail lines adjacent to the development and a light rail which is not well defined at this time.

The proposed development is set approximately 12 metres from the existing rail corridor. The proposed new railway station will be in excess of 150 metres from the closest residential unit of the proposal.

Adjacent to the development to the east is the Lass O'Gowrie Hotel. Noise emissions from the outside beer garden of the hotel may impact upon residents of the proposed development.

The area is defined as *Urban* in accordance with the *NSW Industrial Noise Policy* (INP) and the acoustic climate of the area is generally controlled by typical urban sound sources.

The location of the proposed development is shown below in **Figure 1**.

Figure 1 *Location of Proposed Development Area*

Section 3.1 of The NSW Department of Planning document *Development Near Rail Corridors and Busy Roads – Interim Guideline* (DNRCBR) sets out when an assessment is required for noise from the rail corridor and requires that noise impacts be assessed if the development is within 60 metres of the operational track.

3 DETERMINATION OF NOISE LEVELS AND CRITERIA

3.1 TRAFFIC NOISE IMPACTS ON THE DEVELOPMENT

The proposed development is set approximately 25 metres from the closest existing rail track. The NSW Department of Planning has set out internal noise level criteria for residential dwellings located near busy roads or rail corridors in its document *Development Near Rail Corridors and Busy Roads – Interim Guideline* (DNRCBR). The noise criteria for internal areas affected by noise from busy roads and rail lines are given in Table 3.1 of the DNRCBR and are set out in **Table 1**.

Table 1 *Internal Traffic Noise Criteria*

Type of Occupancy	Internal Noise Criteria	
	Internal Noise Level	Applicable Time Period
Sleeping Areas (Bedroom)	35 dB(A)	Night 9 hour (10pm – 7am)
Other Habitable Rooms (excl garages, kitchens, bathrooms and hallways)	40 dB(A)	At any time

The design level used for sleeping areas is the external night time $L_{Aeq\ 9hr}$ and the external $L_{Aeq\ 15\ hr}$ is used for other habitable areas, with the target noise goals set at the internal noise level criteria for the space type.

Section 3.6.1 of the DNRCBR states that if the internal noise levels of sleeping areas with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia.

The NSW Road Noise Policy (RNP) suggests that maximum internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep and that one or two noise events per night with maximum internal levels of 65-70 dB(A) are not likely to affect health and wellbeing significantly.

3.2 RESIDENTIAL AMENITY FROM THE LASS O'GOWRIE HOTEL

For the assessment of noise emissions from the adjacent Lass O'Gowrie Hotel upon the residential amenity of adjacent units of the development, the appropriate internal levels are taken from *AS/NZS 2107:2000 Acoustics-Recommended design sound levels for building interiors* for houses and apartments near major roads, shown below in **Table 2**.

Table 2 *Criteria for Residential Amenity*

Type of Occupancy / Activity	Recommended Design Sound Level (L_{Aeq})	
Houses & apartments near major roads -	**Satisfactory**	**Maximum**
Living Areas	35	45
Sleeping Areas	30	40

4 METHODOLOGY

4.1 RAIL TRAFFIC NOISE ASSESSMENT

The Wickham Transport Interchange (WTI) is proposed to be located approximately 175 metres to the east of the development, with the stabling yard proposed to be located adjacent to Hamilton Station. A noise and vibration assessment for the WTI was conducted by GHD in July 2014 which has been used for this assessment.

The closest façade of the proposed development is approximately 30 metres from the existing railway track which places the development in the Acoustic Assessment Zone B for passenger rail lines with speeds of less than 80 km/h in accordance with Figure 3.1 of the DNRCBR.

The GHD report has modelled operational rail noise from the proposed WTI at a receiving location on Railway Lane adjacent to the proposed development which is identified as Receiver 8 within the GHD report and is representative of the proposed development. The 10 year results shown in Appendix C of the GHD report show that Receiver 8 is predicted to be exposed to Day $L_{Aeq,\ 15\ hour}$, Night $L_{Aeq,\ 9\ hour}$ and L_{Amax} levels of 57, 55 and 80 dB(A) respectively.

A noise model of the proposed development and rail network was prepared within CadnaA 4.5 (CadnaA) using the Nordic Prediction Method for Train Noise (NMT) TemaNord 1996:524 algorithm using relevant data obtained from the GHD report.

The CadnaA model prepared for this assessment shows the same received rail traffic noise levels at the location of Receiver 8 of the GHD report and is therefore considered to be calibrated.

The façade design levels were calculated for each residential level of the building that had an acoustic view of the adjacent rail line. The external design sound levels are based on the calibrated year 2026 CadnaA model, with receiver assessment points located at window, doors and exposed facades of the proposed development. The predicted noise levels are considered to be the worst case for the 10 year predicted noise levels.

5 RESULTS

5.1 RAIL TRAFFIC NOISE

The internal noise level required by the DNRCBR can be achieved with windows and doors open provided the external noise level is less than 10 dB above the required internal noise level. Accordingly, although predictive calculations we made for each facade on the building, **Table 3** only reports the areas where the internal sound level would not be achieved with windows open and, therefore, some form of noise intrusion control will be required.

Masonry façades will be used for the construction of the development which will provide a minimum Rw of 52 dB, so the only specific treatment that is required for this development is the selection of glass panels and framing for the windows and doors in areas that have direct exposure to road and rail traffic.

Table 3 gives the predicted external façade noise levels for the year of 2026, and specifies the sound transmission loss requirements across the façade as well as the required glazing R_w+ C_{tr} value needed for the building façade at assessed locations.

Table 3 *Required Sound Transmission Loss, Glazing and Ventilation for Traffic Affected Façades*

ID	Modelled 2026 External Sound Level - Façade corrected			Room Type	Internal SPL	Required Sound Transmission Loss		Required Rw +Ctr	Required Glazing	Internal L_{Amax} (windows open)	Internal L_{Amax} (windows closed)	Ventilation Required
	Day	Night				Day	Night					
	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$	L_{Amax}		(dBA)	(dB)	(dB)					
1.05 Bed01 1.OG	49.9	47.7	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes
1.08 Bed02 1.OG	54.2	52	77.2	Bedroom	35	-	17	22	6mm float	65	47	Yes
1.08 bed01 1.OG	55.6	53.4	78.6	Bedroom	35	-	18	23	6mm float	66	48	Yes
1.09 Bed02 1.OG	54.6	52.4	77.6	Bedroom	35	-	17	22	6mm float	65	47	Yes
1.09 bed01 1.OG	54.6	52.4	77.6	Bedroom	35	-	17	22	6mm float	65	47	Yes
1.10 Bed02 1.OG	53.1	50.9	76.1	Bedroom	35	-	16	21	6mm float	64	46	Yes
1.10 bed01 1.OG	54.5	52.3	77.5	Bedroom	35	-	17	22	6mm float	65	47	Yes
1.13 Bed01 1.OG	50.3	48.1	73.3	Bedroom	35	-	13	18	6mm float	61	43	Yes
1.14 Bed01 1.OG	50	47.8	73	Bedroom	35	-	13	18	6mm float	61	43	Yes
1.15 Living 1.OG	49.6	47.4	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
1.15 Bed02 1.OG	50	47.8	73	Bedroom	35	-	13	18	6mm float	61	43	Yes
1.16 Bed01 1.OG	49.7	47.4	72.7	Bedroom	35	-	12	17	6mm float	60	42	Yes
1.19 Bed01 1.OG	56.8	54.6	79.8	Bedroom	35	-	20	25	6mm float	67	49	Yes
1.19 Bed02 1.OG	56.1	53.9	79.1	Bedroom	35	-	19	24	6mm float	67	49	Yes
1.20 Bed01 1.OG	55.6	53.4	78.6	Bedroom	35	-	18	23	6mm float	66	48	Yes
1.20 Bed02 1.OG	53.9	51.7	76.9	Bedroom	35	-	17	22	6mm float	64	46	Yes
2.04 Studio 2.OG	49.8	47.6	72.8	Bedroom	35	-	13	18	6mm float	60	42	Yes
2.05 Bed01 2.OG	49.6	47.3	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
2.08 Bed02 2.OG	54.5	52.3	77.5	Bedroom	35	-	17	22	6mm float	65	47	Yes
2.08 bed01 2.OG	54.2	52	77.2	Bedroom	35	-	17	22	6mm float	65	47	Yes
2.09 Bed02 2.OG	54.7	52.5	77.7	Bedroom	35	-	18	23	6mm float	65	47	Yes
2.09 bed01 2.OG	54.6	52.4	77.6	Bedroom	35	-	17	22	6mm float	65	47	Yes
2.10 Bed02 2.OG	53.1	50.9	76.1	Bedroom	35	-	16	21	6mm float	64	46	Yes
2.10 bed01 2.OG	54.6	52.3	77.6	Bedroom	35	-	17	22	6mm float	65	47	Yes
2.13 Bed01 2.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
2.14 Bed01 2.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
2.15 Bed02 2.OG	50.4	48.1	73.4	Bedroom	35	-	13	18	6mm float	61	43	Yes
2.15 Bed01 2.OG	49.6	47.4	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
2.16 Bed01 2.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
2.19 Bed01 2.OG	56.7	54.5	79.7	Bedroom	35	-	20	25	6mm float	67	49	Yes

ID	Modelled 2026 External Sound Level - Façade corrected				Internal SPL	Required Sound Transmission Loss		Required Rw +Ctr	Required Glazing	Internal L_{Amax} (windows open)	Internal L_{Amax} (windows closed)	Ventilation Required
	Day	Night				Day	Night					
	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$	L_{Amax}	Room Type	(dBA)	(dB)	(dB)					
2.19 Bed02 2.OG	56.1	53.8	79.1	Bedroom	35	-	19	24	6mm float	67	49	Yes
2.20 Bed01 2.OG	55.1	52.9	78.1	Bedroom	35	-	18	23	6mm float	66	48	Yes
2.20 Bed02 2.OG	49.7	47.4	72.7	Bedroom	35	-	12	17	6mm float	60	42	Yes
3.01 Bed01 3.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.04 Studio 3.OG	49.7	47.5	72.7	Bedroom	35	-	13	18	6mm float	60	42	Yes
3.05 Bed02 3.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.08 Bed02 3.OG	52	49.8	75	Bedroom	35	-	15	20	6mm float	63	45	Yes
3.08 bed01 3.OG	51.2	49	74.2	Bedroom	35	-	14	19	6mm float	62	44	Yes
3.09 Bed02 3.OG	52.5	50.3	75.5	Bedroom	35	-	15	20	6mm float	63	45	Yes
3.09 bed01 3.OG	52.4	50.2	75.4	Bedroom	35	-	15	20	6mm float	63	45	Yes
3.10 Bed02 3.OG	50.7	48.5	73.7	Bedroom	35	-	14	19	6mm float	61	43	Yes
3.10 bed01 3.OG	52.8	50.5	75.8	Bedroom	35	-	16	21	6mm float	63	45	Yes
3.11 Bed02 3.OG	50.7	48.5	73.7	Bedroom	35	-	14	19	6mm float	61	43	Yes
3.13 Bed02 3.OG	49.6	47.3	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
3.13 Bed01 3.OG	50	47.8	73	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.14 Bed01 3.OG	49.9	47.7	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes
3.15 Bed02 3.OG	50.6	48.4	73.6	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.15 Bed01 3.OG	50	47.7	73	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.16 Bed02 3.OG	50.5	48.3	73.5	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.16 Bed01 3.OG	50.3	48.1	73.3	Bedroom	35	-	13	18	6mm float	61	43	Yes
3.19 Bed01 3.OG	56.6	54.4	79.6	Bedroom	35	-	19	24	6mm float	67	49	Yes
3.19 Bed02 3.OG	55.3	53.1	78.3	Bedroom	35	-	18	23	6mm float	66	48	Yes
3.20 Bed01 3.OG	51.6	49.4	74.6	Bedroom	35	-	14	19	6mm float	62	44	Yes
3.20 Bed02 3.OG	54.1	51.9	77.1	Bedroom	35	-	17	22	6mm float	65	47	Yes
3.20 Living 3.OG	56.6	54.4	79.6	Bedroom	35	-	19	24	6mm float	67	49	Yes
3.21 Bed02 3.OG	49.6	47.4	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
4.01 Bed01 4.OG	50.2	48	73.2	Bedroom	35	-	13	18	6mm float	61	43	Yes
4.07 Bed02 4.OG	50.8	48.6	73.8	Bedroom	35	-	14	19	6mm float	61	43	Yes
4.07 Bed01 4.OG	49.9	47.7	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes
4.10 Studio SW 4.OG	56.6	54.4	79.6	Bedroom	35	-	19	24	6mm float	67	49	Yes
4.11 Bed02 4.OG	51.1	48.9	74.1	Bedroom	35	-	14	19	6mm float	62	44	Yes
4.11 Bed01 4.OG	49.9	47.7	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes

ID	Modelled 2026 External Sound Level - Façade corrected			Room Type	Internal SPL	Required Sound Transmission Loss		Required Rw +Ctr	Required Glazing	Internal L_{Amax} (windows open)	Internal L_{Amax} (windows closed)	Ventilation Required
	Day	Night				Day	Night					
	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$	L_{Amax}		(dBA)	(dB)	(dB)					
4.12 Bed01 4.OG	49.9	47.7	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes
5.01 Bed01 5.OG	50.3	48.1	73.3	Bedroom	35	-	13	18	6mm float	61	43	Yes
5.03 Studio 5.OG	49.6	47.4	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
5.07 Bed02 5.OG	50.1	47.8	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
5.08 Bed01 5.OG	50.8	48.6	73.8	Bedroom	35	-	14	19	6mm float	61	43	Yes
5.10 Studio SW 5.OG	56	53.7	79	Bedroom	35	-	19	24	6mm float	67	49	Yes
5.11 Bed02 5.OG	51.3	49.1	74.3	Bedroom	35	-	14	19	6mm float	62	44	Yes
5.12 Bed01 5.OG	51.6	49.4	74.6	Bedroom	35	-	14	19	6mm float	62	44	Yes
6.01 Bed01 6.OG	49.9	47.6	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes
6.07 Bed02 6.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
6.08 Bed01 6.OG	50.5	48.3	73.5	Bedroom	35	-	13	18	6mm float	61	43	Yes
6.10 Studio SW 6.OG	55.6	53.4	78.6	Bedroom	35	-	18	23	6mm float	66	48	Yes
6.11 Bed02 6.OG	50.4	48.2	73.4	Bedroom	35	-	13	18	6mm float	61	43	Yes
6.12 Bed01 6.OG	50.6	48.4	73.6	Bedroom	35	-	13	18	6mm float	61	43	Yes
7.01 Bed01 7.OG	49.6	47.4	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
7.02 Bed02 7.OG	49.9	47.6	72.9	Bedroom	35	-	13	18	6mm float	60	42	Yes
7.07 Bed02 7.OG	49.6	47.4	72.6	Bedroom	35	-	12	17	6mm float	60	42	Yes
7.08 Bed01 7.OG	50.3	48.1	73.3	Bedroom	35	-	13	18	6mm float	61	43	Yes
7.10 Studio SW 7.OG	55.3	53.1	78.3	Bedroom	35	-	18	23	6mm float	66	48	Yes
7.12 Bed02 7.OG	50.4	48.2	73.4	Bedroom	35	-	13	18	6mm float	61	43	Yes
7.12 Bed01 7.OG	50.2	48	73.2	Bedroom	35	-	13	18	6mm float	61	43	Yes
8.03 Bed02 8.OG	49.8	47.6	72.8	Bedroom	35	-	13	18	6mm float	60	42	Yes
8.07 Bed02 8.OG	50.8	48.6	73.8	Bedroom	35	-	14	19	6mm float	61	43	Yes
8.09 Studio 8.OG	54.9	52.7	77.9	Bedroom	35	-	18	23	6mm float	65	47	Yes
8.11 Bed01 8.OG	50.9	48.7	73.9	Bedroom	35	-	14	19	6mm float	61	43	Yes
8.12 Studio 8.OG	55	52.8	78	Bedroom	35	-	18	23	6mm float	66	48	Yes
9.04 Bed01 9.OG	50.1	47.9	73.1	Bedroom	35	-	13	18	6mm float	61	43	Yes
9.08 Bed01 9.OG	50.3	48.1	73.3	Bedroom	35	-	13	18	6mm float	61	43	Yes
9.09 Studio 9.OG	54.6	52.4	77.6	Bedroom	35	-	17	22	6mm float	65	47	Yes
9.10 Bed01 9.OG	50.2	47.9	73.2	Bedroom	35	-	13	18	6mm float	61	43	Yes
9.11 Bed01 9.OG	50.5	48.3	73.5	Bedroom	35	-	13	18	6mm float	61	43	Yes
9.12 Studio 9.OG	54.7	52.5	77.7	Bedroom	35	-	18	23	6mm float	65	47	Yes

ID	Modelled 2026 External Sound Level - Façade corrected			Room Type	Internal SPL (dBA)	Required Sound Transmission Loss		Required Rw +Ctr	Required Glazing	Internal L_{Amax} (windows open)	Internal L_{Amax} (windows closed)	Ventilation Required
	Day	Night				Day	Night					
	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$	L_{Amax}			(dB)	(dB)					
10.01 Bed02 10.OG	49.8	47.6	72.8	Bedroom	35	-	13	18	6mm float	60	42	Yes
10.08 Bed01 10.OG	49.8	47.6	72.8	Bedroom	35	-	13	18	6mm float	60	42	Yes
10.09 Studio 10.OG	54.2	52	77.2	Bedroom	35	-	17	22	6mm float	65	47	Yes
10.12 Studio 10.OG	54.4	52.1	77.4	Bedroom	35	-	17	22	6mm float	65	47	Yes
11.09 Studio 11.OG	53.9	51.7	76.9	Bedroom	35	-	17	22	6mm float	64	46	Yes
11.12 Studio 11.OG	54	51.8	77	Bedroom	35	-	17	22	6mm float	65	47	Yes
12.09 Studio 12.OG	53.5	51.3	76.5	Bedroom	35	-	16	21	6mm float	64	46	Yes
12.12 Studio 12.OG	53.7	51.5	76.7	Bedroom	35	-	17	22	6mm float	64	46	Yes
13.09 Studio 13.OG	53.2	51	76.2	Bedroom	35	-	16	21	6mm float	64	46	Yes
13.12 Studio 13.OG	53.3	51.1	76.3	Bedroom	35	-	16	21	6mm float	64	46	Yes
14.09 Studio 14.OG	52.8	50.6	75.8	Bedroom	35	-	16	21	6mm float	63	45	Yes
14.12 Studio 14.OG	53	50.8	76	Bedroom	35	-	16	21	6mm float	64	46	Yes
GHD R8 GF boundary	57.3	55.1	80.3	-	-	-	-	-	-	-	-	-

Table 3 above shows that the internal levels required by the DNRCBR can be achieved at all units of the development with the use of 6mm monolithic glass, however, ventilation is required in the bedrooms identified in order to control the L_{Amax} levels from the rail line.

5.2 RESIDENTIAL AMENITY FROM LASS O'GOWRIE HOTEL

The assessment of noise from people within the Lass O'Gowrie external beer garden adjacent to the development with regard to acoustic amenity has been conducted within the CadnaA noise model prepared for the project.

In order to determine the maximum impact, 12 groups of 10 people talking and laughing loudly with a Sound Power Level of 90 dB(A) were placed in the outside beer garden of the Lass O'Gowrie Hotel to the east of the development at the locations of existing tables.

The received noise from people in the beer garden are shown in **Table 4** and compared with the AS/NZS 2107 criteria shown in **Section 3.2**.

Table 4 *Received Noise from People in the Lass O'Gowrie Beer Garden*

Receiving Room	Received dB(A)	Required Internal SPL	Required Transmission Loss -dB(A)	Required Rw	Glazing	Ventilation
1.21 Bed02 1.OG	70.9	35	36	41	8.38 lam + 6mm float, 50mm between panes	Yes
1.21 Bed01 1.OG	61	35	26	31	6.38 Laminated	Yes
2.05 Bed02 2.OG	49.2	35	14	19	6mm float	Yes
2.05 Bed01 2.OG	49	35	14	19	6mm float	Yes
2.06 Bed01 2.OG	49.1	35	14	19	6mm float	Yes
2.06 Bed02 2.OG	49.9	35	15	20	6mm float	Yes
2.07 Bed01 2.OG	50.8	35	16	21	6mm float	Yes
2.09 Bed02 2.OG	47.1	35	12	17	6mm float	Yes
2.09 bed01 2.OG	47.1	35	12	17	6mm float	Yes
2.15 Bed02 2.OG	50.1	35	15	20	6mm float	Yes
2.15 Bed01 2.OG	47.1	35	12	17	6mm float	Yes
2.16 Bed02 2.OG	46.5	35	12	17	6mm float	Yes
2.16 Bed01 2.OG	45.8	35	11	16	6mm float	Yes
2.17 Bed02 2.OG	50.8	35	16	21	6mm float	Yes
2.17 Bed01 2.OG	47.3	35	12	17	6mm float	Yes
2.18 Bed02 2.OG	47.4	35	12	17	6mm float	Yes
2.18 Bed01 2.OG	51	35	16	21	6mm float	Yes
2.19 Bed01 2.OG	46.7	35	12	17	6mm float	Yes
2.19 Bed02 2.OG	46.5	35	12	17	6mm float	Yes
2.20 Bed01 2.OG	45.9	35	11	16	6mm float	Yes
2.20 Bed02 2.OG	47.1	35	12	17	6mm float	Yes
2.21 Bed02 2.OG	68.1	35	33	38	8.38 lam + 6mm float, 50mm between panes	Yes
2.21 Bed01 2.OG	56.3	35	21	26	6mm float	Yes
3.05 Bed02 3.OG	48.7	35	14	19	6mm float	Yes
3.05 Bed01 3.OG	48.6	35	14	19	6mm float	Yes
3.06 Bed01 3.OG	48.9	35	14	19	6mm float	Yes
3.06 Bed02 3.OG	49.5	35	15	20	6mm float	Yes
3.07 Bed01 3.OG	49.6	35	15	20	6mm float	Yes
3.09 Bed02 3.OG	45.6	35	11	16	6mm float	Yes
3.09 bed01 3.OG	45.2	35	10	15	6mm float	Yes
3.10 bed01 3.OG	45.4	35	10	15	6mm float	Yes
3.15 Bed02 3.OG	50.8	35	16	21	6mm float	Yes
3.15 Bed01 3.OG	48.4	35	13	18	6mm float	Yes
3.16 Bed02 3.OG	48.7	35	14	19	6mm float	Yes
3.16 Bed01 3.OG	47.7	35	13	18	6mm float	Yes
3.17 Bed02 3.OG	50.2	35	15	20	6mm float	Yes
3.17 Bed01 3.OG	47.7	35	13	18	6mm float	Yes
3.18 Bed02 3.OG	48.8	35	14	19	6mm float	Yes
3.18 Bed01 3.OG	51.1	35	16	21	6mm float	Yes
3.20 Bed02 3.OG	47.5	35	13	18	6mm float	Yes
3.21 Bed02 3.OG	66.4	35	31	36	6.38 lam + 6mm float, 50mm between panes	Yes
3.21 Bed01 3.OG	54.6	35	20	25	6mm float	Yes
4.04 Bed01 4.OG	47.9	35	13	18	6mm float	Yes
4.04 Bed02 4.OG	47.9	35	13	18	6mm float	Yes
4.05 Bed01 4.OG	47.9	35	13	18	6mm float	Yes
4.05 Bed02 4.OG	48.3	35	13	18	6mm float	Yes
4.06 Bed1 4.OG	46	35	11	16	6mm float	Yes
4.11 Bed02 4.OG	47.2	35	12	17	6mm float	Yes

Receiving Room	Received dB(A)	Required Internal SPL	Required Transmission Loss -dB(A)	Required Rw	Glazing	Ventilation
4.11 Bed01 4.OG	47.5	35	13	18	6mm float	Yes
4.12 Bed02 4.OG	49.9	35	15	20	6mm float	Yes
4.12 Bed01 4.OG	50.2	35	15	20	6mm float	Yes
4.13 Bed02 4.OG	46.2	35	11	16	6mm float	Yes
4.13 Bed01 4.OG	49.9	35	15	20	6mm float	Yes
5.04 Bed01 5.OG	46.1	35	11	16	6mm float	Yes
5.04 Bed02 5.OG	46.4	35	11	16	6mm float	Yes
5.05 Bed01 5.OG	46.2	35	11	16	6mm float	Yes
5.05 Bed02 5.OG	46.1	35	11	16	6mm float	Yes
5.06 Bed1 5.OG	46.1	35	11	16	6mm float	Yes
5.11 Bed02 5.OG	47.2	35	12	17	6mm float	Yes
5.11 Bed01 5.OG	47.1	35	12	17	6mm float	Yes
5.12 Bed02 5.OG	49.4	35	14	19	6mm float	Yes
5.12 Bed01 5.OG	50.9	35	16	21	6mm float	Yes
5.13 Bed02 5.OG	45.7	35	11	16	6mm float	Yes
5.13 Bed01 5.OG	49.5	35	15	20	6mm float	Yes
6.11 Bed02 6.OG	46.8	35	12	17	6mm float	Yes
6.11 Bed01 6.OG	47	35	12	17	6mm float	Yes
6.12 Bed02 6.OG	49.2	35	14	19	6mm float	Yes
6.12 Bed01 6.OG	49.8	35	15	20	6mm float	Yes
6.13 Bed02 6.OG	46.9	35	12	17	6mm float	Yes
6.13 Bed01 6.OG	49.1	35	14	19	6mm float	Yes
7.11 Bed02 7.OG	46.8	35	12	17	6mm float	Yes
7.11 Bed01 7.OG	47.9	35	13	18	6mm float	Yes
7.12 Bed02 7.OG	48.3	35	13	18	6mm float	Yes
7.12 Bed01 7.OG	49.1	35	14	19	6mm float	Yes
7.13 Bed02 7.OG	46.9	35	12	17	6mm float	Yes
7.13 Bed01 7.OG	48.2	35	13	18	6mm float	Yes
8.10 Bed01 8.OG	49.7	35	15	20	6mm float	Yes
8.11 Bed02 8.OG	49.7	35	15	20	6mm float	Yes
8.11 Bed01 8.OG	50.1	35	15	20	6mm float	Yes
8.12 Studio 8.OG	48.8	35	14	19	6mm float	Yes
9.10 Bed01 9.OG	53	35	18	23	6mm float	Yes
9.11 Bed02 9.OG	53.1	35	18	23	6mm float	Yes
9.11 Bed01 9.OG	53	35	18	23	6mm float	Yes
9.12 Studio 9.OG	51	35	16	21	6mm float	Yes
10.10 Bed01 10.OG	52.6	35	18	23	6mm float	Yes
10.11 Bed02 10.OG	52.9	35	18	23	6mm float	Yes
10.11 Bed01 10.OG	52.7	35	18	23	6mm float	Yes
10.12 Studio 10.OG	51.7	35	17	22	6mm float	Yes
11.10 Bed01 11.OG	52.7	35	18	23	6mm float	Yes
11.11 Bed02 11.OG	53.2	35	18	23	6mm float	Yes
11.11 Bed01 11.OG	52.7	35	18	23	6mm float	Yes
11.12 Studio 11.OG	52.6	35	18	23	6mm float	Yes
12.10 Bed01 12.OG	52.6	35	18	23	6mm float	Yes
12.11 Bed02 12.OG	53.1	35	18	23	6mm float	Yes
12.11 Bed01 12.OG	52.6	35	18	23	6mm float	Yes
12.12 Studio 12.OG	52.8	35	18	23	6mm float	Yes
13.10 Bed01 13.OG	52.6	35	18	23	6mm float	Yes
13.11 Bed02 13.OG	53	35	18	23	6mm float	Yes
13.11 Bed01 13.OG	52.6	35	18	23	6mm float	Yes
13.12 Studio 13.OG	52.6	35	18	23	6mm float	Yes
14.10 Bed01 14.OG	52.5	35	18	23	6mm float	Yes
14.11 Bed02 14.OG	53	35	18	23	6mm float	Yes
14.11 Bed01 14.OG	52.6	35	18	23	6mm float	Yes
14.12 Studio 14.OG	52.4	35	17	22	6mm float	Yes

The table above shows that the internal levels required by AS/NZS 2107 can be achieved in all units of the proposal, provided that glazing and ventilation requirements shown in **Table 4** are implemented.

6 RECOMMENDATIONS

6.1 NOISE MANAGEMENT

The following construction is recommended to ensure that internal sound level is met at all locations within the building.

External Walls

Wall construction to be either:-

- Masonry construction with minimum mass per square meter of 132 kg/m^2,
- 90 mm steel stud frame,
- Insulate cavity within minimum R2.5 Glass Wool Batts,
- 10mm set plasterboard lining.

Or

- Fibre Cement Sheet minimum 9.5 mm thick or equivalent cladding with minimum surface mass of 10.5 kg/m^2,
- 90 mm steel stud frame,
- Insulate cavity within minimum R2.5 Glass wool Batts,
- 10 mm set plasterboard lining.

Windows and Doors

- Glazing for Units 1.21, 2.21 and 3.21 are to be in accordance with **Table 4**,
- All other glazing systems shall be in accordance with AS 1288 with minimum 6mm float glass.

Ventilation

All spaces identified in **Table 3** and **Table 4** shall be provided with ventilation to meet the requirements of Part F4.5(a) of the Building Code of Australia to enable windows to remain closed.

Ventilation to be either:-

- Ducted non-comfort mechanical ventilation complying with AS 1668 and AS/NZS 3666 with an in room sound level not exceeding 30dB(A)
- Acoustica Aeropac or equivalent fitted to individual spaces,
- SilenceAir ™ ventilation to sufficient area to meet the requirements of the code.

7 CONCLUSION

Provided the structure and façade treatments are executed in accordance with this report, the level of internal noise generated by the adjacent rail line will remain within the limits specified by the Development near Rail Corridors and Busy Roads – Interim Guideline.

Please do not hesitate to contact me if you have any questions regarding this report.

Yours faithfully
RCA Acoustics

Document Control

Prepared and Authorised by

Matthew Bain MDesSc (Audio & Acoustics)
Acoustics Consultant

Reviewed by

Geoff Mason
General Manager

Date 5 April 2016

REFERENCES

[1] NSW Government Department of Planning, Development Near Rail Corridors and Busy Roads – Interim Guideline, December 2008.

[2] Department of Environment, Climate Change and Water, Road Noise Policy, March 2011.

[3] Standards Australia, AS NZS 2107-2000 "Recommended design sound levels and reverberation times for building interiors", December 2000.

[4] Environment Protection Authority, NSW Industrial Noise Policy, January 2000.

[5] Environment Protection Authority, Environmental Criteria for Road Traffic Noise, May 1999.

TERMS AND DEFINITIONS

dB(A) .... Unit of sound pressure level, modified by the A-weighting network to represent the sensitivity of the human ear.

SPL....................................... Sound Pressure Level (SPL), the incremental variation of sound pressure from the reference pressure level, 20 µPa, expressed in decibels.

SWL (L_W) .... Sound Power Level (SWL) of a noise sources per unit time expressed in decibels from reference level W_O of 10^{-12} W.

L_X.. Statistical noise descriptor. Where (x) represents the percentage of the time for which the specified noise level is exceeded.

L_{eq}.. Equivalent continuous noise level averaged over time on an equivalent energy basis.

L_1 .... Average Peak Noise Level in a measurement period.

L_{10}.. Average Maximum Noise Level in a measurement period.

L_{90}.. Average Minimum Noise Level in a measurement period.

L_{max} .... Maximum Noise Level in a measurement period.

Background Noise Level........ Noise level determined for planning purposes as the one tenth percentile of the ambient L_{A90} noise levels.

P_O .... Reference Sound Pressure for the calculation of SPL in decibels.

W_O .... Reference Sound Power, 10^{-12} W, for the calculation of SWL in decibels.

Appendix A

GHD Noise and Vibration Assessment - Proposed Wickham Transport Interchange

Transport for NSW

Wickham Transport Interchange
Noise and Vibration Assessment

July 2014

Executive summary

This noise and vibration impact assessment has been undertaken for Transport for NSW for the proposed Wickham Transport Interchange Project (the proposal) and forms part of the Review of Environmental Factors (REF) for the proposal. This report is subject to, and must be read in conjunction with, the limitations set out and the assumptions and qualifications contained throughout the report.

The proposal involves ceasing train services on the Newcastle Branch Line east of Stewart Avenue, Islington and constructing a new station and transport interchange at Wickham west of Stewart Avenue.

Background monitoring

Sensitive receivers and land uses potentially impacted from noise and vibration impacts associated with the proposal have been identified. Noise monitoring was undertaken at six locations along the proposal to determine existing background noise levels. Noise and vibration criteria were established at the surrounding sensitive receivers and land uses. Noise monitoring was undertaken at one location to determine the existing rail emission noise levels between Wickham and Hamilton stations.

Construction noise

Construction works during standard construction hours have the potential to exceed the construction noise management levels at the surrounding residential receivers. Standard noise mitigation measures have been recommended for implementation where feasible and reasonable. Mitigation measures will minimise impacts at the surrounding residential receivers. However, it is unlikely that implementation of all feasible and reasonable noise mitigation measures would reduce noise levels to below the construction noise criteria under all circumstances.

Out of hours works have a high potential to cause exceedances at nearby sensitive receivers. It is recommended that out of house work be considered and assessed in more detail when more information is available about the specific activities that are required to be undertaken outside of standard working hours.

Construction traffic noise

Estimates indicate that construction traffic should generally have minimal impacts to the surrounding road networks, in particular to busy roads such as Maitland Road, Hannell Street/Stewart Avenue and Albert Street.

Peak hour construction traffic accessing the site via Station Street has the potential to increase existing traffic noise by more than 2dB. Accordingly it is recommended that construction traffic movements along Station Street are scheduled during the standard daytime hours where practicable.

To manage construction traffic on local roads, prior to commence of construction a traffic management plan would be prepared detailing specific routes that construction traffic would follow throughout the construction phase. The traffic management plan would also identify temporary traffic changes required for local traffic during the construction phase.

Construction vibration

Based on safe working distances, when high vibration generating activities occur within 100 metres of adjacent residences it is recommended that potentially impacted residents be informed of the nature of the works, duration and contact details.

Having regard to cosmetic building damage, the expected magnitude of ground vibrations should not be sufficient to cause damage if the equipment operates at distances greater than 25 metres from structures. There is the potential for vibration generating construction activities within 35 metres of heritage structures (Hamilton Station) to exceed the cosmetic criteria. Mitigation options are discussed in Section 4.5.

Operational rail noise

Operational rail noise levels have been predicted and potential impacts assessed against the rail assessment trigger noise levels outlined in the Rail Infrastructure Noise Guideline at sensitive noise receivers. Operational rail noise levels are not predicted to exceed the trigger levels, and accordingly no mitigation measures are required.

Groundborne noise

Groundborne noise is generally only considered a potential issue where levels are higher than the airborne noise levels such as for underground railways. As there are no underground sections of rail associated with the proposal, ground borne noise due to operational rail is not assessed further in this report.

Stabling facility impacts

While trains are idling within the stabling facility, with auxiliary systems operating, there is potential for the industrial noise criteria to be exceeded at the most affected residential receivers, particularly during the night-time period.

Operation of train horns and brake air release systems also have the potential to generate sleep disturbance impacts at the most affected residential receivers.

Management and mitigation options are discussed in Section 6.1.7 for stabling facility operational noise impacts.

Interim operational noise impacts during construction

Interim stabling operations during construction of the proposal have been considered. Similar to the predicted impacts for operation of the stabling facility, noise impacts have been predicted at the nearest sensitive receivers during construction. Noise impacts during this interim stabling scenario will be temporary.

Operations of train horns and brake air release systems also have the potential to generate sleep disturbance impacts at the most affected residential receivers during this temporary stabling period.

A number of management and mitigation options are discussed in Section 6.1.7.

Operational vibration

Operational rail vibration impacts have been predicted and assessed against the vibration criteria outlined in the Assessing Vibration: A Technical Guideline. Vibration estimates indicate that the vibration criteria will be achieved at 5 metres from the railway. All receivers and buildings are further than 5 metres from the railway. Accordingly cosmetic damage or human comfort impacts are not anticipated at any sensitive receivers for the proposal.

Contents

Tables

Figures

Appendices

Definitions

Term	Definition
AVTG	Assessing Vibration: A Technical Guideline
CNS (Rail Projects)	Construction Noise Strategy (Rail Projects)
CoRTN	Calculation of Road Traffic Noise
dB	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels.
Down and Up Track	Specific to the Newcastle Branch Line, the Up track carries trains to the Newcastle terminus (eastbound trains) and Down track refers to the track carrying trains away from the Newcastle terminus (westbound trains).
EPA	Environment Protection Authority
Feasible and reasonable (RING definition relating to mitigation measures)	A feasible mitigation measure is a noise mitigation measure that can be engineered and is practical to build, given project constraints such as safety, maintenance and reliability requirements. It may also include options such as amending operational practices (e.g. changing timetable schedules to achieve noise reduction). Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of a mitigation measure. To make such a judgement the following should be considered: • noise impacts • noise mitigation benefits • cost effectiveness of mitigation • community views.
Groundborne vibration	Groundborne vibration is transmitted from source to receiver through the ground.
Groundborne rail noise	Internal noise radiated by the building structure due to ground-borne vibration produced by rail vehicle movements.
Heavy rail	Heavy rail is considered to be rail infrastructure and its associated rolling stock which may be electrified or hauled by diesel locomotives that operates in dedicated rail corridors for either passenger and/or freight transportation. Heavy rail generally operates at higher speeds, has a higher carrying capacity than light rail and travels over longer distances. Passenger train services currently provided by Sydney Trains and NSW TrainLink and freight operations are heavy rail.
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
$L_{A90(period)}$	The A-weighted sound pressure level that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90(15\ min)}$.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{Aeq(15hr)}$	The L_{Aeq} noise level for the period 7:00 to 22:00 hours.
$L_{Aeq(9hr)}$	The L_{Aeq} noise level for the period 22:00 to 7:00 hours.
$L_{A(max)}$ (RING definition)	The maximum noise not exceeded for 95% of rail pass-by events and is measured using the 'fast' response setting on a sound level meter.

Term	Definition
$L_{A(max)}$	The maximum sound level recorded during the measurement period.
$L_{Aeq(1hr)}$ (RING definition)	For sensitive land uses, $L_{Aeq(1h)}$ means the highest 10th-percentile hourly A-weighted L_{Aeq} during the period when the particular class of receiver building/place is in use. Alternatively, the highest measured $L_{Aeq(1h)}$ value can be used where insufficient measurements have been made to provide a valid 10th-percentile level and it can be demonstrated that the measured values are representative.
Level crossing	A road/pedestrian crossing provided at grade across the rail corridor.
Light rail	Light rail refers to a passenger transport system that generally operates at a lower capacity and on a localised, shorter network compared to heavy rail, does not use locomotives to haul the carriages and may operate on shared roadways with other road vehicles.
Mitigation	Reduction in severity
NCA	Noise catchment area
NMT	Nordic Prediction Method for Train Noise (TemaNord 1996:524).
NVRF	Sydney Trains Environmental Management System Guide for Noise and Vibration from Rail Facilities
Overbridge/overpass	A road or pedestrian footway over the railway line.
Rating background level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes.
Receiver	A noise modelling term used to describe a map reference point where noise is predicted. A sensitive receiver would be a home, work place, church, school or other place where people spend time.
RING	Rail Infrastructure Noise Guideline
RNP	Road Noise Policy
SEL	Sound Exposure Level (SEL) parameter closely related to L_{Aeq} for assessment of events (rail pass-bys) that have similar characteristics but are of different duration. The value of acoustic energy over a ‘normalised’ 1-second period as the actual noise event under consideration.
Short-term Vibration	Vibration that occurs so infrequently that it does not cause structural fatigue nor does it produce resonance in the structure.
TIA	Traffic Impact Assessment
Tonality	Noise containing a prominent frequency or frequencies characterised by a definite pitch.
VDV	Vibration Dose Value (VDV) - As defined in BS6472 – 1992, VDV is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).
Vrms	The vibration velocity presented as a root mean square value.
PPV	Peak Particle Velocity

1. Introduction

1.1 Background

In 2012, the NSW Government announced the truncation of the heavy rail line at Wickham as part of the *Newcastle Urban Renewal and Transport Strategy*. Following consideration of options to cease railway operations, it was decided that a new station at Wickham would be constructed on land to the west of Stewart Avenue and that the residual heavy rail corridor comprising the existing Wickham Station and areas to the east would be reviewed for suitability as part of the initial stage of the Newcastle Light Rail project.

1.2 Overview of the proposal

The proposal to truncate the heavy rail line at Wickham and deliver the Wickham Transport Interchange involves:

- cessation of train services between Wickham Station and Newcastle Station
- constructing and operating a new train stabling facility to the north of Hamilton Station, within the existing rail corridor
- constructing and operating a new station and transport interchange at Wickham for pedestrians, cyclists, buses and heavy rail to the west of Stewart Avenue.

Shuttle bus services would be implemented during and following construction to enable train passengers to complete their journeys into the Newcastle city centre.

To continue operating the rail network to the west of the new station, a number of modifications to the rail infrastructure and services between Wickham and Hamilton stations are required. This would involve:

- terminating services at Hamilton Station during construction of the new station and transport interchange
- constructing and operating a new head shunt rail track, about 700 metres in length between the Maitland Road overpass and Wickham Station
- installing new crossovers and turnouts to facilitate the movement of trains between the three rail tracks
- ancillary infrastructure including traction power supply, signalling and overhead wiring.

Some road works would also be required, involving the removal of the railway crossing boom gates and signals at Stewart Avenue and the closure of Railway Street at the level crossing.

The design of the transport interchange makes allowance for the future provision of light rail. The Newcastle Light Rail project will be subject to a separate environmental impact assessment/planning approval process.

1.3 Purpose and scope of this report

This noise and vibration impact assessment has been prepared by GHD Pty Ltd to assess the potential noise and vibration impacts of the proposal based on the current status of design and construction information available. Specifically, this report has been prepared with consideration of the following documents:

- Interim Construction Noise Guideline (ICNG),Department of Environment and Climate Change, 2009
- Assessing Vibration: A Technical Guideline (AVTG), Department of Environment and Conservation, 2006
- Road Noise Policy (RNP), Department of Environment, Climate Change and Water, 2011
- Rail Infrastructure Noise Guideline (RING), Environment Protection Authority (EPA), 2013
- Industrial Noise Policy (INP), EPA, 2000
- Construction Noise Strategy (CNS), Transport for NSW, 2012
- Environmental Management System Guide: Noise and Vibration from Rail facilities (NVRF), Sydney Trains, 2013.

2. Existing environment

2.1 Sensitive receivers locations

Noise and vibration sensitive receivers are defined based on the type of occupancy and the activities performed in the land use. Sensitive noise and vibration receivers could include both existing and proposed:

- residences
- educational facilities
- hospitals and medical facilities
- places of worship
- passive and active recreational areas such as parks and sporting fields. Note that these recreational areas are only considered sensitive when they are in use or occupied.

GHD are not aware of any proposed residential developments around the proposal site. However, if future developments were to occur, the onus would be on local councils and developers to comply with the *State Environmental Planning Policy (Infrastructure) 2007.*

The key existing sensitive receivers and land uses in close proximity to the proposal are detailed in Table 2.1 and shown in Figure 2.1.

Table 2.1 Sensitive receivers and land uses

Noise catchment area (NCA)	Identified residential receivers	Land use type	Noise monitoring logger location no.	Distance to proposal site boundary	Non-residential land uses
NCA 1	R1-R4	Mixed residential and commercial	L1	20 metres	Businesses on Fern Street and Beaumont Street
NCA 2	R5-R7	Mixed residential and commercial	L2	8 metres	Businesses on Ivy Street and Maitland Road
NCA 3	None	Mixed residential and commercial	L1	95 metres	Dental surgery and other businesses on Maitland Road
NCA 4	None	Mainly residential, some commercial	L4	140 metres	KU Wickham Preschool, Christian Science Church
NCA 5	R8-R20	Mainly residential, some commercial	L5	Adjacent to site boundary	Various commercial and industrial businesses, Wickham Public School
NCA 6	R21-R23	Mixed residential and commercial	L6	Adjacent to site boundary	Various businesses, Hunter Street Medical Centre

Noise catchment area (NCA)	Identified residential receivers	Land use type	Noise monitoring logger location no.	Distance to proposal site boundary	Non-residential land uses
NCA 7	None	Commercial	-	Adjacent to site boundary	Various businesses, Newcastle Dental Laser Clinic
NCA 8	R24	Mixed residential and commercial	L3	42 metres	Catholic Church, Newcastle Community Arts Centre
NCA 9	R25-R38	Mainly residential, some commercial	L7	20 metres	Various businesses

Detailed maps of each NCA and identified receivers are provided in Appendix A.

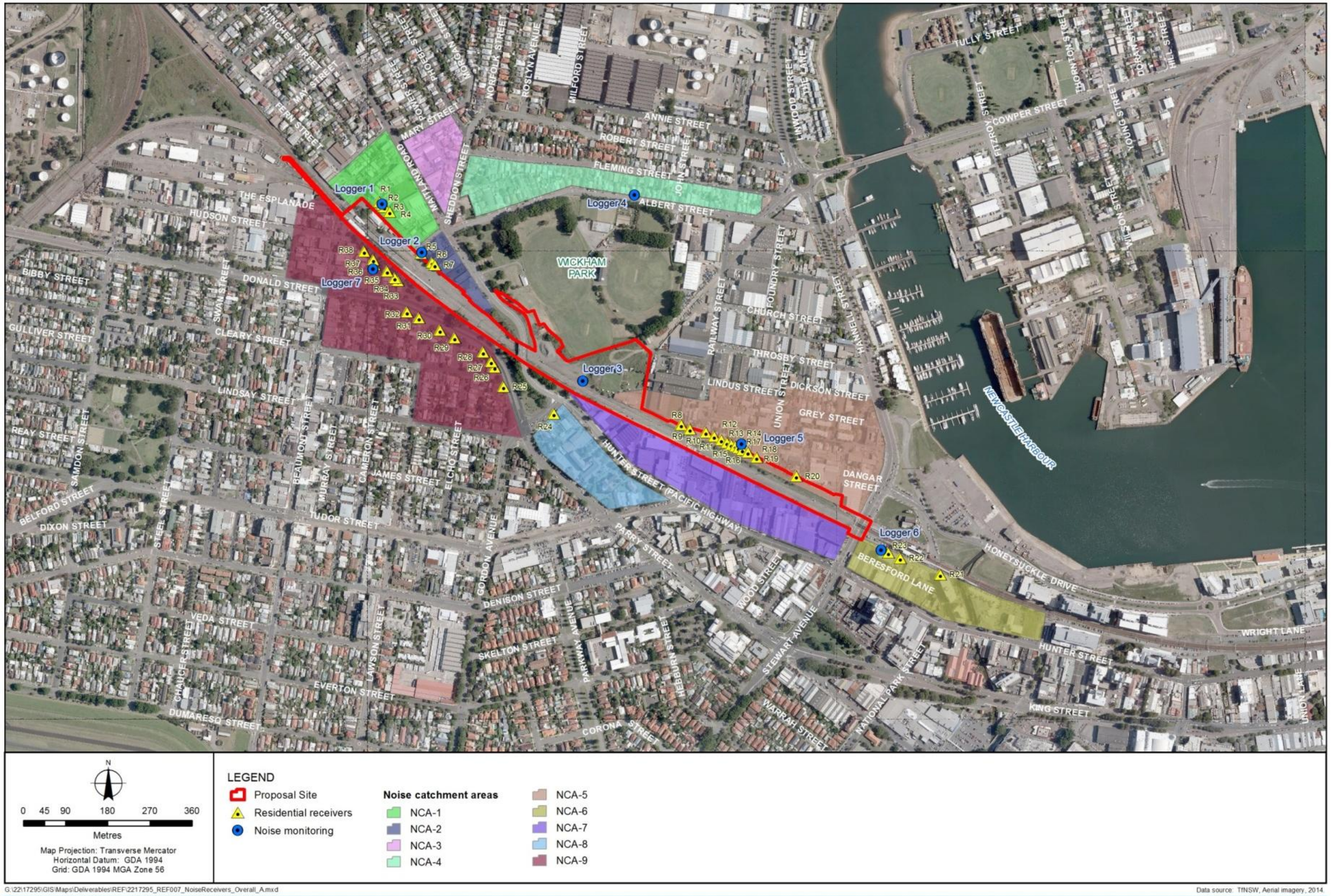


Figure 2.1 Noise and vibration sensitive receivers and monitoring locations

2.2 Background noise monitoring

2.2.1 Noise monitoring methodology

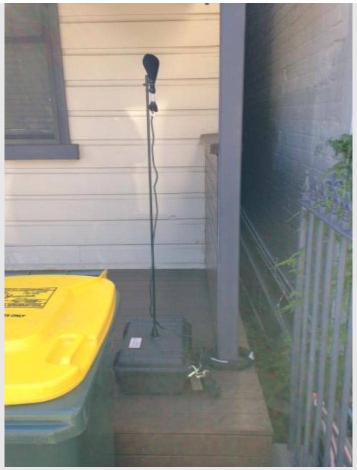
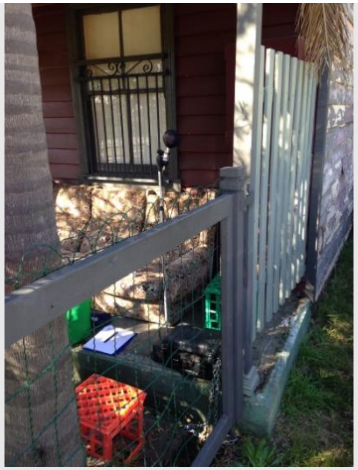
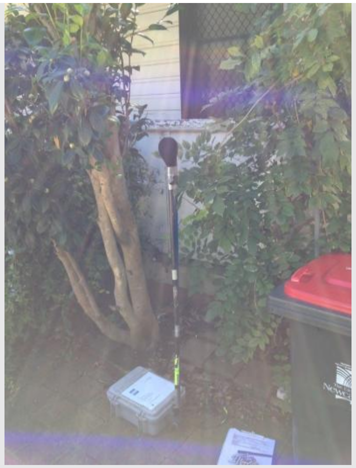
All background noise monitoring activities were undertaken with consideration of the INP long term method. Background noise monitoring took place at six sensitive receiver locations that were considered to provide a good representation of the existing ambient noise environment in the vicinity of the proposal. An additional noise logger (location L3) was placed within the rail corridor with exposure to the existing track and was used to capture train pass-by noise levels.

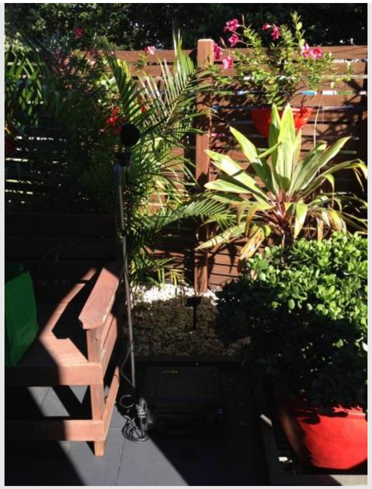
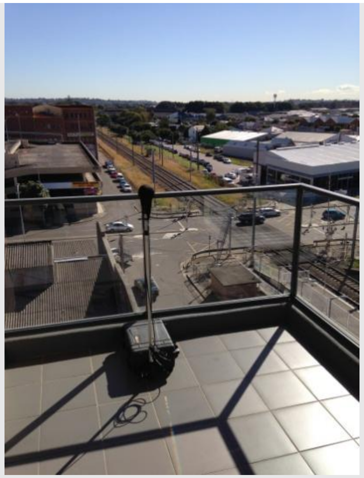
The noise loggers were programmed to accumulate L_{A90}, L_{A10}, L_{Aeq} and L_{Amax} noise descriptors continuously over sampling periods of 15 minutes for the entire monitoring period. The logger at location L3 was also set to capture a 1-second time trace to enable identification of individual train pass-by events. The noise loggers were calibrated using a Quest Type CA-12B sound level calibrator (serial number U1050139).

The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 metres per second, or when rainfall occurred. Concurrent half-hourly weather data was sourced from the Bureau of Meteorology's Nobbys Head automatic weather station.

Table 2.2 provides details of the noise loggers used. Figure 2.1 shows the monitoring locations.

Table 2.2 Background noise monitoring locations and equipment details

	Location L1	Location L2	Location L3	Location L4
Location address	25 Fern Street Hamilton	10 Ivy Street Hamilton	Between Hamilton and Wickham Station	69 Albert Street Wickham
Measurement period	Start time:15/05/2014 11:30 Stop time:23/05/2014 10:45	Start time:15/05/2014 12:45 Stop time:23/05/2014 10:45	Start time:12/05/2014 14:00 Stop time:19/05/2104 15:45	Start time:15/05/2014 12:45 Stop time:23/05/2014 11:15
Equipment details	Rion NL52 Type 1 SN:00131631	Svantek 955 Type 1 SN:27622	Svantek 955 Type 1 SN:27624	Rion NL22 Type 1 SN:00852196
Calibration check	Pre:109.9 dB(A) Post:109.8 dB(A)	Pre:110.0 dB(A) Post:109.9 dB(A)	Pre:110.1 dB(A) Post:110.1 dB(A)	Pre:110.0 dB(A) Post:110.0 dB(A)
Equipment settings	A-weighted Fast time response 15 minute intervals	A-weighted Fast time response 15 minute intervals	A-weighted Fast time response 1/3 octave 15 minute intervals	A-weighted Fast time response 15 minute intervals
Photo				

	Location L5	Location L6	Location L7
Location address	43A Station Street Hamilton	Unit 76056, 20-21 Beresford Street, Newcastle West	4 Eva Street Hamilton
Measurement period	Start time:15/05/2014 13:15 Stop time:23/05/2014 11:30	Start time:16/05/2014 12:50 Stop time:23/05/201 10:30	Start time:15/05/2014 12:45 Stop time:23/05/2014 12:00
Equipment details	Svantek 955 Type 1 SN:27621	Svantek 955 Type 1 SN:27623	Svantek 955 Type 1 SN:27625
Calibration check	Pre:109.9 dB(A) Post:109.5 dB(A)	Pre:110.4 dB(A) Post:110.5 dB(A)	Pre:110.0 dB(A) Post:110.1 dB(A)
Equipment settings	A-weighted Fast time response 15 minute intervals	A-weighted Fast time response 15 minute intervals	A-weighted Fast time response 15 minute intervals
Photo			

2.2.2 Background noise monitoring result summary

A summary of the calculated rating background levels (RBL) $L_{A90(period)}$ and ambient $L_{Aeq(period)}$ noise monitoring results is shown in Table 2.3 for each background noise monitoring location. Detailed noise monitoring tables and charts are provided in Appendix B.

Table 2.3 Summary of RBL and ambient noise monitoring results, dB(A)

Location	RBL $L_{A90(period)}$			Ambiant noise levels $L_{Aeq(period)}$		
	Day	Evening	Night	Day	Evening	Night
L1	48	43	37	59	57	53
L2	47	46	42	58	56	53
L3[1]	45	46	44	60	59	62
L4	45	40	36	64	60	56
L5	40	40	38	59	59	56
L6	56	52	45	64	63	60
L7	44	44	40	53	52	49

Note [1]: The sound level meter at L3 was also programmed to capture the 1/3-octave spectral and broadband L_{Aeq} and L_{Amax} at 1-second intervals enabling extraction of each train pass-by observed during the monitoring period.

2.3 Rail noise monitoring

Operator-attended noise monitoring and unattended noise logging was undertaken between Hamilton Station and Wickham Station at location L3 to determine the pass-by noise levels from train movements. The monitoring location was selected as it provided a clear view of the existing rail line and was situated where trains would be travelling at a generally consistent speed between Hamilton Station and Wickham Station.

The sound level meter and logger were programmed to accumulate L_{Aeq} and L_{Amax} noise levels continuously over 1 second sampling periods. The equipment was calibrated in the field using Quest Type CA-12B sound level calibrator (serial number U1050139).

The noise logger was positioned 11.5 metres from the nearest rail at a height of 1.5 metres on a section of straight and level track. Suitable locations for placement of the noise logger were limited due to site constraints including unrelated construction activities within the rail corridor. The selected logger position provided an appropriate location away from the influence of these construction activities. Equipment and monitoring location details are shown in Table 2.4 and Figure 2.1.

Logger data was filtered in accordance with Australian Standard AS2377, Methods for the measurement of rail bound vehicle noise (2002), to exclude data where wind speeds exceeded 10 metres per second or during periods of rainfall. The unattended rail measurement results are summarised in Table 2.5. The data was correlated with timetable information to assist in the identification of train pass-by events. The RING requires the L_{Amax} levels from the 95th and 50th percentile of rail pass-bys to be reported and ensures that a sufficient number of pass-bys are considered in the analysis.

Attended noise measurements were taken at 6 metres and 10 metres from the nearest rail line on deployment and retrieval of the noise logger on 12 May 2014 and 19 May 2014. Suitable locations for attended noise monitoring were limited due to site constraints including unrelated construction activities within the rail corridor. The selected monitoring positions on each respective day provided a safe location away from these construction activities. The attended measurements were undertaken near to the rail line to reduce unwanted influence of other ambient noise sources during the noise surveys. The sound level meter was programmed to capture the 1/3-octave spectral and broadband L_{Aeq} and L_{Amax} at 1-second intervals enabling extraction of each train pass-by observed during the monitoring period (Table 2.6).

Table 2.4 Rail noise monitoring locations and equipment details

Location	L3 (11.5 metres from nearest rail line)
Measurement period	12-19 May 2014
Equipment details	Svantek SV955 Type 1 SN: 27624
Calibration check	Pre:110.1 Post:110.1
Equipment settings	A-weighted Fast time response 1 sec interval
Site photo	

Table 2.5 Summary of unattended rail noise monitoring results

Source	Descriptor	Noise level (dB(A))/event
Total rail track	$L_{Aeq(15hr)}$	55.5
	$L_{Aeq(9hr)}$	52.3
Passenger	SEL (day – average)	80.5
	SEL (night – average)	79.7
	L_{Amax} (95 percentile)	81.3
	L_{Amax} (50 percentile	72.6
	Events per day (average)	172
	Events per night (average)	58

Table 2.6 Summary of attended pass-by noise monitoring results, dB(A)- Location L1

Train type	Train pass-by noise levels			Distance to track	Observed dominant noise source	Direction of travel	Approx. speed
	L_{Aeq} (passby)	SEL (passby)	L_{Amax} (passby)				
Endeavour	69.7	84.8	79.8	10	wheel/rail	East	40
Endeavour	70.1	82.6	79.7	13	wheel/rail	West	50
Endeavour	71.4	84.4	80.8	10	air release	East	50
Endeavour	69.4	81.9	77.2	13	wheel/rail	West	50
Endeavour	72.1	84.6	81.6	10	wheel/rail	East	40
Endeavour	77.3	89.8	87.6	6	wheel/rail	East	50
Hunter Railcar	69.7	82.9	79.7	10	wheel/rail	East	50
Hunter Railcar	65.6	78.9	75.5	13	wheel/rail, engine	West	60
Hunter Railcar	69.5	82.7	78.3	10	wheel/rail	East	40
Hunter Railcar	67.6	79.4	76.9	13	wheel/rail		60
Hunter Railcar	73.3	85.6	84.1	10	wheel/rail	East	50
Hunter Railcar	65.1	78.3	74.5	13	engine	West	50
Hunter Railcar	68.2	80.5	78.2	9	engine	West	70
Hunter Railcar	73.0	86.8	83.8	6	engine	East	60
Hunter Railcar	70.6	81.4	79.5	9	wheel/rail	West	70
OSCAR	68.4	78.8	77.2	10	engine	East	50
OSCAR	64.4	75.6	70.7	13	wheel/rail	West	50
OSCAR	64.1	77.5	72.0	10	engine	East	50
OSCAR	65.2	75.2	71.7	9	wheel/rail	West	70
OSCAR	65.3	77.9	73.1	6	wheel/rail	East	60
V-Set	69.2	81.5	75.0	10	wheel/rail	East	40
V-Set	68.9	80.4	75.6	13	wheel/rail	West	60
V-Set	70.7	84.5	81.2	10	wheel/rail, brakes	East	50
V-Set	66.9	78.7	73.2	13	wheel/rail	West	40
V-Set	69.7	82.9	76.6	10	wheel/rail	East	50
V-Set	73.6	87.2	84.3	6	wheel/rail, flats	East	50
V-Set	76.8	86.8	82.9	9	wheel/rail	West	70
V-Set	72.5	86.1	84.1	6	wheel/rail	East	50

2.4 Rail pass-by vibration levels

Operator-attended vibration monitoring was undertaken concurrently with attended noise measurements on 12 May and 19 May 2014 using an Instantel Minimate ground vibration monitor (serial number BE12721). Measurements were taken at 5 and 10 metres from the nearest track. A summary of the train pass-by vibration levels are detailed in Table 2.7. Note that the Vibration Dose Value (VDV) is based on waveform measurements which were only triggered where vibration levels exceeded 1 mm/s.

Table 2.7 Train pass-by vibration levels

	5 metres from track	**10 metres from track**
Maximum PPV train pass-by	4.8 mm/s	4.2 mm/s
Average PPV train pass-by	3.0 mm/s	2.5 mm/s
Average VDV train pass-by	0.032 $m/s^{1.75}$	0.027 $m/s^{1.75}$

3. Noise and vibration criteria

3.1 Construction noise and vibration criteria

3.1.1 Construction noise management levels

The ICNG provides guidance for assessment of construction noise. The guideline recommends standard hours for construction activities as:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- no work on Sundays or Public Holidays.

The ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours, assuming all feasible and reasonable mitigation measures are implemented to minimise the impacts to any surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the proposal and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
- works which maintain noise levels at receivers to below the noise management levels outside of the recommended standard construction hours.

Table 3.1 to Table 3.3 detail the noise management levels at sensitive residences and land uses respectively to be applied during construction.

Table 3.1 Construction noise management level at residential receivers

Time of day	Management level	How to apply
Standard construction hours	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. • where the predicted or measured LAeq(15min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • the proponent should also inform all potentially affected residents of the nature of the works to be carried out, the expected noise levels and duration as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (TfNSW) may require respite periods by restricting the hours that very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid- morning or mid-afternoon for works near residences • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard construction hours	Noise affected RBL + 5dB(A)	• a strong justification would typically be required for works outside the recommended standard hours • the proponent should apply all feasible and reasonable work practices to meet the noise affected level • where all feasible and reasonable work practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Table 3.2 Construction noise management levels at non-residential sensitive land uses

Land use	Management level, $L_{Aeq(15min)}$ (applies when properties are in use or occupied)
Classrooms at schools and other educational institutions	Internal noise level – 45 dB(A)
Hospital wards and operating theatres	Internal noise level – 45 dB(A)
Places of worship	Internal noise level – 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level – 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level – 60 dB(A)
Industrial premises	External noise level – 75 dB(A)
Commercial premises	External noise level – 70 dB(A)

Table 3.3 Summary of construction noise management levels at sensitive residential receivers, dB(A)

NCA	Nearest potentially affected receiver	Logger for RBL	Measured RBL L_{A90}			Construction noise management levels L_{Aeq}			
			Day	Evening	Night	Highly noise affected	Standard hours Mon-Fri (7 am-6 pm) Sat (8 am-1 pm) Sun/Pub Hol (Nil)	Outside standard working hours (OOHW) - period 1 Mon-Fri (6 pm-10 pm) Sat (7 am-8 pm) & (1 pm-10 pm) Sun/Pub Hol (8 am-6 pm)	Outside standard working hours (OOHW)-period 2 Mon-Fri (10 pm-7 am) Sat (10 pm-8 am) Sun/Pub Hol (6 pm-7 am)
NCA-1	R1-R4	L1	48	43	37	75	58	48	42
NCA-2	R5-R7	L2	47	46	42		57	51	47
NCA-5	R8-R20	L5	40	40	38		50	45	43
NCA-6	R21-R23	L6	56	52	45		66	57	50
NCA-8	R24	L3	45	46	44		55	51	49
NCA-9	R25-R38	L7	44	44	40		54	49	45

3.1.2 Sleep disturbance criteria during construction

The ICNG states that where works are planned to extend over more than two consecutive nights the assessment should include maximum noise levels, and the extent and number of times the maximum noise level exceeds the rating background level.

The INP application notes regarding sleep disturbance recommend that where the $L_{A1(1min)}$ exceeds the $L_{A90(15min)}$ by more than 15 dB(A), a more detailed analysis is required.

Further guidance is provided in the RNP which concludes, based on the research to date, that:

- maximum internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep
- one or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly.

Discussion of potential sleep disturbance impacts during construction is provided in Section 4.2.3

3.1.3 Traffic noise criteria during construction

The RNP provides traffic noise target levels where there is the potential to create additional traffic on arterial and local roads. The road traffic noise target levels are presented in Table 3.4. The application notes for the RNP state that:

> *for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.*

Table 3.4 RNP traffic noise criteria at sensitive receivers and land uses

Category	Day (7 am-10 pm)	Night (10 pm-7 am)
Existing residences affected by additional traffic on existing sub-arterial/arterial roads	External noise level 60 $L_{Aeq(15hr)}$ dB(A)	External noise level 55 $L_{Aeq(9hr)}$ dB(A)
Existing residences affected by additional traffic on existing local roads	External noise level 55 $L_{Aeq(1hr)}$ dB(A)	External noise level 50 $L_{Aeq(1hr)}$ dB(A)
School classrooms	Internal noise level 40 $L_{Aeq(1hr)}$ dB(A) (when in use)	-
Places of worship	Internal noise level 40 $L_{Aeq(1hr)}$ dB(A) (when in use)	Internal noise level 40 $L_{Aeq(1hr)}$ dB(A) (when in use)
Open space (active use)	External noise level 60 $L_{Aeq(15hr)}$ dB(A) (when in use)	-
Open space (passive use)	External noise level 55 $L_{Aeq(15hr)}$ dB(A) (when in use)	-

Category	Day (7 am-10 pm)	Night (10 pm-7 am)
Child care facilities	Sleeping room internal noise level 35 $L_{Aeq(1hr)}$ dB(A) Indoor play area internal noise level 40 $L_{Aeq(1hr)}$ dB(A) Outdoor play area external noise level 55 $L_{Aeq(1hr)}$ dB(A) (when in use)	-

3.1.4 Construction vibration criteria

Human comfort

Human comfort vibration criteria have been set with consideration to the CNS (Rail Projects) and AVTG. British Standard BS 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) is recognised by the EPA as the preferred standard for assessing 'human comfort'.

The BS 6472 human comfort peak vibration criteria and intermittent vibration dose values are shown in Table 3.5 for the frequency range of 1 Hz to 80 Hz. The intermittent vibration dose value is generally applicable to most construction works. BS 6472 outlines vibration limits which would cause minimal adverse reactions from the occupant and does not consider the short term duration of construction projects or working efficiency. BS 5228.2 – 2009, Code of Practice for noise and vibration control on construction and open sites: Part 2 Vibration recommends that the guidance values presented in Table 3.6 are more appropriate for construction works as it is easier to assess the intermittent vibration criteria against a peak value rather than a dose value. BS 5228.2 also recognises that higher vibration levels are tolerable for short term construction projects as undue restriction on vibration levels can substantially prolong construction works and result in greater annoyance.

Table 3.5 Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$) (BS 6472)

Location	Daytime[1]		Night-time[1]	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical areas[2]	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

Note:

1. Daytime is 7:00 to 22:00 and night-time is 22:00 to 7:00.
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Table 3.6 Guidance on effects of vibration levels (BS 5228.2)

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure.

Cosmetic damage

Currently, there is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Cosmetic damage criteria have been set with consideration of British Standard BS 7385.2 – 1993 Evaluation and measurement for vibration in buildings (Table 3.7) and German Standard DIN 4150-3: 1999-02 Structural Vibration – Part 3: Effects of vibration on structures (Table 3.8). This assessment has been undertaken with reference to the DIN 4150-3: 1999 standard for heritage listed buildings while BS 7385.2 – 1993 has been considered for residential and commercial properties.

Table 3.7 BS 7385.2 – 1993 Transient vibration guideline values for cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominate pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4Hz and above	
2	Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4Hz increasing to 20 mm/s at 15Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

Table 3.8 DIN 4150-3: 1999 Guideline values for short term vibration on structures

Line	Type of structure	Guideline values for velocity, (mm/s)		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

3.2 Operational noise and vibration criteria for rail operations

3.2.1 Operational criteria for rail operations

The Sydney Trains' Environment Protection Licence (EPL) 12208, administered under the *Protection of Environment Operations Act 1997*, requires that 'offensive' environmental noise is minimised, regardless of whether specific noise assessment goals are defined in policies or guidelines.

For this assessment, operational rail noise goals applicable for the operation of trains between the Maitland Road overpass and Wickham Station have been derived from the RING.

The RING presents non-mandatory noise goals that trigger the need for an operational noise assessment to be conducted. Such an assessment would address the potential noise impacts and consider possible mitigation measures that may be feasibly and reasonably applied to mitigate these impacts.

The RING applies to both light and heavy rail infrastructure projects. A 'new' heavy rail line development is one where rail infrastructure is to be developed on land that is not currently an operational rail corridor hence the more stringent 'new rail line noise criteria' apply. Whereas the 'redevelopment' of a heavy rail line occurs where a rail infrastructure project is to be developed on land that is either:

- located within an existing and operational corridor where a rail line is or has been operational
- is immediately adjacent to an existing operational rail line which may result in widening of an existing corridor.

Typically the works associated with the 'redevelopment' of an existing rail line will increase its capacity to carry rail traffic or alter the alignment through design changes. In such cases the 'redevelopment of existing rail line' noise criteria apply.

The section of rail between the Maitland Road overpass and the proposed Wickham Station including the operation of a third track (head shunt) has been assessed as a 'redevelopment of an existing heavy rail line' as the proposal will be developed on land that is immediately adjacent to an existing operational rail line and may result in widening of that corridor. Therefore the 'redevelopment of existing rail line' criteria shown in Table 3.9 apply. Assessment criteria for the operation of the proposed Hamilton stabling facility are discussed in Section 3.3. For residential receivers; the noise trigger levels for absolute levels of rail noise have two components, L_{Aeq} and L_{Amax}. The L_{Aeq} contribution level of rail noise is assessed over the day or night period and the maximum noise level (L_{Amax}) from pass-by events. Typically, the trigger values shown in Table 3.9 need to be exceeded to initiate an assessment of rail noise impacts and investigate mitigation measures

Table 3.9 Airborne rail traffic noise trigger levels for residential land uses

Type of Development	Noise trigger levels dB(A) (External)	
	Day (7 am – 10 pm)	**Night (10 pm – 7 am)**
Redevelopment of existing rail line (external)	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2dB or more, or existing L_{Amax} rail noise levels by 3 dB or more and predicted rail noise levels exceed	
	65 $L_{Aeq(15h)}$ OR 85 L_{AFmax}	60 $L_{Aeq(9h)}$ OR 85 L_{AFmax}

As per the RING, other non-residential sensitive land uses including hospitals, schools and outdoor recreational areas have their own specific noise trigger levels for heavy rail redevelopments that are applicable when the facility or space is in use. Noise trigger levels for these receivers are applicable as internal or external levels depending on the land use. As construction of these buildings is unknown, a conservative 10dB reduction in noise between the external level and internal level has been assumed[1]. The 'redevelopment of existing rail line' criteria are shown Table 3.10.

Table 3.10 Airborne rail traffic noise trigger levels for other sensitive land uses

Other sensitive land use	**Noise trigger levels dB(A) – redevelopment of existing rail line (when in use)**
	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2dB or more *and* resulting rail noise levels exceed:
Schools, educational institutions and child care centres	45 $L_{Aeq(1h)}$ Internal
Places of worship	45 $L_{Aeq(1h)}$ Internal
Hospital wards	40 $L_{Aeq(1h)}$ Internal
Hospitals – other uses	65 $L_{Aeq(1h)}$ External
Open space – Passive use	65 $L_{Aeq(15h)}$ External
Open space – Active use	65 $L_{Aeq(15h)}$ External

3.2.2 Groundborne noise trigger levels for rail operations

For sensitive receivers, the internal groundborne noise trigger levels are shown in Table 3.11. Groundborne noise is generally only considered a potential issue where levels are higher than the airborne noise levels such as for underground railways. As there are no underground sections of rail associated with the proposal, groundborne noise due to operational rail is not assessed further in this report.

Table 3.11 Groundborne noise trigger levels (RING)

Sensitive land use	**Time of day**	**Internal noise trigger levels, dB(A)**
		Development increases existing rail noise levels by 3 dB(A) or more *And* resulting rail noise levels exceed
Residential	Day (7 am – 10 pm)	40 L_{ASmax}
	Night (10 pm – 7 am)	35 L_{ASmax}
Schools, educational institutions, places of worship	When in use	40 to 45 L_{ASmax}

[1] See RING - Technical notes to Tables 1,2 and 3 – Technical Note 6. Allows that a window may be opened to provide adequate ventilation.

3.2.3 Traffic noise criteria during operations

The RNP provides traffic noise target levels where there is the potential to create additional traffic on arterial and local roads. The road traffic noise target levels are presented in Table 3.4.

The application notes for the RNP state that:

> *for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion*

3.2.4 Operational vibration criteria

Human comfort

The AVTG provides methods for assessing potential vibration impacts from construction activities as well as rail operations such as ground-induced vibration created by rolling stock movements.

The AVTG is based on guidelines contained in the British Standards BS 6472:1992 Evaluation of human exposure to vibration in buildings (1–80 Hz).

Intermittent vibration is assessed using the VDV. Acceptable VDV's, as outlined in AVTG, are the same as for construction vibration impacts presented in Table 3.5.

Cosmetic damage

The CNS (Rail Projects) recommends the use of British Standards BS-7385-2: 1993 Evaluation and measurement for vibration in buildings for establishing cosmetic damage guideline criteria.

Cosmetic damage criteria have been set with consideration to British Standard BS 7385.2 – 1993 Evaluation and measurement for vibration in buildings (Table 3.7) and German Standard DIN 4150-3: 1999-02 Structural Vibration – Part 3: Effects of vibration on structures (

Table 3.11). This assessment has been undertaken with reference to the DIN 4150-3: 1999 standard for heritage-listed buildings while BS 7385.2 – 1993 has been considered for residential and commercial properties.

3.3 Operational noise criteria for stabling facility and new station

The Sydney Trains' Environment Protection Licence 12208, administered under the *Protection of Environment Operations Act 1997*, requires that 'offensive' environmental noise is minimised, regardless of whether specific noise assessment goals are defined in policies or guidelines.

The RING (Appendix 3) specifically states that train noise from sidings and rail lines exclusively serving industrial premises (e.g. a stabling yard or maintenance facilities) must be assessed in accordance with the INP. In the context of the proposal, this includes noise from train stabling activities including stationary trains and trains entering and exiting the stabling area. Non-rail stationary noise sources at the new station including loudspeaker announcements, air conditioning systems and other mechanical plant are also assessed using the INP criteria and methodology.

The INP includes both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level, and to limit the total noise level from all sources near a receiver.

The INP noise criteria are planning levels and are not mandatory limits required by legislation, however the noise criteria assist the regulatory authorities to establish licensing conditions. Where noise criteria are predicted to be exceeded, feasible and reasonable noise mitigation strategies should be considered. In circumstances where noise criteria cannot be achieved, negotiation is required with the regulatory authority to evaluate the economic, social and environmental costs and benefits of the proposal against the noise impacts. The regulatory authority then sets statutory compliance levels that reflect the achievable and agreed noise limits from the proposal.

The intrusive noise criteria controls the relative audibility of operational noise compared to the background level at residential receivers. The amenity criteria limit the total level of extraneous noise for all receiver types. Both sets of criteria are calculated and, in the case of steady noise sources, the more stringent of the two in each time period normally apply. For noise sources with intermittent characteristics, both noise criteria should be assessed independently.

Residential receiver areas are characterised into ‘urban’, ‘suburban’, ‘rural’ or other categories based on land uses and the existing level of noise from industry, commerce and road traffic. With consideration to the INP, residential receivers identified in this assessment have been classified as ‘urban’ given the close proximity to existing commercial districts and road traffic noise.

Table 3.12 presents the operational noise criteria for the stabling facility and proposed Wickham Station.

Table 3.12 Operational noise criteria at residential receivers

	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
NCA-1			
Rating background level $L_{90(period)}$)	48	43	37
Intrusiveness criteria $L_{eq(15min)}$	53	48	42
Existing industrial noise contribution $L_{eq(period)}$	Nil		
Amenity criteria (urban) $L_{eq(period)}$ INP Table 2.2 adjusted	60	50	45
Operational noise criteria	**53**	**48**	**42**
NCA-2			
Rating background level L90(period)	47	46	42
Intrusiveness criteria $L_{eq(15min)}$	52	51	47
Existing industrial noise contribution $L_{eq(period)}$	Nil		
Amenity criteria (urban) $L_{eq(period)}$ INP Table 2.2 adjusted	60	50	45
Operational noise criteria	**52**	**50**	**45**
NCA-5			
Rating background level $L_{90(period)}$)	40	40	38
Intrusiveness criteria $L_{eq(15min)}$	45	45	43
Existing industrial noise contribution $L_{eq(period)}$	Nil		
Amenity criteria (urban) $L_{eq(period)}$ IMP Table 2.2 adjusted	60	50	45

	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Operational noise criteria	**45**	**45**	**43**
NCA-6			
Rating background level $L_{90(period)}$	56	52	45
Intrusiveness criteria $L_{eq(15min)}$	61	57	40
Existing industrial noise contribution $L_{eq(period)}$	Nil		
Amenity criteria (urban) $L_{eq(period)}$ INP Table 2.2 adjusted	60	50	45
Operational noise criteria	**60**	**50**	**40**
NCA-8			
Rating background level $L_{90(period)}$	45	46	44
Intrusiveness criteria $L_{eq(15min)}$	50	51	49
Existing industrial noise contribution $L_{eq(period)}$	Nil		
Amenity criteria (urban) $L_{eq(period)}$ INP table 2.2 adjusted	60	50	45
Operational noise criteria	**50**	**50**	**45**
NCA-9			
Rating background level $L_{90(period)}$	44	44	40
Intrusiveness criteria $L_{eq(15min)}$	49	49	45
Existing industrial noise contribution $L_{eq(period)}$	Nil		
Amenity criteria (urban) $L_{eq(period)}$ INP table 2.2 adjusted	60	50	45
Operational noise criteria	**49**	**49**	**45**

3.4 Sleep disturbance criteria during operations

The Sydney Trains' NVRF provides guidance on the assessment of sleep disturbance based on the INP. The NVRF requires assessment of predicted event L_{Amax} or $L_{A1,\ 1\ minute}$ noise levels at the receiver. The NVRF suggests that sleep disturbance meet the L_{Amax} ≤ background + 15 dB(A) for stations. Other facilities, such as stabling yards, may need to consider alternative sleep awakening criteria as described in the RNP, depending on the nature of the facility.

The NVRF advises that sleep awakening should be considered the worst case measure of sleep disturbance.

In the absence of clear guidelines and criteria, the NVRF recommends that, instead of setting project sleep disturbance goals, levels in the guidelines should be applied as indicators of the potential for sleep disturbance and awakening as part of a comprehensive assessment, that is:

1. Assess the potential for sleep disturbance in accordance with the INP. Take the external sleep disturbance level of (background + 15) $dBL_{A1,1\ minute}$ as the preliminary indicator.
2. Assess the potential for sleep disturbance using the higher noise levels specified in the RNP. Take the internal sleep awakening level of 50 $dBL_{A1,1\ minute}$ as a worst case 'maximum' a project would consider as a project noise emission. Typically this would translate to external levels of 60 $dBL_{A1,1minute}$ with windows sufficiently open to provide adequate ventilation.

3. Conduct a qualitative (descriptive) review of the factors listed above, which may affect the nature and extent of sleep disturbance impacts due to a project.
4. Conduct a quantitative assessment of the predicted $L_{A1,1minute}$ noise levels against the sleep disturbance and sleep awakening levels.

Discussion of potential sleep disturbance during operation of the Hamilton stabling facility is presented in Section 6.1.5.

4. Assessment of construction impacts

4.1 Construction methodology

4.1.1 Construction timing and scheduling

It is anticipated that the majority of work for the proposal would be undertaken during the recommended standard working hours adopted as follows:

- Monday to Friday: 7 am to 6 pm
- Saturday: 8 am to 1 pm
- Sundays and Public Holidays: no work.

However, there is potential that some work could be undertaken outside of the standard working hours, including:

- construction works requiring road occupancy or railway possessions
- construction works at a sufficient distance from sensitive receivers so that the noise levels are maintained to below the noise management levels outside of the recommended standard construction hours.

Construction of the proposal is expected to commence in late 2014. The proposal is anticipated to take approximately 24 months to complete and is expected to commence operation in late 2016.

4.1.2 Construction process

An indicative construction program and methodology is provided in Table 4.1. Construction activities would overlap between the key stages.

- stage 1 – establish site compound at the location of the former Morrow Park Bowling Club behind Wickham Park. Commence early works
- stage 2 – cease train services east of Stewart Avenue. Hamilton Station to operate as the western terminus station of the Newcastle Branch Line
- stage 3 – construct railway sidings north of Hamilton Station
- stage 4 – construct new station and interchange facilities.

Table 4.1 Indicative construction stages and program

Stage	2014			2015			2016		
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Receive all necessary approvals	■								
Establish site compound	■								
Early works	■								
Cease train services east of Stewart Avenue and close Railway Street level crossing	■	■							
Construct Hamilton sidings		■	■	■	■	■	■	■	
Construct new station and interchange facilities		■	■	■	■	■	■	■	■
New rail facilities open to public									■

4.2 Construction noise impacts

4.2.1 Methodology

The noise emissions from the construction of the proposal have been assessed through noise modelling using Computer Aided Noise Abatement (CadnaA v4.4) to predict noise levels at the nearest identified noise sensitive receivers.

CadnaA calculates noise propagation according to ISO 9613-2, Acoustics – Attenuation of sound during propagation outdoors. The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights or ‘downwind’ conditions which are favourable to sound propagation.

Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

Model scenarios and configuration

Construction modelling only considered the following three main stages of construction works:

1. early works
2. construction of Hamilton Sidings
3. construction of new station and interchange facilities.

The remaining construction stages are expected to have minimal impacts.

The following assumptions were made with regard to the model configuration:

- a general ground absorption coefficient of 0.5 was used throughout the model assuming a hard reflective surface. A ground absorption coefficient of 1 was used to represent Wickham Park
- modelling is based on atmospheric conditions of 10˚C and 70% humidity.

The noise modelling assumptions are as follows:

- the noise model was used to predict noise levels during typical worst case 15 minute period of operation where all equipment was operating for 75% of the time
- all noise sources were modelled approximately 2 metres above ground level
- single storey and double storey receivers were modelled at a height of 1.5 metres and 4.5 metres above ground respectively.

Noise generating equipment

The specific construction equipment required for the proposal will be confirmed with the construction contractor and the proposed construction methodology prior to commencement of construction. For the purposes of the assessment, the likely noise generating equipment anticipated to be used for each construction scenario is detailed in Table 4.2 with the corresponding sound power level.

Noise levels have been obtained from CNS (Rail Projects) and AS2436 – 2010 Guide to noise and vibration control on construction, demolition and maintenance sites. Other equipment may be used, however it is anticipated that they would produce similar noise emissions.

Table 4.2 Modelled construction scenario, location and equipment sound power levels, dB(A)

Stage	Scenario modelled	Activity	Indicative plant and equipment	Sound power level
Early works	Substation connection	Trenching	Crane	110
			Backhoe	111
			Hand tools	102
Construct Hamilton sidings	Hamilton sidings	Out of hours works	Crane	110
			Semi-trailer	107
			Boring rig	110
			Excavator (20 tonne)	105
			Concrete truck	112
			Concrete pump	109
			Elevated work platform	102
			Hi rail trucks	95
			Tip truck	108
		Earthworks and retaining wall construction	Excavator (20 tonne)	105
			Air compressors	100
			Crane	110
			Dump trucks	108
			Loader	107
			Flatbed trucks	107
			Concrete truck	112
			Vibratory roller	114
			Vibrating pad compactors	104
			Grader	110

Stage	Scenario modelled	Activity	Indicative plant and equipment	Sound power level
		Track laying and turnouts	Loader	107
			Hi rail dumpers (14 tonne)	95
			Hi rail Hiab	99
			Tamper	111
			Regulator	114
			Rail grinder	112
			Vibratory roller	114
			Excavator	105
			Crane	110
			Rail saw	115
			Welding equipment	105
			Track laying machine	114
			Dynamic stabiliser	111
			Grader	110
			Tip truck	108
Construct new station and interchange facilities	New station at Wickham	OHW works	Crane	110
			Semi-trailer	107
			Boring rig	110
			Excavator (20 tonne)	105
			Concrete truck	112
			Concrete pump	109
			Elevated work platform	102
			Hi rail trucks	95
			Tip truck	108
		Piling works	Piling rigs	110
			Cranes	110
			Loader	107
			Flatbed truck	107
			Dump truck	108
			Concrete truck	112
			Pumps	106
		Station works	Crane	110
			Excavators (20 tonne)	105
			Vibratory roller	114
			Hand tools	102
			Dump trucks	108
			Boring Rig	110
			Semi-trailer	107
			Generators	99
			Concrete truck	112

Stage	Scenario modelled	Activity	Indicative plant and equipment	Sound power level
			Concrete pump	109
			Tip truck	108
			power tools	116
			Loader	107
		Track laying and turnouts	Front End Loaders	107
			Hi rail dumpers (14 tonne)	95
			Hi rail Hiab	99
			Tamper	111
			Regulator	114
			Rail grinder	112
			Vibratory roller	114
			Excavator	105
			Crane	110
			Rail saw	115
			Welding equipment	105
			Track laying machine	114
			Dynamic stabiliser	111
			Grader	110
			Tip truck	108

It should be noted that the magnitude of off-site noise impact associated with construction would be dependent upon a number of factors:

- intensity and location of construction activities
- type of equipment used
- existing local noise sources
- intervening terrain, and
- prevailing weather conditions.

Construction machinery would likely move about the study area altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power.

4.2.2 Predicted construction noise impacts

Table 4.3 presents the predicted noise impacts associated with each major stage of works along with a comparison to the relevant construction noise criteria. The assessment is limited to receivers located within the NCAs identified in Section 2. The noise levels outlined in the table would typically be short-term, lasting for the duration of the construction period when works are conducted in the vicinity of each receiver.

Table 4.3 Predicted construction noise impacts, $L_{eq\ (15min)}$ dB(A)

NCA	Nearest potentially affected receiver	CNML			Construction scenario								Maximum noise impacts		Exceedances of CNML		
					Substation connection	Hamilton sidings			Wickham Station								
		Day	Evening	Night	Trenching	Earthworks	Track laying and turnouts	Out of hours works	Piling works	Station works	Track laying and turnouts	Out of hours works	Standard hours	Out of hours (Night)	Day	Evening	Night
NCA-1	R1	58	48	42	**64**	**71**	**72**	70	35	36	44	35	72	70	14	22	28
	R2	58	48	42	**64**	**71**	**72**	70	31	33	46	31	72	70	14	22	28
	R3	58	48	42	**62**	**70**	**71**	69	35	36	46	35	71	69	13	21	27
	R4	58	48	42	58	**71**	**72**	70	39	36	48	39	72	70	14	22	28
NCA-2	R5	57	51	47	54	**78**	**79**	77	35	36	52	35	79	77	22	26	30
	R6	57	51	47	53	**77**	**78**	76	43	43	53	42	78	76	21	25	29
	R7	57	51	47	52	**77**	51	76	42	44	53	42	77	76	20	25	29
NCA-5	R8	50	45	43	33	40	**51**	39	**58**	**58**	**82**	58	82	58	32	13	15
	R9	50	45	43	35	42	**51**	41	**59**	**60**	**83**	59	83	59	33	14	16
	R10	50	45	43	36	44	48	43	**63**	**62**	**82**	63	82	63	32	18	20
	R11	50	45	43	34	44	49	43	**65**	**64**	**85**	65	85	65	35	20	22
	R12	50	45	43	32	42	49	41	**66**	**66**	**86**	66	86	66	36	21	23
	R13	50	45	43	29	42	49	41	**67**	**67**	**85**	67	85	67	35	22	24
	R14	50	45	43	32	41	49	40	**70**	**69**	**84**	71	84	71	34	26	28
	R15	50	45	43	34	40	48	39	**71**	**70**	**83**	72	83	72	33	27	29
	R16	50	45	43	34	41	48	40	**72**	**72**	**82**	73	82	73	32	28	30
	R17	50	45	43	35	42	48	41	**75**	**74**	**81**	75	81	75	31	30	32
	R18	50	45	43	27	42	48	39	**78**	**78**	**79**	78	79	78	29	33	35
	R19	50	45	43	19	42	48	41	**83**	**84**	**84**	83	84	83	34	38	40
	R20	50	45	43	34	42	47	71	**80**	**79**	**79**	78	80	78	30	33	35
NCA-6	R21	66	57	50	31	38	44	37	51	52	61	50	61	50	-	-	-

NCA	Nearest potentially affected receiver	CNML			Construction scenario								Maximum noise impacts		Exceedances of CNML		
					Substation connection	Hamilton sidings			Wickham Station								
		Day	Evening	Night	Trenching	Earthworks	Track laying and turnouts	Out of hours works	Piling works	Station works	Track laying and turnouts	Out of hours works	Standard hours	Out of hours (Night)	Day	Evening	Night
	R22	66	57	50	32	39	44	38	55	56	61	54	61	54	-	-	4
	R23	66	57	50	32	39	43	38	57	57	60	56	60	56	-	-	6
NCA-8	R24	55	51	49	40	51	**59**	50	41	41	**67**	41	67	50	12	-	1
	R25	54	49	45	31	**59**	**60**	58	47	48	**59**	47	60	58	6	9	13
	R26	54	49	45	35	**64**	**65**	63	46	47	**57**	46	65	63	11	14	18
	R27	54	49	45	44	**65**	**66**	64	46	47	**57**	46	66	64	12	15	19
	R28	54	49	45	45	**67**	**68**	66	46	47	**57**	46	68	66	14	17	21
	R29	54	49	45	47	**64**	**65**	63	45	46	**56**	45	65	63	11	14	18
	R30	54	49	45	46	**65**	**66**	64	45	45	**55**	44	66	64	12	15	19
NCA-9	R31	54	49	45	46	**64**	**65**	63	44	44	54	44	65	63	11	14	18
	R32	54	49	45	46	**62**	**63**	61	43	44	54	43	63	61	9	12	16
	R33	54	49	45	50	**69**	**70**	68	43	43	53	43	70	68	16	19	23
	R34	54	49	45	50	**69**	**70**	68	43	43	53	43	70	68	16	19	23
	R35	54	49	45	52	**69**	**70**	68	43	43	53	42	70	68	16	19	23
	R36	54	49	45	47	**68**	**69**	67	42	43	52	42	69	67	15	18	22
	R37	54	49	45	**55**	**69**	**70**	68	42	43	52	42	70	68	16	19	23
	R38	54	49	45	**59**	**69**	**70**	68	42	42	52	42	70	68	16	19	23

Note: **Bold text** indicates exceedance of the noise affected construction management level during recommended construction hours and red text indicates exceedances of the construction management level for out of hours work (night period)

The results presented in Table 4.3 indicate that there is the potential that construction activities could impact on surrounding sensitive receivers, even more so if activities were to be scheduled outside the standard construction hours. The substation connection trenching works are anticipated to be short-term, whereas construction of the Hamilton sidings and new station are expected to progress through the duration of the construction period.

Certain activities, in particular earthworks, track laying and turnout installation have the potential to exceed the standard hours criteria at the nearest sensitive receivers within all NCAs. It is also likely that the out of hours work would generate exceedances in all NCAs if they were to occur. The highly noise affected level of 75 dB(A) may also be exceeded for residences located in NCA-1, NCA-2 and NCA-5, given their close proximity to the proposal. Therefore it is recommended that the CNS (Rail Projects) standard noise mitigation measures and additional noise mitigation measures detailed in Section 4.5 (Table 4.9) be implemented where feasible and reasonable.

In addition, it is recommended that out of hours work be assessed for potential noise impacts and appropriate mitigation measured on a case-by-case basis, once more information is known about the out of hours activities.

4.2.3 Sleep disturbance impacts

There is the potential for sleep disturbance impacts where out of hours construction activities during the night time period are undertaken in the vicinity of sensitive receivers.

The INP application notes provide some guidance on the assessment of sleep disturbance but notes that conclusive research on the subject is limited. The INP application notes indicate that there is the potential for sleep disturbance where the $L_{A1(1min)}$ exceeds the $L_{A90(15min)}$ by more than 15 dB(A) inside the residence's bedroom.

Typically, $L_{A1(1min)}$ noise levels are around 5 dB to 10 dB(A) greater than the $L_{Aeq(15minute)}$ noise levels. Typically a window will provide a 10 dB reduction when open and a 20 dB reduction when closed. To be conservative, it is assumed that windows would be kept open during night-time construction activities. Therefore there is the potential for sleep disturbance impacts where noise levels ($L_{Aeq(15min)}$ outside the bedroom) are more than background plus 15 dB(A).

Once details of the requirements for construction activities outside of the standard construction hours during the night-time period are determined, sleep disturbance impacts at specific residential receivers can be predicted.

4.3 Construction traffic impacts

Construction vehicle movements have the potential to generate temporary adverse noise impacts along access routes which use public roads as vehicles deliver materials to and from the proposal site.

The ICNG does not provide specific guidance in relation to acceptable noise levels associated with construction traffic. For assessment purposes, guidance is taken from the RNP, which aims to protect sensitive receivers against excessive traffic noise levels increases. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely acceptable to the average person.

Detailed information regarding construction-related traffic volumes and access routes was not available at the time of this assessment. Therefore, a number of assumptions have been made in the Traffic Report for the purposes of assessing construction traffic noise impacts.

Table 4.4 provides an estimate of construction vehicles and access points to the rail corridor. An additional access route on the southern side of the railway corridor from Donald Street would also be used during early works (an estimated period of 1-2 months). The volumes using this access point would be very low and are therefore not shown in the table.

Table 4.4 Construction traffic generation estimates

Type	Peak hour Volumes (two way)					
	Station Street	Ivy Street	Wickham Park (Maitland Road)	Railway Lane	Railway Street	Total
Heavy Vehicles	32	12	8	28	2	82
Light Vehicles	15	15	16	90	15	151

Most construction vehicle movements would take place during standard daytime construction hours. However, there may be occasions where construction traffic is generated out of standard hours.

For the purposes of this assessment, an estimation of the traffic noise level increases on selected roads from construction traffic has been made. An assumption has been made that existing peak hour volumes account for 10 percent of daily traffic volumes.

Existing road traffic volumes have been sourced from the Traffic and Transport Assessment (GHD 2014) for the roads around the proposal site. Existing traffic volumes are provided below in Table 4.5.

Table 4.5 Assumed existing traffic volumes

Road	Daily traffic	15 Hour (7am to 10pm)	9 Hour (10pm to 7am)
Railway Street	3500	3150 (10% HV)	350 (5% HV)
Station Street	500	450 (5% HV)	50 (0% HV)
Throsby Street	1000	900 (10% HV)	100 (5% HV)
Albert Street, east of Railway Street	4000	3600 (10% HV)	400 (5% HV)
Albert Street, west of Railway Street	2500	2250 (10% HV)	250 (5% HV)

The increase in road traffic noise due to the additional traffic generated by the facility can be calculated using the following relationship:

$$\text{Noise increase (dB)} = 10\log\left(\frac{V1}{V2}\right)$$

Here V1 represents the final volumes and V2 represents the initial volumes.

The predicted increase in road traffic noise due to construction traffic is provided in Table 4.6. Estimates indicate that construction traffic should generally have minimal impacts to the surrounding road networks, in particular to busy roads such as Maitland Road, Hannell Street/Stewart Avenue and Albert Street.

Due to the low traffic volumes (less than 500 vehicles per day), existing traffic noise along Station Street is likely to be under the RNP criteria at residential receivers. However, peak hour construction traffic accessing the site via Station Street has the potential to increase existing traffic noise by more than 2 dB(A) at residential receivers. It is therefore recommended that, as far as practicable, construction traffic movements along Station Street are scheduled during the standard daytime hours.

Table 4.6 Predicted noise level increase due to construction traffic

Road	Daily Traffic	Estimated peak hour movements (10% of daily)	Additional peak hour movements generated by construction traffic	Predicted peak hour increase in road traffic noise dB(A)
Railway Street	3500	350	135[1]	1.4
Station Street	500	50	47	**2.9**
Throsby Street	1000	100	-	-
Albert Street, east of Railway Street	4000	400	67[2]	0.7
Albert Street, west of Railway Street	2500	250	67[2]	1.0

1. *It has been assumed all construction traffic accessing Railway Lane would also travel on Railway Street.*

2. *Construction traffic for Albert Street was not available. It has been assumed all construction traffic accessing Railway Street would also access Albert Street with a 50% split from each direction.*

Haulage routes and construction traffic volumes would be required to be confirmed during future design stages with the exceedances at receivers along these roads to be confirmed at this stage.

It is recommended that the noise mitigation measures detailed in Section 4.5 be implemented where feasible and reasonable. Traffic on local roads will be managed in a traffic management plan which would be prepared prior to commencement of construction detailing specific routes that construction traffic and local traffic would follow throughout the construction phase. These routes where possible would avoid residential areas and other sensitive receivers.

It is recommended that when more detailed construction traffic generation, existing traffic volumes and traffic routes are determined, the construction traffic noise assessment be reviewed and revised.

4.4 Construction vibration impacts

Energy from construction equipment is transmitted into the ground and transformed into vibrations, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on the following:

- efficiency of the energy transfer mechanism of the equipment (i.e. impulsive; reciprocating, rolling or rotating equipment)
- frequency content
- impact medium stiffness
- type of wave (surface or body)
- ground type and topography.

The CNS (Rail Projects) provides safe working distances for vibration intensive activities, which are provided in Section 4.5.3. Since a detailed plant list and equipment locations are yet to be confirmed identifying specific residences that have the potential to be impacted by construction, this vibration impact assessment has been based on the worst case buffer distances. Therefore, it is recommended that:

- all potentially affected receivers located within 100 metres of the works be informed of the extent and nature of the proposed works
- as a general guide, all vibratory equipment should operate at least 25 metres from buildings or structures in order to prevent cosmetic damage unless the equipment is listed in Section 4.5.3 in which case the corresponding buffer distance may be used. If any buildings are identified within the safe working distances for building damage, the construction contractor should undertake a building condition survey and a copy of the report should be sent to the landholder.

When compared to the structural vibration goals outlined in Section 3.1.4 there is potential for vibration generating construction activities near to heritage structures to exceed the cosmetic criteria outlined in DIN4150-3:1999. Table 4.7 presents a list of the identified heritage structures within 50 metres of the proposal along with their proximities. Table 4.8 presents the nearest anticipated safe working distances to heritage structures.

Table 4.7 Heritage structures within 50 metres of the proposal

Heritage Structure	Address	Approximate distance to the proposal (m)
Sydney Junction Hotel	8 Beaumont Street, Hamilton	On boundary
Hamilton Junction Signal Box	Beaumont Street railway crossing	On boundary
Hamilton Station Hotel	6 Fern Street, Islington	20
Hamilton Railway Depot and Triangle	The Esplanade, Hamilton	On boundary
Hamilton Station Buildings	Beaumont Street, Hamilton	Within proposal site
Residence	22 Maitland Road, Islington	16
Lass O'Gowrie Hotel	14 Railway Street, Wickham	12
Dairy Farmers Building	924 Hunter Street, Newcastle West	50
Former Newcastle Cooperative Store	854-864 Pacific Highway, Newcastle West	On boundary
Wickham Railway Station	Beresford Street, Newcastle West	25
Former School of Arts	20 Hannell Street, Wickham	50
Residence	15 Charles Street, Wickham	10

Table 4.8 Anticipated safe working distance (heritage structures)

Activity	Anticipated safe working distance (Heritage structures) (m)
15 tonne compactor	35
Roller\rock hammer	30
Dozer	15
Excavators, Scrapers, Graders, etc.	7

Vibration results from measurements logged within the Greta Station building during the May 2011 track construction works undertaken as part of the Hunter8 project on the track adjacent to the station indicated a maximum recorded PVS of 2.87 mm/s, which occurred during removal and excavation of the old track. Tamping and ballast regulation generated a maximum PVS of 0.98 mm/s at the floor of the station building. These vibration velocities are within the DIN 4150-3 criteria for heritage structures of 3 mm/s. As similar works are proposed to be undertaken adjacent to Hamilton Station, vibration damage of the station structure is not anticipated, however it is recommended that the mitigation measures detailed in Section 4.5.1 be considered and implemented where feasible and reasonable.

4.5 Construction management and mitigation measures

As discussed in Section 4.2.2, there is the potential that construction activities could impact on surrounding sensitive receivers, even more so if activities were to be scheduled outside the standard construction hours. In practice, all feasible and reasonable measures would be implemented to minimise noise emissions from the construction activities. A Noise and Vibration Management Plan would be prepared and implemented for the proposal including the mitigation measures in the following sections.

The mitigation measures provided are in accordance with the CNS and the ICNG.

4.5.1 Standard mitigation measures

The noise and vibration mitigation measures detailed in Table 4.9 would be implemented to reduce the impact on the surrounding receivers and sensitive land uses.

Table 4.9 Standard mitigation measures for construction noise and vibration

Action required	Details
Management measures	
Implement community consultation measures	• periodic notification (letterbox drop or equivalent) • project website • project info line • email distribution list.
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all relevant project specific and standard noise and vibration mitigation measures • relevant licence and approval conditions • standard hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • construction traffic routes • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.

Action required	Details
Monitoring	A noise monitoring program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any licence conditions.
Attended vibration measurement	Attended vibration measurements are required at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Source controls	
Construction hours and scheduling	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period	If highly noise affected impacts are predicted high noise and vibration generating activities may only be carried out in continuous blocks not exceeding three hours each, with a minimum respite period of one hour between each block. If highly noise affected impacts are predicted no more than four consecutive nights of high noise and/or vibration generating work may be undertaken over any seven day period, unless otherwise approved by the relevant authority.
Equipment selection	Use quieter and less vibration emitting construction methods where feasible and reasonable.
Maximum noise levels	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria listed in Table 2 of the CNS.
Rental plant and equipment	The noise levels of plant and equipment items are to be considered in the selection of rental plant and equipment and cannot be used on site unless compliant with the criteria in Table 2 of the CNS.
Use and siting of plant	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
Plan worksites and activities to minimise noise and vibration	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.

Action required	Details
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Path controls	
Shield stationary noise sources such as pumps, compressors, fans etc.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

4.5.2 Additional mitigation measures

Due to the highly variable nature of the activities and the potential for work needing to be undertaken outside the standard construction hours, the proposal's noise management levels are likely to be exceeded at times. Consultation and cooperation with the neighbours of the site will assist in minimising uncertainty, misconceptions and adverse reactions to noise.

In circumstances where the noise levels are predicted to exceed acceptable levels after implementation of the general work practices, the relevant additional mitigation measures detailed in Table 4.10 should be considered.

Based on the predicted noise levels in Table 4.3, additional mitigation measures detailed in Table 4.9 are likely to be required for works during standard construction hours. For any activities required outside of the standard construction hours where the noise levels in Table 4.3 exceed the noise criteria, the additional mitigation measures detailed in Table 4.10 would be adopted through consultation with the surrounding sensitive receivers and land uses. The additional mitigation measures will also minimise sleep disturbance impacts. Once details of the requirements for construction activities outside of the standard construction hours are determined, sleep disturbance impacts and the additional mitigation measures required at specific residential receivers can be determined.

Table 4.10 Additional mitigation measures (Transport for NSW, CNS)

<table>
<tr><th colspan="2" rowspan="2">Criteria</th><th colspan="4">$L_{Aeq(15\ min)}$ noise level above rating background level</th></tr>
<tr><th>0 to 10 dBA</th><th>10 to 20 dBA</th><th>20 to 30 dBA</th><th>>30 dBA</th></tr>
<tr><th colspan="2">Time period</th><th>Noticeable</th><th>Clearly audible</th><th>Moderately intrusive</th><th>Highly intrusive</th></tr>
<tr><td rowspan="2">Standard</td><td>Weekday (7 am– 6 pm)</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">LB, M</td><td rowspan="2">LB, M</td></tr>
<tr><td>Saturday (8 am – 1 pm)</td></tr>
<tr><td rowspan="3">Evening</td><td>Weekday (6 pm–10 pm)</td><td rowspan="3">-</td><td rowspan="3">LB</td><td rowspan="3">M, LB</td><td rowspan="3">M, IB, LB, PC, SN</td></tr>
<tr><td>Saturday (1 pm – 10 pm)</td></tr>
<tr><td>Sunday (8 am – 6 pm)</td></tr>
<tr><td rowspan="3">Night</td><td>Weekday (10 pm–7 am)</td><td rowspan="3">LB</td><td rowspan="3">M, LB</td><td rowspan="3">M, IB, LB, PC, SN</td><td rowspan="3">AA, M, IB, LB, PC, SN</td></tr>
<tr><td>Saturday (10 pm – 8 am)</td></tr>
<tr><td>Sunday (6 pm – 7 am)</td></tr>
</table>

Monitoring (M): Compliance noise monitoring

Individual Briefings (IB): Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. TfNSW representatives would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the proposal.

Letter box drops (LB): Letter box drops or media advertisements.

Phone Calls (PC): Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs.

Specific Notifications (SN): Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise objectives. This form of communication is used to support periodic notifications.

Alternative accommodation (AA)

4.5.3 Vibration buffer distances

In addition to the standard mitigation measures discussed in Table 4.9, recommended safe working distances for vibration intensive plant from the CNS are provided in Table 4.11. These safe working distances are indicative only and may vary depending on the equipment used and the ground conditions.

Table 4.11 Recommended safe working distances for vibration-intensive plant

Plant	Rating/description	Safe working distance[1] (m)	
		Cosmetic damage[2]	Human response[3]
Vibratory roller	< 50 kN (typically 1 to 2 tonnes)	5	15-20
	< 100 kN (typically 2 to 4 tonnes)	6	20
	< 200 kN (typically 4 to 6 tonnes)	12	40
	< 300 kN (typically 7 to 13 tonnes)	15	100
	> 300 kN (typically 13 to 18 tonnes)	20	100
	> 300 kN (> 18 tonnes)	25	100
Small hydraulic hammer	300 kg – 5 to 12 tonnes excavator	2	7
Medium hydraulic hammer	900 kg – 12 to 18 tonnes excavator	7	23
Large hydraulic hammer	1600 kg – 18 to 34 tonnes excavator	22	73
Vibratory sheet piling	Sheet piles	2- 20	20
Boring rig	≤ 800 mm	2 (nominal)	n/a
Jackhammer	Hand held	1 (nominal)	Avoid contact with structure

Note 1: More stringent conditions may apply to heritage and/or other sensitive structures.

Note 2: Safe working distances for cosmetic damage based on BS7385:2 Evaluation and Measurement for Vibration in Buildings Part 2: Guide to Damage Levels from Ground-borne Vibration.

Note 3: Safe working distances for human response based on the Assessing Vibration: A technical guideline (DEC, 2006).

5. Assessment of rail operational impacts

5.1 Methodology

The methodology applied to the assessment of operational rail noise is summarised as follows:

- existing and future train speeds for the study area were provided by Transport for NSW
- train numbers and types were sourced from a schedule of train movements provided by Transport for NSW
- existing absolute rail L_{Aeq} and L_{Amax} levels were calculated using noise logger data obtained at logger location L3. These results have been used to inform the modelling process
- rail noise pass-by levels for each train type were calculated using attended pass-by noise measurements described in Section 2.3
- modelling and prediction of the operational noise levels was undertaken for ‘build’ and ‘no-build’ scenarios at the identified sensitive receivers. In addition to modelling the existing scenario for model calibration purposes, RING requires assessment at two distinct future timeframes:
  - year of project commencement (2016)
  - design year (10 year horizon, 2026)
- as rail volumes are not anticipated to change as a result of the proposal, nor are they foreseeable in the future, only a single ‘build’ and a single ‘no-build’ scenario have been modelled for both LAeq and LAmax impacts
- railway noise predictions were undertaken using Computer Aided Noise Abatement (Cadna-A) software v4.4 and the Nordic Prediction Method for Train Noise (NMT) TemaNord 1996:524 algorithm. This algorithm is recognised and accepted by the RING. Train input data was calculated from attended pass-by measurements of Hunter Railcar, OSCAR, V-Sets and Endeavour trains using the NMT method for adding new trains
- comparison of operational rail noise predictions was undertaken to identify potential impacts with consideration to the relevant RING trigger levels.

Note that absolute rail noise levels refer to the noise levels emitted by rail only without the contribution of any other noise source. Whereas ambient noise levels include rail and other noise sources such as traffic noise, industry and wildlife.

5.1.1 Train volumes and details adopted

Rail line volumes have been extracted from data provided by Transport for NSW. The train types, volumes, and train lengths are detailed in Table 5.1 for each train type.

Table 5.1 Adopted train volumes and train details

Train	Direction	Trains entering or exiting new station: Day (7 am – 10 pm)	Night (10 pm – 7 am)	Train Class/ Type	Train ID	Train length (m)
OSCAR (8-car)	Up	2	0	Passenger Electric	OD 6901–6999, 6843–6854 ON 5901–5949, 5821–5826 ONL 5951–5999, 5871–5876	163
	Down	2	0	Passenger Electric		
OSCAR (4-car)	Up	12	7	Passenger Electric		81.5
	Down	13	6	Passenger Electric		
V-Set (8-car)	Up	9	6	Passenger Electric	8000/9000 V-sets	192
	Down	8	7	Passenger Electric		
V-Set (4-car)	Up	17	2	Passenger Electric		96
	Down	17	2	Passenger Electric		
Hunter Railcar (2-car)	Up	34	11	Passenger Diesel	HM 2701-2707 HMT 2751-2757	50.5
	Down	35	10	Passenger Diesel		
Endeavour (2-car)	Up	12	3	Passenger Diesel	TE 2801-2815 LE 2851-2865	50.5
	Down	12	3	Passenger Diesel		

5.1.2 Determining the existing rail noise L_{Aeq}

Data obtained from the noise logger at location L3 was reviewed and analysed to identify train pass-by events which occurred during the monitoring period and capture the L_{Aeq} and L_{Amax} representative of each train pass-by noted during the monitoring period.

Having regard to the assessment requirements of RING, the existing absolute rail noise L_{Aeq} at the monitoring locations were determined as follows:

$$L_{Aeq(T)} = 10\log_{10}\frac{1}{T}\Sigma\left(n_i \times 10^{\left(\frac{L_{AEi}}{10}\right)}\right)$$

Where:

- T is the total time in the relevant period (day or night) in seconds
- n_i is the number of each type of event

L_{AEi} is the representative event L_{AE} for each type of event as determined from individual measurements at the most affected receiver, which is the summed over the different types of events occurring at the site.

$$L_{AEi} = L_{Aeq(period)} + 10\log_{10}T$$

The absolute rail noise L_{Aeq}'s have been used to inform the modelling process.

5.1.3 Rail noise model setup

Acoustic modelling was undertaken using CadnaA to predict the effects of rail traffic noise from the proposed project. The Nordic prediction method for train noise (NMT), TemaNord 1996:524 was used for modelling as this is able to produce L_{Aeq} and L_{Amax} levels.

The proposed development has been modelled based on data available at the time of the assessment, and as such, should be used for comparison purposes only. The model reflects the status of the design at the time of the assessment, which may change through design development.

Atmospheric conditions

The following atmospheric conditions were implemented in the model configuration:

- atmospheric conditions of 10°C and 70% humidity were used
- neutral weather conditions.

Model configuration

Further noise model inputs and assumptions are presented in Table 5.2.

Table 5.2 Railway model inputs and assumptions

Inputs/assumption	Data incorporated into noise model
Facade correction	+2.5 dB(A) to account for sound reflected from the facade.
Ground absorption	A ground absorption coefficient of 0.5
Receiver heights	Ground floor – 1.5 m above building ground level. First floor – 4.5 m above building ground level.
Ground topography	0.2 metre terrain contours (within 200 metres of the project area) 1 metre terrain contours (200 to 600 metres from the project area)
Rail alignment	Existing and proposed alignments provided by Transport for NSW
Railway sources	Refer to Section 5.1.1
Railway volumes	For the year 2026 rail volumes refer to Table 5.1.

Inputs/assumption	Data incorporated into noise model
Railway speeds	Main track (Up and Down) – 60 km/h Head shunt – 40 km/h
Source height	Top of rail 0.17 metres above ballast. Train source heights vary based on source type and spectra as per NMT.
Turnouts and crossings	+6 dB(A) correction applied as per NMT.

5.1.4 Rail source noise levels

Rail noise levels to input into the noise model for each train type were calculated using the NMT method for adding new trains and data obtained from attended pass-by noise measurements described in Section 2.3. The NMT method for adding new trains involves the adjustment of noise measurement data for each train type to a normalised speed, distance and train length. The NMT prediction model is then able to use this input data for calculation of noise levels across the model area. A summary of the noise source data for each train type (considering the operating conditions provided in Table 5.1 and Table 5.2) is provided in Table 5.3.

Table 5.3 Summary of NMT noise source data for each train type, dB(Lin)

Train	Normalised train noise spectra, SELn dB(Lin) (NMT)[2]							
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
OSCAR (Electric)	29.2	27.7	29.1	24.8	16.6	12.3	6.8	1.6
V-Set (Electric)	28.5	30.4	33.2	31.5	22.1	18.6	17.1	7.1
Hunter Railcar (Diesel)	34.2	31.4	35.7	31.7	25.4	21.2	15.8	14.2
Endeavour (Diesel)	35.3	37.8	37.7	34.8	26.1	24.8	19.2	14.0

5.1.5 Noise model verification

The noise modelling process was verified against the absolute existing rail noise levels $L_{Aeq(15hr)}$ and $L_{Aeq(9hr)}$ and $L_{Amax(95th\ percentile)}$ calculated from data obtained at logger location L3. The noise monitoring methodology and data is summarised in Section 2.2 and the process to extract absolute rail noise levels is described in Section 5.1.2.

Transportation noise models are generally deemed to be verified if the average difference between the measured and calculated values are within +/-2 dB(A).

A comparison of the modelling and monitoring results is shown in Table 5.4. The predicted results and measured results have an acceptable variance of within 2 dB(A). Therefore, the results provide a reasonable level of confidence in the accuracy of the noise model used for predicting the noise levels at the receivers for each scenario.

[2] Normalised to 60 km/h for 100 metres train length at a position 10 metres from track centre line.

Table 5.4 Noise model verification results, dB(A)

Location	Measured absolute existing 2014 rail noise levels (dB)			Noise model predictions, 2014 existing scenario (dB)		
	Day L_{Aeq} (15hr)	Night L_{Aeq} (9hr)	L_{Amax} (95th Percentile)	Day L_{Aeq} (15hr)	Night L_{Aeq} (9hr)	L_{Amax}
L3 (11.5 m from nearest track)	55.5	52.3	81.3	55.2	52.9	81.3

5.2 Predicted airborne rail noise levels

The predicted airborne rail noise levels at the nearest sensitive receivers identified in Figure 2.1 are detailed in Appendix B. The L_{Amax}, $L_{Aeq(15hr)}$ day and $L_{Aeq(9hr)}$ night noise contour plots are shown in Appendix C. There are no nearby noise sensitive receivers that are anticipated to exceed the RING airborne noise trigger levels. Airborne rail noise level ranges for each NCA are provided in Table 5.5 for the build and no-build scenarios. Note that the predicted noise levels include a 2.5 dB(A) facade correction.

Where the existing rail line is removed to the east of Stewart Avenue, rail noise levels decrease significantly for NCA 6. The removal of the level crossing at Railway Street is also predicted to reduce L_{Aeq} and L_{Amax} noise levels at nearby receivers within NCA-5, however the introduction of a head shunt track and reduction of separation distance to residences within NCA-5 will marginally increase noise levels. Also the introduction of turnouts between the proposed Wickham Station and Maitland Road overbridge are expected to marginally increase rail airborne noise levels within NCA-8.

The predicted noise levels and relative increase at the nearest identified sensitive receivers is provided in Appendix C. Noise contours are shown in Appendix D.

Table 5.5 Airborne rail noise levels at nearby residential receivers, dB(A)

Receiver		Scenario 1 Existing base case			Scenario 2 Proposal opening year/ 10 year horizon			Change in noise levels		
ID	NCA	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}
R1 to R4	NCA 1	45 to 46	42 to 44	67 to 71	45 to 46	42 to 44	67 to 71	0 to 0.1	0 to 0.2	-0.1 to 0
R5 to R7	NCA 2	51 to 52	49 to 50	74 to 75	51 to 52	49 to 50	75 to 75	0 to 0.1	0.1 to 0.1	-0.1 to 0.3
R8 to R20	NCA 5	53 to 55	50 to 53	76 to 83	47 to 57	45 to 55	74 to 80	-6 to 2.3	-5.9 to 2.7	-3.4 to 3.6
R21 to R23	NCA 6	45 to 48	42 to 45	67 to 70	36 to 38	34 to 36	50 to 52	-11.7 to -8.1	-11.4 to -7.9	-18.2 to -15.4
R24	NCA 8	43 to 43	41 to 41	66 to 66	49 to 49	47 to 47	73 to 73	5.7 to 5.7	5.9 to 5.9	6.8 to 6.8
R25 to R38	NCA 9	43 to 50	41 to 48	64 to 73	45 to 50	43 to 48	64 to 73	0 to 1.8	0 to 1.9	-0.1 to 0.3

5.3 Other operational rail noise impacts

5.3.1 Impact on existing rail network

The RING states that, ‘the guideline does not apply to the mitigation of noise from existing rail lines where no rail infrastructure projects are proposed (rail noise abatement programs are to be developed to provide relief for those acutely affected by rail noise).’ Therefore there is no requirement under the current guideline to provide mitigation treatments to residences exposed to higher rail volumes on the existing rail network outside the proposal area.

5.3.2 Horn noise

The RING states that, ‘the noise triggers in this guideline apply to noise from safety devices such as warning horns and bells at level crossings as this is a normal part of operational rail noise. This noise should be taken into account when predicting noise levels and reported in terms of $L_{Aeq(15hr)}$, $L_{Aeq(9hr)}$ and L_{Amax}. It is recommended that the design of new and upgraded railway lines consider noise from safety devices and aim to reduce noise levels from such devices whenever possible.’

With the removal of the Railway Street and Stewart Avenue crossings, train horn and level crossing bell events are anticipated to be reduced in the vicinity of these areas for trains heading in both directions. It is expected that trains leaving the new station and head shunt track would not use horns when departing.

Train horn usage within the stabling area is discussed in Section 6.1.

5.3.3 Wheel curve squeal

'Lateral slip of the tread running surface of the wheel across the rail-head is the most probable cause of wheel squeal’[3], which excites natural modes in the wheel which generate tonal noise at mid to high frequency. There is the potential that wheel curve squeal can occur on curved tracks at levels of up to L_{Amax} 100 dB(A) at 15 metres and is considered more annoying due to the tonal characteristics.[4] Wheel curve squeal should be controlled through management measures such as gauge face lubricators, track maintenance and rolling stock maintenance.

As the proposal consists of a relatively straight section of track, wheel squeal is not anticipated. Additional noise through turnouts and crossovers has been considered in the operational rail noise model.

5.3.4 Braking

Braking can result in brake squeal which could produce similar noise emissions to wheel curve squeal. Brake squeal is generated through the brake and the wheel and can be controlled through rolling stock wheel maintenance or low squeal brake blocks. The L_{Amax} criterion refers to the maximum noise level not exceeded for 95 percent of rail pass by events. Accordingly, with appropriate maintenance, brake squeal may not occur for more than 5 percent of the time and has therefore not been included in the predicted L_{Amax} noise levels for the proposal.

---

[3] Rail Wheel Squeal – Some Causes and a case study of freight car wheel squeal reduction (Tickell, C.E. et al 2004)

[4] RAC Line Based Noise PRP Study Noise Source Working Paper (Report 10-1142-R1 September 2000)

5.4 Operational vibration impacts

Human comfort

The AVTG provides a methodology to assess human comfort using VDV levels where there are repeated events of variable magnitude.

Vibration monitoring was undertaken based on existing passenger rail movements at location L3. Based on the measurement data, at 5 metres from the track, the average pass-by VDV level for triggered events generating at least 1 mm/s vibration velocity was 0.03 $mm/s^{1.75}$ when passenger trains were operating at approximately 60 km/h.

The nearest residential receiver is approximately 10 metres from the proposed stabling area, where train speeds will be less than 25 km/h, therefore compliance with the criteria at the measurement location indicates compliance at all sensitive receivers.

Based on the supplied rail movements and conservatively assuming all trains run on the nearest track, the estimated VDV values are presented in Table 5.6.

Table 5.6 Predicted VDV at 5 metres from the rail line ($m/s^{1.75}$)

VDV	Criteria	Distance
		5 metres
Day (15 hour)	0.2	0.11
Night (9 hour)	0.13	0.08

Vibration estimates indicate that VDV values are below the human comfort criteria at 5 metres from the rail line. VDVs for the night time are lower than daytime due to there being fewer rail movements per hour during the night period.

Since all residential receivers are further than 5 metres from the proposal, no adverse vibration impacts are anticipated in relation to human comfort.

Cosmetic damage

Vibration estimates indicate that the vibration criteria will be achieved at 5 metres from the railway for residential structures. Between the Maitland Road overbridge and the new station, all receivers and buildings are further than 5 metres from the railway therefore cosmetic damage impacts are not anticipated where trains would be travelling at speeds of up to 60 km/h.

West of the Maitland Road overbridge, the development at 12 Maitland Road will be located approximately 4 metres from the nearest siding where trains may travel at slower speeds of 25 km/h. As vibration is a function of train speed and applicable vibration guideline levels are 15 mm/s for buildings of this nature, cosmetic damage is not anticipated at this location.

Therefore, cosmetic damage due to rail operations are not anticipated any sensitive receivers for the proposal.

5.5 Airborne rail noise mitigation measures

As there are no predicted exceedances of RING airborne rail noise criteria at nearby identified receivers for the future horizon project ‘build’ scenario, no mitigation measures are required in relation to operational rail noise.

6. Assessment of operational noise impacts from fixed infrastructure

6.1 Hamilton stabling facility

Noise from the proposed stabling facility is assessed against the NSW INP, separate to operational rail noise. The Sydney Trains NVRF has also been considered in the assessment of stabling facility noise. All activities associated with the movement and stabling of trains on the new tracks west of the Maitland Road overpass have been assessed. In total, there are four sidings within the stabling facility, along with the required turn-outs to connect the stabling tracks to the two existing tracks and proposed head shunt track.

6.1.1 Modelling methodology

Noise emissions from the stabling facility have been assessed through noise modelling using CadnaA v4.4 to predict sound pressure levels at the nearest identified noise sensitive receivers.

CadnaA was configured to calculate sound propagation according to ISO 9613-2, Acoustics – Attenuation of sound during propagation outdoors. The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights or ‘downwind’ conditions which are favourable to sound propagation.

Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

6.1.2 Modifying factor adjustments

The INP requires that modifying factor adjustments are applied if the noise sources contain tonal, intermittent or low frequency characteristics, which have the potential to increase annoyance. According to the definitions provided in the INP, the noise sources at the stabling facility are not likely to require the addition of modifying factors, with the exception of air release during exhaustion of the brake pipe. Conservatively, a 5 dB modifying factor has been applied to this noise source to account for this potentially impulsive characteristic.

6.1.3 Modelling configuration

When a train enters a stabling facility, a number of operational activities take place. The train will enter slowly and once the train comes to a standstill, the brake pipe would be exhausted and the parking brake would be engaged. Exhausting the brake pipe releases compressed air to the atmosphere, causing a short term noise event. The air typically exhausts from underneath the train at the two end carriages (of a four-carriage train).

After the parking brake is engaged, the trains will idle for approximately 45 minutes while decanting takes place. During this time, it has been assumed that all auxiliary equipment will continue to operate, including the motor-alternators, air compressors and air conditioning fans. Once decanting is completed, the trains will then be stabled with all auxiliary equipment shut down. While stabled, train interiors are cleaned. Once the train is shut down, there are expected to be negligible noise emissions. Trains will start up again 30 minutes prior to departing the stabling facility. During this time, it has been assumed that all auxiliary equipment will operate, including the motor-alternators, air compressors and air conditioning fans.

It is assumed that the stabling facility would be primarily used for decanting and general maintenance/cleaning of trains. It has been assumed that none of the following activities would occur within the stabling facility:

- wheel lathe works or other noisy maintenance activities
- audible alarm system or PA system announcements
- train washing (external).

Train movements within the stabling facility will occur at low speeds and therefore train noise emissions would be mainly dominated by on board equipment (such as motor generators, air compressors and air conditioners) rather than wheel rail noise.

Based on the current train schedule, there would be a total of 24 movements into or out of the stabling facility each 24-hour period. Of these, nine movements occur during the day (7 am to 10 pm) and the remaining 15 movements occur during the night (10 pm – 7 am). Since the night-time period generally exhibits lower background noise levels relative to the evening and day periods, the night-time is expected to be the most sensitive time period.

Table 6.1 presents the sound power levels adopted for train noise sources within the stabling facility. Sound power levels have been derived based on noise measurements taken by GHD of idling trains at Newcastle Station, unless otherwise specified. Noise levels provided in Table 6.1 are consistent with those provided in Table 3 of Sydney Trains NVRF.

Based on the current train schedule, operations at the stabling yard will generally comprise of the following:

- minimal to no use between the daytime hours of 7 am to 6 pm other than occasional use as a layover area for both electric and diesel passenger trains
- evening and night-time arrivals – a number of electric trains arrive at the stabling facility between the hours of 6 pm and 10:30 pm. A small number of electric trains also depart the facility during this time
- night-time operations – up to six electric train movements throughout the night, but with the majority of trains stabled during the night
- early morning departures – the bulk of electric trains depart the stabling facility in the early morning (4 am to 6 am) ready for operation.

Following completion and commissioning of the new station at Wickham and Hamilton Stabling Yard works, trains would temporarily layover during the day time in the stabling yard, head shunt track, and at the new station (Platform 3) for activities such as cleaning, decanting, maintenance inspections, amalgamation and division, prior to re-entering service. Only electric trains would be stabled at the Hamilton stabling yard overnight. Diesel trains would be stabled elsewhere near Broadmeadow Station.

A number of operational scenarios have been modelled to represent potential worst-case noise emissions from the stabling facility.

Table 6.1 Stabling facility train sound power levels Lw dB re 10^{-12} W

Source	SWL dB(A)	Location	Comments
Air conditioning fans	78 L_{Aeq}	Top of carriage	Occurs at two locations on each carriage.
Motor alternator	98 L_{Aeq}	Under floor	Noise source is at two locations on a 4-carriage train. Assumed to be located on carriage 1 and 4.
Air compressor cycle	93 L_{Aeq}	Under floor	Noise source is at two locations on a 4-carriage train. Assumed to be located on carriage 1 and 4. Sound power averaged over complete compressor cycle.
Horn	138 L_{Amax}[1]	End of train, under floor	Assumed to be at front of train. Sound power based on a short 'toot'. It has been assumed that the horn would be used to signal that a train is about to move. Horn assumed to occur for 0.5 seconds.
Brake air release	112 L_{Amax}[2]	Under floor	Noise source is at two locations on a four-carriage train. Assumed to be located on carriage 1 and 4.
Diesel train stationary	103 L_{Aeq}[3]	At side of carriage	Based on Hunter Rail Car - Idling
Diesel train 15km/h	108 L_{Aeq}[3]	At side of carriage	Based on Hunter Rail Car – Notch 2

1. Horn noise source: Engineering Standard Rolling Stock. RSU 600 – Minimum operating standards for rolling stock – multiple unit train specific interface standards, Version 1.6, June 2013. Horn noise level based on 'Town horn' generating 90 dB(A) at 100 metres in front of a stationary train.

2. Brake air release source: North West Rail Link, Noise and vibration technical paper for operations and additional construction works, prepared by SLR Consulting, October 2012. Includes 5 dB adjustment for impulsive characteristic.

3. Diesel train noise level based on Hunter Rail Car data from GHD noise level database.

It has been assumed that Siding 4 (outside track) will be used first, followed by the three remaining sidings. In this sequence, the first train to be stabled for the night can enter and shut down in Siding 4, which is nearest to sensitive receivers on Fern Street and Ivy Street. With a train shut down in Siding 4, the body of the train would provide shielding of noise from other trains in the stabling facility as well as noise from Hamilton Station.

It has also been assumed that this train would be the last to depart, thus providing shielding from other trains as they depart. Table 6.2 presents the modelled scenarios for stabling facility operations.

Table 6.2 Modelled stabling facility scenarios

Scenario	Operating conditions
Scenario 1	Train entering and idling in Siding 4. No other trains in stabling facility.
Scenario 2	Train in Siding 4 is turned off. Train idling in Siding 3.
Scenario 3	Train in Siding 4 is turned off. Train idling in Sidings 2 and 3.
Scenario 4	Train in Siding 4 is turned off. Train idling in Sidings 1, 2 and 3.
Scenario 5	Diesel train entering, then idling at western end of Siding 1 during the daytime only. No other trains in stabling facility.

For all scenarios, the body of the outer train was included in the noise model to provide shielding from trains stabled on inner sidings. For Scenarios 1 to 4, an eight-carriage train was modelled in Siding 4. For Scenario 3, an eight-carriage train was modelled in Siding 2 and for Scenario 4, an eight-carriage train was modelled in Siding 1. To represent worst-case conditions, all trains in the stabling facility have been modelled with eight carriages for Scenarios 1 to 4.

From Table 6.1, the primary noise source on stabling trains, while systems are operating, is the motor-alternator located under the first and fourth carriages of each four-carriage train. It has been assumed that the motor-alternators will operate for the full 15-minute assessment period, representing either the 45 minutes where a train idles on arrival, or the 30 minutes where a train starts-up prior to departure.

6.1.4 Predicted stabling facility noise impacts

Results of the stabling facility operational noise modelling indicate that impacts are greatest where a train enters and idles within Siding 4, however where this train is switched off it provides an effective noise barrier to northern NCAs for trains entering and using subsequent sidings.

The results are presented below in Table 6.3. Noise contour maps for scenario 4 are shown in Appendix E.

Table 6.3 Predicted stabling facility noise levels – $L_{eq\ (15\ minute)}$ dB(A)

Modelled scenario	NCA	Most affected residential receiver(s)	Residential criterion Leq dB(A)			Highest predicted Leq dB(A)	Highest exceedance dB(A)		
			Day	Evening	Night		Day	Evening	Night
Scenario 1	NCA-1	R4	53	48	42	**45**	-	-	3
	NCA-2	R5, R6, R7	52	51	47	**67**	15	16	20
	NCA-9	R33, R34, R35	49	49	45	**46**	-	-	1
Scenario 2	NCA-1	R4	53	48	42	41	-	-	-
	NCA-2	R5, R6, R7	52	51	47	**52**	-	1	5
	NCA-9	R33, R34, R35	49	49	45	**48**	-	-	3
Scenario 3	NCA-1	R4	53	48	42	**51**	-	3	9
	NCA-2	R5, R6, R7	52	51	47	**53**	1	2	6
	NCA-9	R33, R34, R35	49	49	45	**51**	2	2	6
Scenario 4	NCA-1	R4	53	48	42	**53**	-	5	11
	NCA-2	R5, R6, R7	52	51	47	**54**	2	3	7
	NCA-9	R33, R34, R35	49	49	45	**52**	3	3	7
Scenario 5 (daytime only)	NCA-1	R1, R2, R3, R4	53	48	42	**57**	4	n/a (daytime only)	
	NCA-2	R5, R6, R7	52	51	47	52	-		
	NCA-9	R33, R34, R35, R36, R37, R38	49	49	45	**55**	6		

6.1.5 Sleep disturbance

Short-term high noise level events such as train horns and brake air releases have the potential to cause sleep disturbance at sensitive receivers if they rise significantly above the background level. The INP does not specifically address sleep disturbance from these types of noise level events.

The INP Application Notes refers to the RNP and suggests that the $L_{A1,1min}$ noise level should not exceed the background L_{A90} level by more than 15 dB(A). This value is used as a screening test to identify potential for sleep disturbance.

Further guidance is provided in the RNP which concludes, based on the research to date, that:

- maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions
- one or two events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and well-being significantly.

Horn noise and noise from brake air release has been modelled as separate activities for assessment against the sleep disturbance criterion (due to their short duration and higher maximum noise levels). L_{Amax} noise impacts have been predicted at the most exposed sensitive receivers in each NCA. This has been achieved by modelling the horn and brake air release noise sources at a number of possible locations within each of the four sidings, and taking the maximum predicted noise level for each receiver.

Table 6.4 shows the predicted L_{Amax} noise levels in each of the NCA around the stabling facility for horn noise and brake air release noise. The model results indicate that significant exceedances of the sleep disturbance indicator levels are predicted at the most affected residential receivers, particularly from the use of train horns within the stabling facility. For this reason, it is strongly recommended that an alternative warning system be implemented during the night-time for use within the stabling facility, if required. Further noise mitigation measures are discussed in Section 6.1.7.

L_{Amax} levels from brake air release noise is also predicted to exceed the sleep disturbance indicator levels at the most exposed residential receivers in NCA-1, NCA-2 and NCA-9, with a maximum exceedance of up to 20 dB with a train on the nearest siding during the night time period. With trains on sidings located further away, impacts would decrease. Based on the current daily train schedule, there would be up to 15 movements within the stabling facility per night, each with the potential for brake air release noise. The above factors indicate there is potential for adverse sleep disturbance impacts at the nearest identified receivers from brake air release noise, particularly those within NCA-2 on Ivy Street. It is therefore recommended that as far as practicable, trains within the stabling facility between the night-time hours of 10pm to 7am use sidings 1, 2 or 3 and a train is stabled in Siding 4 to shield noise from these trains at sensitive receivers on Fern Street and Ivy Street. Further noise mitigation measures are discussed in Section 6.1.7.

Table 6.4 Predicted L_{Amax} noise levels

Noise Source L_{Amax}	NCA	Most affected residential receiver(s)	L_{Amax} dB(A) Sleep disturbance indicator	L_{Amax} dB(A) Predicted
Brake air release	NCA-1	R4	52	63
	NCA-2	R5, R6, R7	57	77
	NCA-9	R33, R34, R35	55	56
Horn	NCA-1	R4	52	74
	NCA-2	R5, R6, R7	57	98
	NCA-9	R33, R34, R35	55	76

6.1.6 Interim operational stabling scenario

During construction, trains will be stabled overnight on the existing tracks between Hamilton Station and approximately 250 metres east of the Maitland Road overpass. Trains will be stabled in this way until the proposed stabling facility is constructed and operational (approximately 2 years). This situation poses potential for noise impacts from idling trains that have not been assessed under the operational noise impact assessment.

Similarly to operation of the stabling facility, noise from trains stabling in the interim scenario should also be assessed against the INP and sleep disturbance criteria.

Operational noise impacts

To represent a worst-case scenario for this interim stabling scenario, a series of idling trains has been modelled on both tracks from the eastern end of Hamilton Station platform to approximately 250 metres east of Maitland Road overpass. This scenario represents all possible arrangements of idling trains along this section of track. As discussed previously, idling train noise is dominated by the motor-alternator, located under the floor of carriage one and four of a four-carriage train.

During the interim stabling scenario, residential receivers within NCA-2, NCA-8 and NCA-9 have the greatest potential for exposure to stabled train noise. Predicted worst-case interim stabling noise levels are shown in Table 6.5. Predicted results indicate that compliance with the day; evening and night-time INP criteria would be achieved in NCA-2 and NCA-8. Under the worst-case modelled scenario, residential receivers within NCA-9 are predicted to exceed the INP criteria during evening and night-time periods by up to 10 dB(A).

Table 6.5 Predicted interim stabling noise levels – $L_{eq\ (15\ minute)}$ dB(A)

NCA	Most affected residential receiver(s)	Residential criterion L_{eq} dB(A) Day	Evenin g	Nigh t	Highest predicted L_{eq} dB(A)	Highest exceedance dB(A) Day	Evenin g	Night
NCA-2	R5, R6, R7	57	51	47	45	-	-	-
NCA-8	R24	55	51	49	49	-	-	-
NCA-9	R25-R32	54	49	45	**55**	1	6	10

Sleep disturbance

Noise from trains operating horns and brake air release systems also has the potential to generate sleep disturbance impacts during the night-time. As a worst-case scenario, horn noise and noise from brake air releases have been modelled along the sections of stabling areas. Table 6.6 presents predicted results for the L_{Amax} assessment. Predicted results indicate that the sleep disturbance indicator levels are met for brake air release noise, however are exceeded for horn noise at the most affected receivers within NCA-2, NCA-8 and NCA-9.

Table 6.6 Predicted interim stabling L_{Amax} noise levels

Noise Source	NCA	Most affected residential receiver(s)	L_{Amax} dB(A)	
			Sleep disturbance indicator	Predicted
Brake air release	NCA-2	R5, R6, R7	52	47
	NCA-8	R24	57	52
	NCA-9	R25 – R32	55	53
Horn	NCA-2	R5, R6, R7	52	**63**
	NCA-8	R24	57	**77**
	NCA-9	R25-R32	55	**79**

6.1.7 Best practice noise management measures for stabling yards

Sydney Trains NVRF states that where noise levels from a stabling facility are predicted to exceed the recommended goals, feasible and reasonable noise management and mitigation options should be applied to reduce the noise levels as far as practicable.

Sydney Trains NVRF provides best practice options for managing noise emissions from stabling facilities in Section 4.3 of the document. It identifies the following standard practice noise management options:

- ensure that horns are used only to the extent required to meet safety and engineering procedures and criteria (i.e. no excessive use of horns)
- educating employees to bear in mind neighbouring properties (keep voices down, stand away from receivers to talk).

Best practice noise management and mitigation measures, as outlined in Section 4.3.2 of Sydney Trains NVRF include:

- the use of alternative horn test and warning procedures or removing the requirement to test the horn altogether
- powering down trains whenever possible, rather than idling
- the use of 'barrier trains' to shield noise from other trains within the stabling facility
- scheduling noisy activities to less sensitive time, such as day or evening times
- consultation with the affected residents.

In addition to these measures, and specifically to reduce predicted horn noise impacts, Transport for NSW will liaise with NSW TrainLink to revise their horn testing procedure such that horns will be tested east of Maitland Road, west of Railway Street, away from sensitive receivers.

The INP highlights three main strategies for noise control, being:

- controlling noise at the source
- controlling the transmission of noise
- controlling noise at the receiver.

Noise control at the source is addressed above. Further options for noise control in the pathway and at the receiver are discussed below.

Controlling noise in the pathway

Once all strategies have been employed to control noise at the source, the next most effective approach is to control noise in the transmission path, between the source and the receiver.

Controlling noise in the transmission path is typically achieved through the use of a noise barrier. Barriers are more effective the closer they are to the noise source, or the receiver. The effectiveness of barrier performance is also determined by the materials used (absorptive or reflective, density). Noise barriers typically require a density of at least 15 kg/m^2 to be effective.

The use of noise barriers to control noise from the stabling facility has been incorporated into the noise model. As previously identified, the primary noise source from an idling train within the stabling facility is the motor-alternator, located under the floor of the train, at a height of approximately 0.5 metres above the rail.

For the purposes of demonstrating their likely effectiveness, a noise barrier of three metres in height has been modelled along the boundary fence, adjacent to Ivy Street and Fern Street to shield receivers in NCA-1 and NCA-2. A barrier of three metres in height has also been modelled along the southern boundary fence, adjacent to Hamilton Station, running parallel to the most southern existing platform.

The assumed noise barriers were found to have a small mitigating effect at the nearest residential receivers in NCA-1 (Fern Street) and NCA-9 (Eva Street), with a reduction in noise levels of less than 2 dB(A). This is primarily due to the distances between the noise source, barrier and receiver. A barrier closer to the dominant train noise sources would provide the most effective path attenuation. However, the location of the noise barrier would need to be considered in the context of stabling facility site activities and space available to the operating main line.

Due to the smaller separation distance, a noise barrier was found to be effective at reducing noise levels at residential receivers along Ivy Street in NCA-2. Reductions of 8-10 dB(A) at the most affected receiver were achieved. While this reduction is substantial, based on the predicted results shown in Table 6.3, exceedances of the adopted criteria are still likely at the most affected receivers. Therefore, other noise mitigation options or locations of noise barriers (closer to the source) would need to be investigated.

Controlling noise at the receiver

Another option for noise control is at the receiver. Noise control at the receiver may be in the form of negotiations (as identified in the Sydney Trains NVRF) and/or architectural treatment to protect the internal environment of the receiver. Architectural treatment typically consists of increased insulation, upgraded glazing on windows and acoustic seals around windows and doors. Architectural treatment aims to control the transmission of noise to internal parts of the residence. To allow for windows to be closed, air conditioning is typically required to be installed. As architectural treatment may be less effective in some building types (e.g. weatherboard homes), as a last resort, property acquisition may be required.

Based on the above strategies, it may be possible to reduce operational noise from the stabling facility to acceptable levels during the day and evening period, however it will be difficult to achieve compliance with the external night-time noise criteria.

Further investigation into suitable noise mitigation options would be undertaken as part of subsequent design stages in consultation with affected residences.

Interim stabling yard operations

Although this stabling scenario will be temporary, it may last for a period of up to 2 years during project construction. Therefore, the above mitigation measures would also be relevant to the interim situation, specifically:

- construction of temporary noise walls close to the stabling areas to minimise LAeq and LAmax noise levels at residential receivers within NCA-9
- limit the use of train horns during the night-time period, or, preferably, use alternative (non-audible) warning means, if required.

6.2 New station operational noise

Noise from operation of the public address (PA) system, air conditioning units and other mechanical plant from the new station is also assessed against the INP criteria.

The nearest residential receivers to the new station are located on Station Street. The nearest residence is located immediately adjacent to the station at approximately 20 metres, however most residences are located at least 50 metres from the station and platforms.

Prediction of operational noise from the PA system and mechanical plant is not practical at this stage given the limited design detail available around the design of the new station. Station noise should be considered in more detail at later design stages when specifics of these noise sources are better known.

PA systems can typically be designed to minimise noise impact at surrounding receivers through the use of measures such as speaker selection, orientation and placement. It is expected that with appropriate design and best practice management measures in place, noise from the PA system should not cause adverse noise impacts at nearby sensitive receivers. It is recommended that the operation of the PA system during the night-time (10 pm to 7 am) be minimised.

Noise from mechanical plant associated with the operation of the new station (such as air conditioning units) would also be managed through design measures, such as locating sources away from residential receivers.

Potential noise impacts from the new station would be assessed in more detail as part of subsequent design stages, when information such as speaker location and mechanical plant locations are known.

7. Operational traffic noise impacts

Operation of the proposal is expected to generate additional traffic on local road networks. Essentially, traffic (including light vehicles and busses) which currently access Newcastle Station, would access the new station following the proposal.

It is anticipated that the majority of vehicles accessing the new station will make use of Station Street, Railway Street and Albert Street. Throsby Street may also be used to access Hannell Street from Railway Street, or vice versa.

The majority of traffic generated by the proposal is expected to be light vehicles, consisting of taxis or private vehicles. There will also be a small number of coaches accessing the new station for transport of patrons to regional areas.

7.1 Existing traffic

Existing traffic noise on Albert Street was measured at logging location L4. Measured existing traffic noise levels are provided below in Table 7.1. With consideration to the RNP, Albert Street is considered as a sub-arterial road. Existing traffic noise on Albert Street currently exceeds the RNP criteria during both day and night time periods by up to 3 dB.

Observations made at logging location L5 indicated that existing noise in this area was primarily influenced by noise sources other than road traffic noise, such as rail noise, commercial noise and insects. Therefore, the measured road traffic noise indicators are not considered representative of actual road traffic noise levels on Station Street. To provide an estimate of existing levels of road traffic noise, the United Kingdom's Calculation of Road Traffic Noise (CoRTN) was used with CadnaA noise modelling software to predict traffic noise at residential receivers along Station Street. Existing traffic volumes were modelled as per those in Table 4.5.

With consideration to the RNP, Station Street is considered as a local road.

Table 7.1 Existing traffic noise levels, dB(A)

Location	Criteria		Existing traffic noise levels	
	Day (7 am – 10 pm)	Night (10 pm – 7 am)	Day $L_{Aeq(15hr)}$ (7 am – 10 pm)	Night $L_{Aeq(9hr)}$ (10 pm – 7 am)
Logger 4 – Albert Street	60 $L_{Aeq(15hr)}$	55 $L_{Aeq(9hr)}$	63 $L_{Aeq(15hr)}$	57 $L_{Aeq(9hr)}$
Station Street[1]	55 $L_{Aeq(1hr)}$	50 $L_{Aeq(1hr)}$	50 $L_{Aeq(1hr)}$	< 50 $L_{Aeq(1hr)}$[2]

1. Predictions include a facade correction for reflection of + 2.5 dB. Predictions based on a distance of 10 metres to the road.
2. While existing traffic volumes on Station Street during the night-time were not available, they are expected to be very low. Traffic noise estimate is very conservative.

7.2 Traffic generation

An estimate of traffic volumes generated by the proposal is provided in Table 7.2.

Table 7.2 Assumed additional operational traffic generation

Street	Operational Traffic (VPD)	
	Taxis	Private vehicles
Station Street	100	500
Railway Street, south of Throsby Street	100	500
Railway Street, north of Throsby Street	50	250
Throsby Street	50	250
Albert Street, east of Railway Street	30	150
Albert Street, west of Railway Street	20	100

7.3 Operational traffic noise impacts

The increase in road traffic noise due to the additional traffic generated by the operation of the proposal was calculated using the same equation as detailed in Section 4.3.

The predicted increase in road traffic noise level is provided in Table 7.3.

Table 7.3 Predicted operational road traffic noise level increase

Roadway	Existing VPD (2014)	Generated light and heavy vehicle movements per day	% increase in total traffic	Predicted noise level increase (based on total traffic) dB(A)
Railway Street	3500	600	18	0.7
Station Street	500	600	120	3.4
Throsby Street	1000	300	30	1.1
Albert Street, east of Railway Street	4000	180	5	0.2
Albert Street, west of Railway Street	2500	120	5	0.2

The predicted growth in traffic due to proposal operations would increase the existing traffic noise by less than 2 dB(A) at Railway Street, Throsby Street and Albert Street. The RNP states that an increase of 2 dB(A) represents a level which is considered barely perceptible to the average person.

Due to a substantial increase in vehicle volumes on Station Street, road traffic noise levels are predicted to increase by more than 3 dB(A). While this could be noticeable, due to the relatively low total vehicle volumes on Station Street (even with the addition of the proposal), the RNP road traffic noise criteria is expected to continue to be met. It is recommended that further assessment be made at detailed design phase of the proposal, when more accurate traffic volumes and predictions are available.

8. Conclusion

Transport for NSW has engaged GHD to prepare a noise and vibration assessment as part of the Review of Environmental Factors for the proposed Wickham Transport Interchange Project. This assessment has led to the following conclusions, which are subject to the limitations outlined in Section 1.3.

Construction works during standard construction hours have the potential to exceed the construction noise management levels at the surrounding residential receivers. Standard noise mitigation measures have been recommended for implementation which will reduce impacts at surrounding residential receivers. However, it is unlikely that implementation of the standard noise mitigation measures would reduce noise levels to below the construction noise criteria under all circumstances.

Out of hours works is likely to cause exceedances at nearby sensitive receivers. It is recommended that out of hours work be considered and assessed in more detail when more information about specific activities during out of hours work are known.

Estimates indicate that construction traffic should generally have minimal impacts to the surrounding road networks, in particular to busy roads such as Maitland Road, Hannell Street/ Stewart Avenue and Albert Street.

Peak hour construction traffic accessing the site via Station Street has the potential to increase existing traffic noise by more than 3 dB. It is therefore recommended that, as far as practicable, construction traffic movements along Station Street are scheduled during the standard daytime hours.

Construction traffic on local roads should be managed in a traffic management plan which would be prepared by TfNSW detailing specific routes that local and construction traffic would follow throughout the construction phase.

Based on the safe working distances, when high vibration generating activities occur within 100 metres of adjacent residences it is recommended that the potentially impacted residents be informed of the nature of the works, duration and project contact details.

Based on the safe working distances, having regard to the potential for cosmetic building damage, the expected magnitude of ground vibrations should not be sufficient to cause damage if the equipment operates at distances greater than 25 metres from structures.

There is the potential for vibration generating construction activities within 35 metres of heritage structures (Hamilton Station) to exceed the cosmetic criteria. A number of management and mitigation options are discussed in this report.

Operational rail vibration impacts have been predicted and assessed against the vibration criteria outlined in the AVTG at sensitive receivers potentially impacted by noise from the proposal. Vibration estimates indicate that the vibration criteria will be achieved at 5 metres from the railway. All receivers and buildings that are further than 5 metres from the railway are accordingly unlikely to receive cosmetic damage or human comfort impacts from the proposal.

Operational rail noise impacts have been predicted and assessed against the rail trigger noise levels outlined in the RING at sensitive receivers potentially impacted by noise from the proposal. Operational rail noise levels are not predicted to exceed the trigger levels, accordingly no mitigation measures are required.

Groundborne noise is generally only considered a potential issue where levels are higher than the airborne noise levels such as for underground railways. As there are no underground sections of rail associated with the proposal, groundborne noise due to rail operations is not considered likely.

While trains are idling within the stabling facility, with auxiliary systems operating, there is potential for the industrial noise criteria to be exceeded at the most affected residential receivers, particularly during the night-time period. Operations of train horns and brake air release systems also have the potential to generate sleep disturbance impacts at the most affected residential receivers. Further consideration of reasonable and feasible mitigation measures (e.g. noise walls, architectural treatment or as a last resort, property acquisition) would be undertaken during subsequent design stages to manage predicted exceedances of noise goals.

Interim stabling operations during construction of the proposal have been considered. Similar to the predicted impacts for operation of the stabling facility, noise impacts have been predicted at the nearest sensitive receivers. Noise impacts during this interim stabling scenario will be temporary. Operation of train horns and brake air release systems also have the potential to generate sleep disturbance impacts at the most affected residential receivers during this temporary stabling scenario. A number of management and mitigation options are discussed in this report.

9. References

Australian Standards 2002, AS 2377 – 2002, Acoustics – Methods for the measurement of railbound vehicle noise

Australian Standards 2010, AS 2436 - 2010, Guide to noise and vibration control on construction, demolition and maintenance sites

Australian Standards 1997, AS 1055 – 1997, Description and Measurement of Environmental Noise

British Standards 2009, BS 5228.2 – 2009, Code of Practice Part 2 Vibration for noise and vibration on construction and open sites – Part 2: Vibration

British Standards 1993, BS-7385-2: 1993, Evaluation and measurement for vibration in buildings

British Standards 1992, BS 6472 – 1992, Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)

Bureau of Meteorology's Nobbys Head Automatic Weather Station data

Department of Environment and Conservation 2006, Assessing Vibration; A Technical Guideline, Sydney

Department of Environment and Climate Change 2009, Interim Construction Noise Guideline, Sydney

Department of Environment, Climate Change and Water 2011, Road Noise Policy, Sydney

Environmental Protection Authority 2000, Industrial Noise Policy, Sydney

Environment Protection Authority 2013, Rail Infrastructure Noise Guideline, Sydney

GHD 2014, Wickham Transport Interchange Project, Traffic and Transport Assessment

Roads and Traffic Authority 2001, Environmental Noise Management Manual, Sydney

Sydney Trains 2013, Environmental Management System Guide Noise and Vibration Rail Facilities

Transport Construction Authority 2010 Construction Noise Strategy (Rail Projects)

Tickell, C.E. et al 2004 Rail Wheel Squeal – Some Causes and a case study of freight car wheel squeal reduction

Nordic Council of Ministers 1996, TemaNord 1996:524, Railway Traffic Noise – Nordic Prediction Method, Copenhagen

Appendix C – Predicted airborne rail noise levels

Table C-1 Airborne rail noise levels at nearby residential receivers[5], dB(A)

Receiver		Scenario 1 Existing base case			Scenario 2 Proposal opening year / 10 year horizon			Change in noise levels		
NCA	ID	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}	L_{Aeq} Day	L_{Aeq} Night	L_{Amax}
NCA-1	R1	46	44	71	46	44	71	0	0	0
NCA-1	R2	46	44	70	46	44	70	0.1	0.1	0
NCA-1	R3	46	44	70	46	44	69	0	0	-0.1
NCA-1	R4	45	42	67	45	42	67	0.1	0.2	0
NCA-2	R5	51	49	74	51	49	75	0	0.1	0.3
NCA-2	R6	52	50	75	52	50	75	0.1	0.1	-0.1
NCA-2	R7	52	50	75	52	50	75	0.1	0.1	-0.1
NCA-5	R8	55	53	80	57	55	80	2.3	2.7	-0.5
NCA-5	R9	55	53	83	57	55	80	1.5	2	-3.4
NCA-5	R10	55	52	80	55	53	78	0.5	1.1	-2.2
NCA-5	R11	54	51	78	56	54	78	1.9	2.5	0.4
NCA-5	R12	53	51	76	55	53	79	1.6	2.1	2.6
NCA-5	R13	53	51	76	54	53	79	1.2	1.7	3
NCA-5	R14	53	51	76	54	52	80	0.6	1	3.6
NCA-5	R15	53	51	76	53	51	79	-0.1	0.3	3.1
NCA-5	R16	53	51	76	52	50	78	-1	-0.7	2.4
NCA-5	R17	53	51	76	51	49	77	-1.7	-1.4	0.8
NCA-5	R18	53	50	76	50	48	74	-2.4	-2.2	-1.9
NCA-5	R19	53	51	76	49	47	75	-3.8	-3.6	-1.6
NCA-5	R20	53	51	76	47	45	74	-6	-5.9	-1.9
NCA-6	R21	45	42	68	36	34	50	-8.1	-8	-18.2
NCA-6	R22	46	44	67	38	36	52	-8.1	-7.9	-15.4
NCA-6	R23	48	45	70	36	34	52	-11.7	-11.4	-17.7
NCA-8	R24	43	41	66	49	47	73	5.7	5.9	6.8
NCA-9	R25	43	41	64	45	43	64	1.8	1.9	0
NCA-9	R26	47	45	70	48	46	70	0.7	0.7	0
NCA-9	R27	49	47	71	49	47	71	0.3	0.4	-0.1
NCA-9	R28	50	48	73	50	48	73	0.1	0.1	0
NCA-9	R29	49	47	70	50	47	70	0.3	0.3	-0.1
NCA-9	R30	49	46	69	49	47	69	0.4	0.4	-0.1
NCA-9	R31	47	45	67	48	45	68	0.4	0.4	0.3
NCA-9	R32	46	43	65	46	44	65	0.5	0.5	0.2
NCA-9	R33	49	47	71	49	47	71	0.1	0.1	-0.1
NCA-9	R34	49	47	72	50	47	72	0.1	0.1	0
NCA-9	R35	50	48	73	50	48	73	0.1	0.1	0
NCA-9	R36	48	46	71	48	46	71	0	0	0
NCA-9	R37	50	48	73	50	48	73	0.1	0.1	0
NCA-9	R38	49	47	72	50	47	72	0.1	0.1	0

[5] inclusive of 2.5 dB façade correction