CHAPTER 10

NOISE AND VIBRATION

10 NOISE AND VIBRATION

10.1 Introduction

This section summarises the results of the operational and construction noise and vibration assessment undertaken by SLR Consulting Australia Pty Ltd. It describes the assessment methodology, a summary of the existing noise environment, the potential noise and vibration impacts and the proposed mitigation and management measures. The Noise and Vibration Technical Paper is included as Technical Paper 3.

The noise and vibration assessment is based upon the current project description outlined in Chapters 6 and 7. During the detailed design stage, and following the award of the construction and operation contracts, the successful tenderers may choose to construct or operate the NWRL in a different manner to that which is described in this EIS.

Should circumstances arise that result in minor changes to the NWRL design, the noise and vibration impacts would not be expected to be greater than those described and assessed in this EIS. If the detailed design phase does result in significant changes, these would need to be assessed and approved on a case by case basis in accordance with the relevant Environment Protection Licence and / or Conditions of Approval. The project noise and vibration design objectives are unlikely to change throughout the project, and the successful tenderer(s) would be required to comply with the recommended mitigation measures described in this chapter or provide alternative mitigation measures if appropriate.

During construction, contractors would be required to prepare a Construction Noise and Vibration Impact Statement (CNVIS) for each major stage of works or activity, outlining the potential noise and vibration impacts, proposed mitigation and management measures, and community consultation process. These would be approved by the Principal, TfNSW, prior to the works being undertaken.

In determining feasible and reasonable mitigation measures for each construction site, the CNVIS would incorporate the mitigation measures described in the Conditions of Approval for Stations, Rail Infrastructure and Systems, and follow the guidelines in the *NWRL Construction Noise and Vibration Strategy* (CNVS) – refer to Appendix J of the Noise and Vibration Technical Paper (Technical Paper 3).

During the detailed design stage, the operator would be required to prepare an Operational Noise and Vibration Management Plan (ONVMP) which would identify the relevant noise and vibration criteria, the predicted noise and vibration impacts, monitoring procedures and response procedures. A noise and vibration technical report would be prepared by the operator during the detailed design stage, to confirm the proposed mitigation, management and maintenance measures.

In determining feasible and reasonable mitigation measures, the assessment would need to consider the relevant operational noise and vibration guidelines administered by the EPA, any commitments made in this EIS and the Submissions Report, and the Conditions of Approval for Stations, Rail Infrastructure and Systems. The noise and vibration technical report and ONVMP would be approved by the Principal, TfNSW, prior to the commencement of operations.

10.2 Methodology

The main steps involved in the noise and vibration assessment were to:

- Characterise the existing noise environment based on attended and unattended noise measurements at representative locations across the project area.
- Determine noise and vibration objectives and management levels in accordance with relevant guidelines.
- Conduct modelling to quantify the potential noise and vibration impacts.
- Assess the significance of potential impacts identified.
- Identify mitigation and management measures to minimise operational and construction noise and vibration impacts.
- Document the recommended mitigation and management measures to be implemented during construction and operation.
- Identify any residual impacts with the mitigation measures in place.

10.3 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 10.1 sets out the Supplementary Director General's Requirements, the Concept Plan Approval Requirements and the Statement of Commitments as they relate to noise and vibration, and where these have been addressed within this chapter. Unless otherwise stated, references are to chapters of EIS 2 in relation to operations, and stations and rail systems construction.

Table 10.1 Director General's Requirements, Conditions of Approval and Statement of Commitments

Reference	Description	Addressed
Supplementary Director-General's Requirements		
SSI 5414 31 Aug 2012	The assessment of construction and operational noise shall have considerations of the relevant components of *Assessing Vibration: a technical guideline* (DECCW, 2006), *Interim Construction Noise Guideline* (DECC, 2009), *NSW Industrial Noise Policy* (EPA, 2000), *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (DECC, 2007) and the *NSW Road Noise Policy* (DECCW, 2011).	The assessments undertaken of construction and operational noise within this chapter are consistent with the guidelines as appropriate.
Concept Plan Approval Requirements		
2.6	In relation to operational noise and vibration, the Proponent shall ensure that: ▪ the project rail corridor is designed consistent with the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (DECC, 2007); ▪ the project stabling facilities are designed consistent with the *Industrial Noise Policy* (EPA, 2000); and ▪ the project is designed to be consistent with *Assessing Vibration: A Technical Guideline* (DECC, 2006).	The assessment of operational noise and vibration within Sections 10.6, 10.7, 10.8 and 10.9 is consistent with the guidelines as appropriate.

Reference	Description	Addressed
3.6	The Proponent shall review the noise and vibration impacts of the project during construction (including construction traffic) and operation, considering all reasonable and feasible mitigation options at existing and planned future receivers.	Noise and vibration impacts during construction (relating to rail systems and stations) and operation, including mitigation options are detailed in Sections 10.6 to 10.11. Construction noise and vibration assessment relating to the major civil works is within EIS 1.
Statement of Commitments		
20	A detailed noise and vibration assessment of the proposed construction activities, including blasting if required, would be undertaken as part of design development and would include the investigation of the potential need for reasonable and feasible mitigation in accordance with relevant policies and guidelines.	Detailed construction noise and vibration assessment for rail systems and stations is provided in Section 10.11. Construction noise and vibration assessment relating to the major civil works is within EIS 1.
21	Consult with local Councils, Growth Centres Commission and RailCorp in relation to land use planning and development controls to minimise the need for physical noise mitigation.	EIS 2 Chapter 5
22	In regard to operational noise, the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (Department of Planning, 2007) would be used to implement the following activities: ▪ Modelling of operational noise impacts (including ground borne noise) in more detail as part of the design development; ▪ Identification of acoustic mitigation measures to meet, where reasonable and feasible, the design goals; and ▪ Select representative locations for the project at which it is appropriate to later assess compliance.	Operational noise assessment, including modelling and representative locations to later assess compliance is detailed in Sections 10.6 and 10.7. A summary of operational mitigation measures is provided in Section 10.12.
23	In regard to train stabling operational noise, the following would be undertaken: ▪ Determine the extent of any physical noise mitigation measures in consultation with Department of Environment and Climate Change, RailCorp and Growth Centres Commission; and ▪ Review the results of RailCorp's investigations into addressing horn noise and consider the feasibility in consultation with RailCorp of implementing a low volume horn test.	Operational noise assessment from train stabling within Section 10.8.
24	Investigate feasible and reasonable mitigation measures to manage operational vibration in consultation with Councils, the Department of Environment and Climate Change and RailCorp.	Assessment of operational vibration within Section 10.7. Summary of mitigation measures in Section 10.12.

10.4 Existing Environmental Conditions

The existing noise environment varies along the length of the proposed alignment, as would be expected from the wide range of commercial, urban, residential and industrial land uses within the study area.

Ambient noise measurements were undertaken at 10 locations along the proposed alignment, supplemented with attended measurements to confirm the major noise sources influencing the measurements. This information was supplemented with ambient noise data collated during the previous NWRL proposal and other recent projects, resulting in a total of 25 representative locations across the project area.

Ambient noise surveys are undertaken to assist in determining noise criteria for the operation of fixed facilities such as the stations, substations, tunnel ventilation systems and the train stabling and maintenance facility. They also establish the baseline noise levels upon which the construction noise management levels (NMLs) are based.

For construction, the relevant ambient noise parameters are evaluated during the daytime (7am to 6pm), evening (6pm to 10pm) and night-time (10pm to 7am) periods. For operations, the daytime period is defined as 7am to 10pm and the night-time is defined as 10pm to 7am. The stabling facility has been assessed using the guidelines supplied in the NSW *Industrial Noise Policy* (INP – EPA, 2000) and therefore, has different time period definitions. These are outlined in Section 10.8.

RBL *Rating Background Level* – This is the background noise level. This parameter represents the average minimum noise level during the daytime, evening and night-time periods.

$L_{Aeq(period)}$ *The Energy Average Noise Level* evaluated over a defined measurement period (typically 15 minutes, or the relevant daytime, evening or night-time period).

L_{Amax} or $L_{A1(1min)}$ The "typical maximum noise level" for an event, used in the assessment of potential sleep disturbance during night-time periods or maximum noise levels during train passby events.

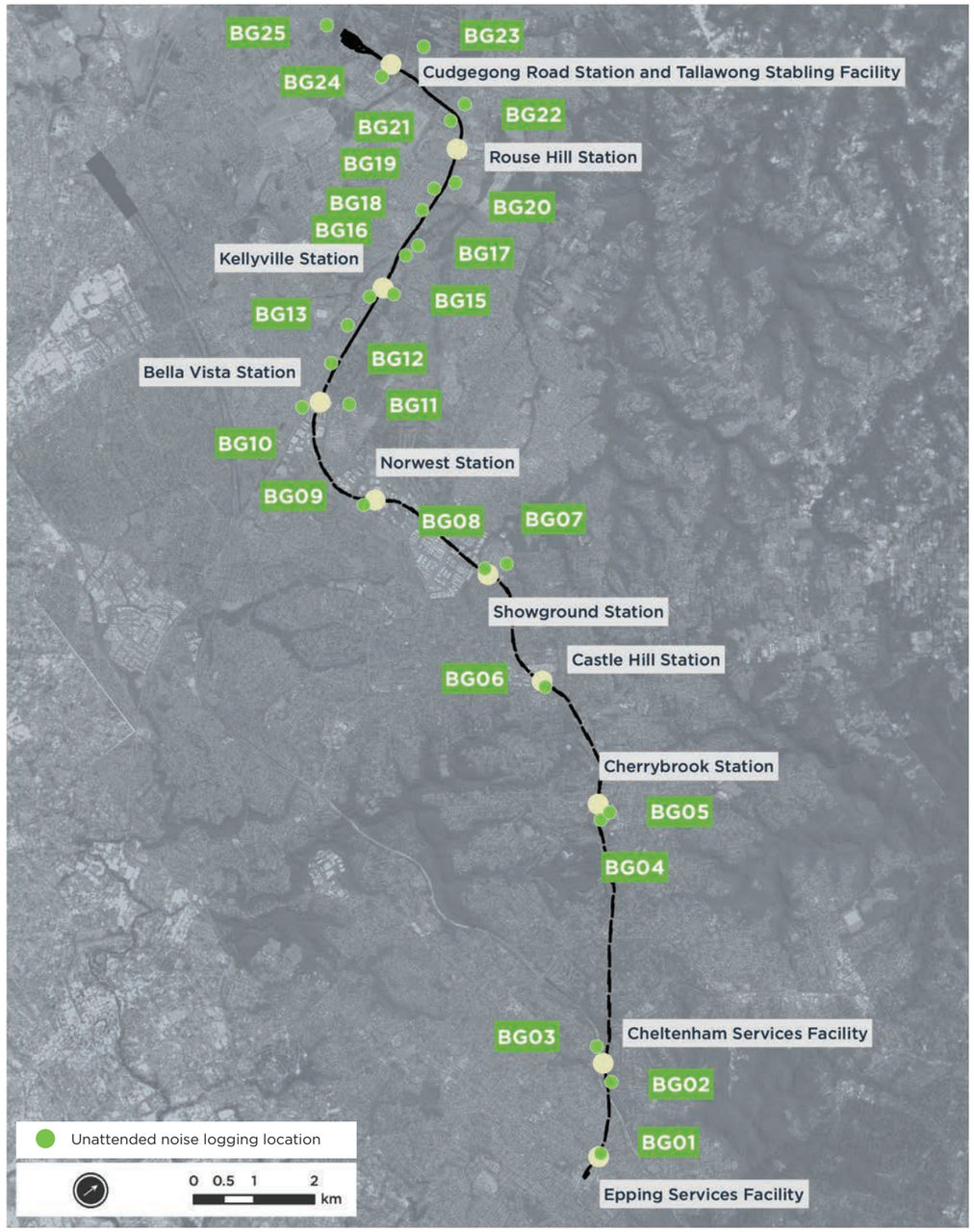
Unattended noise monitors were placed at sensitive receiver locations in the vicinity of the key sites for a minimum period of one week. The results of the unattended noise survey are summarised in **Table 10.2**. The location of the unattended noise monitors are illustrated in the Site Plan in **Figure 10.1** and Appendix B of the Noise and Vibration Technical Paper (Technical Paper 3).

Table 10.2 Summary of Unattended Noise Logging

Location	Noise Level (dBA)[1]						
	Daytime 7.00 am to 6.00 pm		Evening 6.00 pm to 10.00 pm		Night-time 10.00 pm to 7.00 am		
	RBL	LAeq	RBL	LAeq	RBL	LAeq	LAmax[4]
BG01	45	56	41	54	32	51	61-70
BG02	49	55	41	52	31	48	53-62
BG03	55	61	52	60	35	55	63-69
BG04	45	53	41	51	34	49	47-65
BG05	37	50	38	48	30 [2]	45	53-63
BG06	50	61	47	59	31	54	66-73
BG07	54	70	48	67	30	65	75-83
BG08	54	64	45	59	34	54	65-71
BG09	47	53	45	52	38	47	53-68
BG10	46	53	45	52	36	50	59-63
BG11	36	52	35	46	31	43	47-58
BG12	51	61	48	60	33	57	69-75
BG13	51	60	50	58	34	54	63-69
BG14	47	62	48	61	38	58	69-73
BG15[3]	39	49	41	48	39	48	53-62
BG16[3]	45	55	46	53	37	51	57-62
BG17	48	62	44	59	32	56	68-75
BG18	54	63	52	60	47	58	70-74
BG19	52	64	49	62	32	59	70-74
BG20	41	52	41	50	33	48	55-62
BG21	51	60	51	58	39	55	63-67
BG22	52	68	51	66	39	63	78-83
BG23	44	57	43	51	34	48	49-72
BG24[3]	45	59	49	59	38	55	66-71
BG25[3]	43	53	44	54	30 [2]	58	61-86

Note 1: The RBL and LAeq noise levels have been obtained using the calculation procedures documented in the NSW Industrial Noise Policy (INP).
Note 2: In accordance with the INP, where the RBL is found to be less than 30 dBA, then it is set to 30 dBA.
Note 3: Where the daytime RBL is lower than the evening RBL, then the daytime RBL has been used to determine the construction NMLs.
Note 4: Maximum noise levels during the night-time period have been determined from the daily noise logging plots where the lower noise level is based on the 25th percentile of the 15-minute LAmax noise levels and the upper range is based on the 75th percentile of the 15-minute LAmax noise levels

Figure 10.1 Site Plan of Unattended Noise Logging Locations



10.5 Sensitive Receivers

A review of the existing and proposed land uses within an area approximately 100 metres either side of the proposed alignment and construction sites was undertaken for the purpose of identifying the nature and location of sensitive receivers. This information was collated from a combination of site inspections, street-level imagery and review of aerial photography.

For noise and vibration assessment purposes, all residential receivers are considered to be of a sensitive nature. Other sensitive receivers include commercial receivers, educational facilities, schools, childcare centres, places of worship and hospitals.

Some facilities such as sound recording studios, performance spaces and precision laboratories have an increased sensitivity to noise and vibration. Adjacent to the NWRL proposal such facilities include the Hillsong Church recording studio (HUB building).

A number of commercial buildings have been identified along the alignment as being potentially sensitive to noise and vibration. The noise assessment did not involve detailed inspections of these buildings. They would be investigated in more detail as the design progresses.

10.6 Airborne Operational Noise

Noise emissions from suburban electric passenger trains are predominantly caused by the rolling contact of steel wheels on steel rails. Other noise sources on electric passenger trains (such as air-conditioning plant and air compressors) are generally insignificant in noise level when compared with the wheel rail interaction, unless the train is travelling at a very low speed or is stationary.

10.6.1 Operational Noise Trigger Levels

The assessment of operational noise impacts was in accordance with the *Interim Guideline for Assessment of Noise from Rail Infrastructure Projects* (IGANRIP – DECC, 2007). For airborne noise created by the operation of surface track (from the tunnel portal at Bella Vista to the entrance of the Tallawong Stabling Facility), noise trigger levels are applicable, which if exceeded, require consideration of noise mitigation for existing and planned sensitive receivers, both at opening and at an indicative time in the future (taken to be ten years after opening). The noise trigger levels are shown in **Table 10.3** and **Table 10.4**, for the different receiver types. For this assessment, proposed future residential areas include the Area 20 precinct, the Rouse Hill Town Centre, 301 Samantha Riley Drive and future development areas around the proposed NWRL stations.

In terms of the $L_{Amax,95\%}$ assessment parameter, the noise trigger levels at residential receivers are the same during the daytime and night-time periods. This is on the basis that the train speeds are proposed to be the same during the daytime and night-time periods. The $L_{Aeq(9hour)}$ noise trigger levels during the night-time period are 5 dB lower (ie more stringent) than the daytime period.

The $L_{Aeq(period)}$ noise parameter is dependent on the number of trains during the relevant daytime or night-time period, whereas the $L_{Amax,95\%}$ noise level is independent of the number of trains. The L_{Amax} noise level is a 95th percentile level, ie one train out of every 20 passbys may have an L_{Amax} noise level greater than stated, but 19 out of 20 train passbys are expected to exhibit lower maximum noise levels than the 95th percentile L_{Amax}.

Table 10.3 Residential Airborne Noise Trigger Levels for Surface Track

Type of Development	Residential Noise Trigger Levels (dBA)		
	Daytime 7.00 am to 6.00 pm	Night-time 10.00 pm to 7.00 am	Comment[1]
New Rail Line	Development increases existing rail noise levels AND Resulting rail noise levels exceed:		These numbers represent external levels of noise that trigger the need for a rail infrastructure project to conduct an assessment of its potential noise impacts. An increase in existing rail noise levels is taken to be an increase of 2.0 dB or more in L_{Aeq} in any hour or an increase of 3.0 dB or more in L_{Amax}.
	60 $L_{Aeq(15hour)}$ 80 L_{Amax}	55 $L_{Aeq(9hour)}$ 80 L_{Amax}	

Note 1: As the NWRL is a new rail line where sensitive receivers are not exposed to existing rail noise, the noise increase component of the trigger levels are not applicable

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Table 10.4 Airborne Noise Trigger Levels for Surface Track – Other Sensitive Receivers

Sensitive Land Use	Noise Trigger Levels (dBA)
	New Rail Line Development
	Development increases existing rail noise levels by 2.0 dB or more in L_{Aeq} in any hour AND Resulting rail noise levels exceed:
Schools, educational institutions – internal	40 $L_{Aeq(1hour)}$
Places of worship – internal	40 $L_{Aeq(1hour)}$
Hospitals – internal	35 $L_{Aeq(1hour)}$
Hospitals – external	60 $L_{Aeq(1hour)}$
Passive recreation	LAeq as per residential noise level values in **Table 10.3** (does not include maximum noise level component)
Active recreation (eg golf course)	65 $L_{Aeq(24hour)}$

Note 1: As the NWRL is a new rail line where sensitive receivers are not exposed to existing rail noise, the noise increase component of the trigger levels are not applicable.

10.6.2 Operational Noise Modelling

The input data used in the modelling for this project has been chosen to ensure that the calculated noise levels accurately reflect the likely future NWRL fleet of new single-deck trains operating on slab track. Other key inputs to predict airborne noise emissions along the alignment included:

- The NWRL would be constructed with continuously welded rail.
- The locations of turnouts (or crossovers).
- The presence of tight radius curves (less than 600 m radius).
- The track geometry in relation to the adjacent terrain.
- The location of sensitive receivers.

The train speeds assumed in the noise modelling are shown in **Figure 10.2**. The current viaduct design includes concrete box girder cross sections, concrete slab track with resilient rail fasteners and 1 metre high noise barriers (parapets). Other surface track sections (except for the train stabling facility) are also proposed to comprise concrete slab track.

The IGANRIP specifies that the noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period into the future to represent the expected typical maximum level of train usage. In order to support the noise modelling predictions, estimated train numbers for the at opening and future operating scenarios have been provided.

The rail traffic estimates used in the modelling scenarios are summarised in **Table 10.5**. The train numbers in **Table 10.5** are indicative only and are based on the estimated passenger demand, minimum service levels and the upper design limit of the NWRL of 20 trains per hour in future peak times.

Figure 10.2 NWRL Speed Profile for the Purposes of Noise and Vibration Assessment

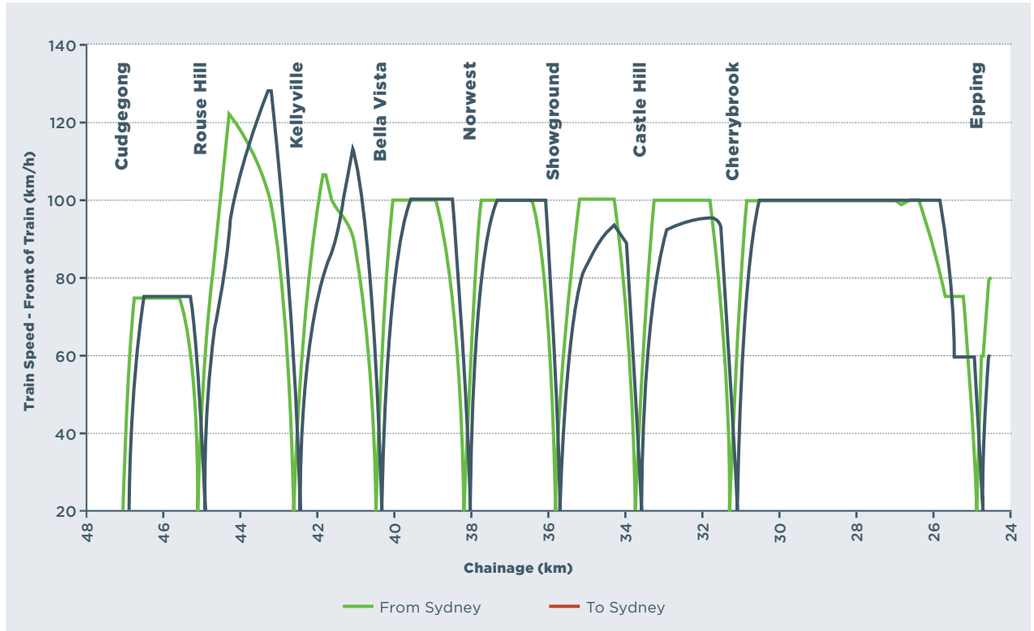


Table 10.5 Rail Traffic Scenarios for the Purposes of Noise and Vibration Assessment

Scenario	Trains per Weekday Period				
	Day 7.00 am to 10.00 pm		Night 10.00 pm to 7.00 am		Total 24 hour
	Up	Down	Up	Down	
Opening	122	124	29	27	302
Future Scenario	172	182	39	29	422

10.6.3 Noise Mitigation Requirements and Options Investigation

In order to establish the likely requirements for noise mitigation, particularly adjacent to the proposed viaduct, preliminary investigations of the noise impacts on indicative "representative" receivers were undertaken.

The purpose of these investigations was to develop an understanding of the balance between direct noise and structure-radiated noise, for an indicative scenario with the viaduct deck 10 metres above flat terrain and a train speed of 100 km/h, with representative buildings located at 50 metres to 100 metres from the viaduct, and the future train numbers (10 years after opening). A series of mitigation scenarios for direct noise are considered, beginning with no specific noise mitigation, then examining source noise control (in the form of rail dampers) and path noise control (in the form of absorptive noise barriers).

The details of this investigation are provided in the Noise and Vibration Technical Paper (Technical Paper 3).

Baseline Noise Mitigation Requirements

On the basis of this investigation, it was determined that mitigation of direct noise would be required in all areas of surface track.

Source noise control in the form of rail dampers would be expected to provide around a 4 dB reduction in direct noise. The full benefit of rail dampers would be apparent at receivers where direct airborne noise is dominant, particularly for receivers that are elevated relative to the tracks. At locations where structure-radiated noise dominates, the net benefit would be reduced to around 2 dB to 3 dB.

Noise barriers one metre in height, located on the viaduct edge have been found to give typically a 6 dB reduction in net noise to existing one or two-storey detached houses around 50 metres to 100 metres from the proposed viaduct. As with rail dampers, the benefit of noise barriers is reduced at locations where structure-radiated noise dominates.

The reductions in direct airborne noise expected from source control and noise barriers are cumulative in areas where the track is at grade, in cutting or on embankment. However in the viaduct sections, the net noise benefit for typical existing one or two-storey detached houses is limited by the noise contribution from the viaduct structure. Once the direct airborne noise level is reduced to below the structure-radiated noise, further reductions in airborne noise would not significantly reduce the overall noise levels. To be effective, noise mitigation efforts must concentrate on the dominant noise source.

On the basis of the preliminary investigations, the baseline noise mitigation measures in **Table 10.6** have been adopted for the more detailed assessment.

Table 10.6 Summary of Baseline Noise Mitigation Requirements

Noise Mitigation Measure1	Location	Comments
1 m high noise barriers	Bella Vista Station to Cudgegong Road Station	Noise barriers with absorptive facing are assumed in the noise modelling, one metre high above rail level. For viaduct section, barriers are located on the outer edge of both sides of the viaduct. For other surface track locations at-grade or on embankment, the noise barriers should be positioned as close as possible to the train (subject to track access and safety requirements).
2 m high noise barriers	Up side adjacent to OK Caravan Park	A two metre high noise barrier with absorptive facing is assumed in the noise modelling at this area based on the close proximity of adjacent receivers. The noise barriers should be positioned as close as possible to the train (subject to track access and safety requirements).
Rail Dampers	Kellyville Station to Cudgegong Road Station (except near stations)	Rail dampers are not required for existing sensitive receivers or known future developments between Bella Vista Station and Kellyville Station or in the immediate vicinity of stations where train speeds and noise levels comply with the noise trigger levels.
Resilient Rail Fasteners	Viaduct Track and Bridges	Direct-fix fasteners with dynamic stiffness 20 kilonewtons per millimetre (kN/mm) are assumed in the noise modelling to minimise structure-radiated noise from the viaduct and bridges.

Note 1: There are several different options which may be implemented for the detailed design of the surface track sections, based on the detailed design of the track form and elevated structures. The proposed baseline measures are based on the NWRL concept design.

10.6.4 Noise Impacts and Mitigation for Existing Receivers

Baseline Operational Noise Impacts on Existing Receivers

Following the opening of the NWRL, noise levels with the baseline mitigation measures in **Table 10.6** are predicted to be below the IGANRIP noise trigger levels at the majority of existing receivers, with the exception of one residence on Terry Road (between Rouse Hill Station and Cudgegong Road Station) west of the OK Caravan Park, and a number of residential properties between Kellyville Station and Rouse Hill Station.

The predicted exceedances at opening are marginal, typically within 1 dB of the L_{Aeq} trigger levels. No exceedances of the $L_{Amax,95\%}$ trigger level are predicted.

For the future operating scenario (10 years after opening), there is not expected to be an increase in the $L_{Amax,95\%}$ noise levels over the levels at opening, but the daytime $L_{Aeq(15hour)}$ and night-time $L_{Aeq(9hour)}$ noise levels are predicted to increase, by 1.6 dB and 0.8 dB respectively (as a result of additional trains).

In this future operating scenario, the number of sensitive receivers exceeding the L_{Aeq} noise triggers increases. Exceedances of the residential noise trigger levels for the future operating scenario (approximately 10 years after opening) are shown in **Table 10.7**. No exceedances of the noise trigger levels have been identified for non-residential receivers.

Table 10.7 Noise Trigger Level Exceedances for Existing Receivers (Baseline Future Scenario Approximately 10 years After Opening)

Location	Description	Maximum Predicted Noise Levels		
		$L_{Amax,95\%}$ (dBA)	$L_{Aeq(15hour)}$ (dBA)	$L_{Aeq(9hour)}$ (dBA)
Terry Road, Rouse Hill	1 detached house	80	61	56
Fitzroy Place to Lycett Avenue, Kellyville	5 detached houses	78	62	57
Bentwood Terrace, Stanhope Gardens	5 detached houses	77	61	56
Farrier/Miller Way, Kellyville Ridge	19 detached houses	77	62	57
Kilbenny Street, Kellyville Ridge	5 apartment buildings (upper levels)	77	62	57

Note 1: The noise trigger levels are LAmax,95% 80 dBA, LAeq(15hour) 60 dBA and LAeq(9hour) 55 dBA. Exceedances of the relevant noise trigger levels are shown in bold text.

Discussion of Additional Feasible and Reasonable Mitigation Measures

The noise modelling results presented in **Table 10.7** includes the baseline mitigation measures presented in **Table 10.6**. With these measures, several locations have been identified where the IGANRIP noise trigger levels are exceeded at existing residences. Further assessment of feasible and reasonable noise mitigation measures has therefore been undertaken for the surface section of the NWRL corridor in accordance with IGANRIP and is summarised in this chapter and detailed in Technical Paper 3.

Section 3.1 of IGANRIP provides the following guidance in relation to determining feasible and reasonable mitigation measures:

Feasibility relates to engineering considerations and what can practically be built or modified, given the opportunities and constraints of a particular site.

Reasonableness relates to a judgement which takes into account the following factors:

- Noise-mitigation benefits – noise reduction provided, number of people protected.
- Cost of mitigation – total cost and cost variation with level of benefit provided.
- Community opinion.
- Aesthetic impacts.
- Track maintenance and access requirements.
- Noise levels for affected land uses – existing and future levels, expected changes in noise levels.
- Benefits arising from the development or its modification.

A range of additional mitigation measures to further reduce noise levels were investigated, including source, path and receiver control (refer Table 5.8 in Technical Paper 3). Noise mitigation options which may be feasible and reasonable are summarised below:

- Management of train speeds between Kellyville and Rouse Hill.
- Design viaduct structure (shape, materials and track design) to minimise structure-radiated noise in the detailed design stage.
- Application of additional absorptive material, for example to the viaduct deck (only effective in conjunction with reduced structure-radiated noise levels).
- Acceptance of minor exceedances of the noise trigger levels at locations where road traffic noise dominates.
- Property treatments.

Discussion of Location-Specific Noise Mitigation Options for Existing Receivers

The following discussion provided a summary of the noise mitigation options for the five receiver areas identified in **Table 10.7** with minor exceedances of the noise trigger levels.

With the exception of the Terry Road receiver, all of the sensitive receiver locations with minor exceedances of the noise trigger levels are adjacent to the NWRL track section (between Kellyville Station and Rouse Hill Station) where the proposed train speed is greater than 100 km/h. In these areas, managing train speeds is predicted to reduce the direct and structure-radiated noise levels to below the noise trigger levels. During the detailed design stage, this option would be considered as a potential noise mitigation measure, taking into account other factors such as the change in journey time, the existing noise exposure from road traffic and other factors.

Terry Road, Rouse Hill

This residence is situated approximately 13 metres from the rail track, adjacent to a section of viaduct. For the future scenario, a marginal 1 dB exceedance of the L_{Aeq} noise trigger levels is predicted for the daytime and night-time periods with compliance predicted for the L_{Amax} noise trigger level. Noise levels at this location would be predominantly influenced by structure-radiated noise.

The affected property is located within the Area 20 Precinct and the plan for the area shows land marked for medium density development at some point in the future.

The noise mitigation options at this locality are limited to designing the viaduct structure (as part of the detailed design) to minimise the structure-radiated noise. Additional airborne noise mitigation in the form of a higher noise barrier or additional sound absorption would be of no benefit to this receiver. Building treatments would not normally be considered in locations such as this where there are minor exceedances of the noise trigger levels.

Kilbenny Street, Kellyville Ridge

Kilbenny Street has approximately 100 apartments spread over five blocks along the surface track alignment. Minor exceedances of the L_{Aeq} noise trigger levels are predicted for upper level apartments facing Windsor Road and the rail corridor, with increasing direct rail noise impacts at higher levels of the buildings.

Noise mitigation options include optimisation of the detailed design of the viaduct (shape, materials and track design) and / or the addition of absorptive materials on the viaduct deck.

Acceptance of the marginal 2 dB exceedances of the L_{Aeq} noise trigger levels is recognised as an option for this location, in view of the fact that the affected apartments are likely to have been planned and designed to minimise road traffic noise intrusion from Windsor Road. Noise logging conducted on this site in 2005 as part of the Windsor Road Upgrade indicated that the existing noise levels are dominated by road traffic noise, with L_{Aeq} levels above those associated with the proposed NWRL operations.

Farrier Way and Miller Way, Kellyville Ridge

Nineteen houses have been identified in this area with marginal exceedances of the L_{Aeq} noise trigger levels for the future scenario. The nineteen houses are shown in Appendix C of Technical Paper 3, and generally located between Farrier Way and Miller Way, and Windsor Road (some of the street addresses are Beck Place, Loft Place and Stave Place).

With the proposed noise barriers and rail dampers, the direct contribution and the structural contribution to overall noise are comparable at this location. Noise mitigation options include optimisation of the detailed design of the viaduct (shape, materials and track design) and / or the addition of absorptive materials on the viaduct deck.

The acceptance of marginal 2 dB exceedances of the L_{Aeq} noise trigger levels is also an option, recognising that existing noise levels are dominated by road traffic noise, at L_{Aeq} levels above those associated with the proposed NWRL operations.

Fitzroy Place to Lycett Avenue

Five houses have been identified with exceedances of the L_{Aeq} noise trigger levels for the future scenario. These houses are shown in Appendix C of Technical Paper 3, and generally spread along the ends of the streets between Fitzroy Place and Lycett Avenue on the northern side. The predicted exceedances are a marginal 1 dB to 2 dB in L_{Aeq}, with compliance predicted for the L_{Amax} noise parameter.

With the proposed noise barriers and rail dampers, the structural contribution to overall noise is predicted to be several dB above the direct contribution. Noise mitigation options include optimisation of the detailed design of the viaduct (shape, materials and track design) to reduce structure-radiated noise or acceptance of the marginal 1 dB to 2 dB exceedances of the L_{Aeq} noise trigger levels.

Bentwood Terrace, Stanhope Gardens

Five houses have been identified on Bentwood Terrace with marginal exceedances of the L_{Aeq} noise trigger levels in the future scenario. The exceedance is predicted to be up to 1 dB for the daytime and night-time L_{Aeq}, with compliance predicted for L_{Amax} noise parameter.

With the proposed noise barriers and rail dampers, noise from direct contribution and structural contribution to overall levels are comparable at this location. Noise mitigation options include optimisation of the detailed design of the viaduct (shape, materials and track design) and / or the addition of absorptive materials on the viaduct deck.

It is also recognised that acceptance of the marginal 1 dB exceedances of the L_{Aeq} noise trigger levels is an option, recognising that the existing noise levels are dominated by road traffic noise, at L_{Aeq} levels above those predicted to result from the proposed NWRL operations.

10.6.5 Noise Impacts and Mitigation for Future Developments

For future development the IGANRIP notes that the control of noise and vibration issues resulting from rail traffic should be the joint responsibility of the rail operator and of surrounding land users. Future land use planning measures must take into account the rail link and include relevant mitigation measures in relevant design/ planning requirements.

For this assessment, potential future developments are taken to be as described in Chapter 14. The key areas (in the above ground section of the alignment) are around Bella Vista Station, around Kellyville Station, around Rouse Hill Station, the Area 20 Precinct, and around Cudgegong Road Station.

For new developments, increased separation distance from the rail corridor can be used as a noise mitigation measure. Acoustic setbacks and buffer zones can be employed, with roadways or open recreation areas providing the buffer zone. Where a buffer zone is insufficient or impractical for controlling noise, it may be necessary to control the layout and construction of buildings, with sensitive areas of occupancy in a building being oriented away from the noise source. Part 87 of the Infrastructure SEPP requires sensitive non-rail developments to achieve internal $L_{Aeq(9hour)}$ noise levels of 35 dBA during the night-time period within bedrooms, and 40 dBA in other habitable areas at any time of the day. Advice to developers on how to achieve these levels is given in the NSW Department of Planning *Development Near Rail Corridors and Busy Roads - Interim Guideline.*

Notwithstanding the options for mitigation available to the developer, the mitigation options described above for existing receivers can also benefit future developments. Of the noise mitigation options above, those considered to be feasible and reasonable for reducing the impact of airborne operational noise from the NWRL on future receivers are:

- ❖ Design viaduct structure (shape, materials and track design) to minimise structure-radiated noise in the detailed design stage.
- ❖ Application of rail dampers (in locations where these are not already proposed).
- ❖ Application of additional absorptive material, for example to the viaduct deck.
- ❖ Provision of low-height barriers close to the track in conjunction with vehicle side skirts, in place of the proposed 1 metre barriers on the viaduct edge.
- ❖ Facade and glazing design to achieve the internal noise criteria for new developments.

Standard window glazing of a building will typically attenuate external noise levels by 20 dB to 25 dB with windows closed. Even with windows open, the indoor noise level is approximately 10 dB lower than the external noise level. Where attenuation of more than 25 dB is required, then upgraded glazing could be considered (eg double glazing or laminated glazing with acoustic seals), along with provision of mechanical ventilation to meet the requirements of the Building Code of Australia.

Discussion of Noise Mitigation Options for Future Developments

The following discussion of noise mitigation options for any future medium to high-density development areas is representative of worst-case noise impacts on a multi-storey building overlooking the rail line, even where the tracks are constructed on elevated viaducts.

Consistent with development that occurs around existing railway lines, future development would be subject to standard noise mitigation measures which are well understood and applied in the development industry.

Bella Vista Station to Kellyville Station

Future planning indicates that mixed use development may occur in the immediate vicinity of Bella Vista Station from the time of opening, and extend north over time. In this section the rail tracks are proposed to be located in a cutting, after emerging from the tunnels at Bella Vista Station.

Train speeds would be lower when departing from the station and the cutting would provide shielding to future developments immediately north of Bella Vista Station. Consequently the noise impacts on developments close to the station are expected to be low.

Midway between Bella Vista Station and Kellyville Station, trains are expected to reach a speed of approximately 100 km/h. Assuming a multistorey building set back 40 metres from the nearest track at the location with the highest speeds gives worst-case facade noise levels at future capacity as shown in **Table 10.8**.

The predicted noise levels indicate that future high-rise development in this area may benefit from additional noise mitigation ion the form of rail dampers or adsorptive material. In the absence of details of future development in this area, additional mitigation is not proposed at this stage.

Table 10.8 Noise at Future Developments between Bella Vista Station and Kellyville Station

Location	Building Level	$L_{Amax,95\%}$ (dBA)	L_{Aeq}(15hour) (dBA)	$L_{Aeq(9hour)}$ (dBA)	Required Facade Attenuation (dB)[1]
Mid-way between Bella Vista Station and Kellyville Station, set back 40 metres from the near track	1	76	59	54	19
	2	77	60	55	20
	3	78	61	56	21
	4	80	63	58	23
	5	83	65	60	25
	6	87	68	63	28
	7	90	71	66	31
	8	92	72	67	32

Note 1: Required facade attenuation with windows closed, assuming provision of mechanical ventilation to meet the requirements of the Building Code of Australia. Results requiring upgraded glazing to achieve the indoor $L_{Aeq(9hour)}$ 35 dBA Infrastructure SEPP noise limit are shown in bold text. Standard window glazing will typically attenuate 20 dB.

Kellyville Station to Rouse Hill Station

Future planning indicates that commercial and retail development may occur in the immediate vicinity of Kellyville Station from the time of opening, with mixed use development on the eastern side of the railway over time.

Through this section the rail tracks are on viaduct. Train speeds used for noise and vibration assessment, and hence noise impacts, would be highest midway between the two stations, with the highest speeds of the NWRL occurring in this section (refer to **Figure 10.2**). The resulting noise levels for multi-storey developments set back 40 metres from the nearest track are shown in **Table 10.9** .

Planning is underway to rezone 301 Samantha Riley Drive for a high density mixed use development. Noise impacts on this development have been predicted and are also shown in **Table 10.9**.

Planning is also underway for further development to the north of the existing Rouse Hill Town Centre area. Current plans indicate that while this development would include residential areas, these would be set back from the rail corridor behind commercial buildings. At this stage, it is considered that rail noise impacts on residential receivers in this development would be low.

The proposed mitigation between Kellyville Station and Rouse Hill Station includes rail dampers in addition to the 1 metre high noise barriers. Future developments in close proximity to the rail line would need to consider rail noise impacts in their design, including upgraded glazing with acoustic seals and the provision of mechanical ventilation to enable residents to keep windows closed (if desired) to meet the internal noise criteria.

Table 10.9 Noise Levels at Future Multistorey Residence between Kellyville and Rouse Hill

Location	Building Level	$L_{Amax,95\%}$ (dBA)	$L_{Aeq(15hour)}$ (dBA)	$L_{Aeq(9hour)}$ (dBA)	Required Facade Attenuation (dB)[1]
301 Samantha Riley Drive	1	75	58	53	18
	2	75	58	53	18
	3	76	59	54	19
	4	76	59	54	19
	5	78	60	55	20
	6	80	62	57	22
	7	82	64	59	24
	8	84	65	60	25
	9+	85	65	60	25
Mid-way between Kellyville Station and Rouse Hill Station, set back 40 m from the near track	1	75	58	53	18
	2	76	60	55	20
	3	78	62	57	22
	4	80	64	59	24
	5	82	65	60	25
	6	85	67	62	27
	7	88	69	64	29
	8	88	70	65	30

Note 1: Required facade attenuation with windows closed, assuming provision of mechanical ventilation to meet the requirements of the Building Code of Australia. Results requiring upgraded glazing to achieve the indoor $L_{Aeq(9hour)}$ 35 dBA Infrastructure SEPP noise limit are shown in bold text. Standard window glazing will typically attenuate 20 dB.

Area 20 Precinct

An area of future urban development (known as Area 20) is proposed immediately west of Windsor Road and north of Schofields Road (on both sides of the viaduct track section). Open space and then medium density development is planned west of the end of the main viaduct, where the track goes into cutting then moves onto embankment (near the existing caravan park) and then an additional viaduct section. Train speeds through this section would generally be lower than in the rest of the above ground section. For this reason, noise impacts are generally lower than between (for example) Kellyville Station and Rouse Hill Station. However, near curves and adjacent to crossovers such as the one proposed near Cudgegong Road Station, increased noise levels may occur.

Maximum noise levels for multi-storey developments in the Area 20 Precinct near Windsor Road are predicted to be up to 86 dBA $L_{Amax,95\%}$, 69 dBA $L_{Aeq(15hour)}$ and 64 dBA $L_{Aeq(9hour)}$ at a setback distance of 40 metres from the railway line. High density developments adjacent to the curving viaduct over Windsor Road would benefit from the proposed noise barriers and rail dampers. Further from Windsor Road, noise levels would generally be lower, except in the vicinity of the crossovers which would result in localised higher noise levels. Noise from these crossovers could potentially be mitigated by increasing the height of the noise barrier on the southern side, to approximately two metres above top of rail height, where the track is on embankment adjacent to the Cudgegong crossovers.

Cudgegong Road Station Area

Cudgegong Road Station is proposed to be located in a cutting. The area around the station would, in the future, be developed to form a town centre. Due to the low train speeds in this area and the location of the station in a cutting, no consideration of specific noise mitigation to protect future development opportunities is necessary around Cudgegong Road Station.

10.6.6 Summary of Noise Mitigation Recommendations

To mitigate noise impacts at existing residential receivers, it is recommended that the NWRL design incorporates one metre high noise barriers above top of rail at all above-ground locations (except where the track is in cutting). On the northern side adjacent to the OK Caravan Park, the height of the barrier should be two metres above top of rail. A two metre high noise barrier along the embankment on the southern side opposite the caravan park is also recommended to mitigate potential noise impacts on future developments in the vicinity of the crossovers.

Rail dampers are recommended in all areas of surface track between Kellyville Station and Cudgegong Road Station, except in the immediate vicinity of the stations where lower speeds mean there would be no benefit. The one metre high noise barriers between Bella Vista Station and Kellyville Station are expected to reduce the direct noise levels to below the structure-radiated levels and noise trigger levels for all existing sensitive receivers.

The resulting noise modelling results at all existing receivers adjacent to viaduct sections are predicted to include a structure-radiated noise contribution. It may be possible to reduce the noise radiated from the structure to below the levels assumed in this assessment. This would be investigated in the detailed design phase.

It would be possible to reduce noise impacts by up to 2 dB between Kellyville Station and Rouse Hill Station by managing train speeds. The benefits of this option should be considered against the operational consequences.

10.7 Ground-borne Operational Noise and Vibration

Railway vibration is generated by dynamic forces at the interface of the rail head and train wheels and can be transmitted into adjacent buildings via the tunnel structure and intervening ground. If the levels of vibration are sufficiently high (ie in buildings very close to rail tracks), then this vibration can be felt as tactile vibration by the occupants of nearby buildings. In extreme conditions (and in the absence of mitigation measures), rattling or visible movement of loose objects (crockery, plants, etc) may also sometimes occur.

After entering a building, this vibration may cause the walls and floors to vibrate faintly and hence to radiate noise, which is commonly termed ground-borne or regenerated noise. If it is of sufficient magnitude to be audible, this noise can have a low frequency rumbling character. This type of noise can be experienced in buildings adjacent to many urban underground rail systems, including several buildings close to the existing CityRail tunnels in the Sydney CBD.

The assessment of the potential operational ground-borne noise and vibration impacts for the NWRL project has been undertaken for the underground tunnel sections of the alignment from Epping to the portals near Bella Vista.

Ground-borne vibration impacts at sensitive receivers adjacent to the surface sections have not been considered, because the offset distance from the tracks to the receivers is generally sufficient to ensure that any associated ground-borne vibration impacts are negligible.

10.7.1 Noise and Vibration Objectives

Operational Ground-borne Vibration Objectives

Ground-borne vibration levels from the NWRL have been assessed in accordance with the requirements of *Assessing Vibration – a technical guideline* (DEC, 2006).

The impacts of ground-borne vibration in buildings fall into three main categories:

- Those in which the occupants or users of the building are inconvenienced or disturbed – termed human perception or human comfort vibration.
- Those where the building contents may be affected.
- Those in which the integrity of the building or the structure itself may be prejudiced.

The vibration design objectives adopted for the project are based on human comfort considerations, rather than the less stringent building damage risk criteria or potential effects on building contents. The proposed vibration design objectives for all sensitive receiver categories are listed in **Table 10.10**.

Table 10.10 Human Comfort Vibration Design Objectives

Receiver Type	Period	Vibration Design Objective[1]
Residential	Day	106 dB_V[3](0.2 mm/s)
	Night	103 dB_V (0.14 mm/s)
Commercial (including offices, schools and places of worship)	When in use	112 dB_V (0.4 mm/s)
Industrial	When in use	118 dB_V (0.8 mm/s)
Theatres	When in use	106 dB_V (0.2 mm/s)
Critical working areas[2]	Any time	100 dB_V (0.1 mm/s)

Note 1: The vibration design objectives are based on the maximum 1 second root mean square (RMS) vibration level not exceeded for 95% of train passbys.
Note 2: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring.
Note 3: Vibration velocity levels are expressed in terms of decibels (dBV re 10-9 m/s). A level of 100 dB corresponds to 0.1 mm/s (RMS) and a level of 120 dB corresponds to 1 mm/s (RMS).

In the case of railway tunnels, the ground-borne noise trigger levels presented in the following section almost always dictate lower vibration levels than the vibration objectives indicated in **Table 10.10**. Hence other than at specific facilities with particularly high sensitivity to vibration, compliance with the ground-borne noise trigger levels should ensure that the above vibration design objectives would also be achieved.

Operational Ground-borne Noise Objectives

The ground-borne noise assessment has been undertaken in accordance with the requirements of the IGANRIP. The "new rail line" trigger levels have been adopted for the ground-borne noise assessment as design objectives to be achieved at all locations, where feasible and reasonable. IGANRIP provides ground-borne noise trigger levels for residential receivers, schools, educational institutions and places of worship. For the NWRL project, appropriate design objectives for other sensitive receiver types have been determined.

Table 10.11 summarises the ground-borne noise design objectives for the NWRL project for all sensitive receiver types.

Table 10.11 NWRL Ground-borne Noise Design Objectives for Sensitive Receivers

Receiver	Time of Day	Noise Trigger Level (dBA)[1]
Residential	Day (7.00 am to 10.00 pm)	40 dBA
	Night (10.00 pm to 7.00 am)	35 dBA
Schools, educational institutions, places of worship[1]	When in use	40 dBA to 45 dBA[2]
Retail Areas	When in use	50 dBA
General Office Areas	When in use	45 dBA
Private Offices and Conference Rooms	When in use	40 dBA
Cinemas, Public Halls and Lecture Theatres	When in use	35 dBA
Drama Theatres	When in use	NR 25[3]
Film/Television Studios and Sound Recording Studios	When in use	NR 15[3]
Workshops / Industrial Buildings	-	N/A

Note 1: The ground-borne noise design objectives are based on the maximum LAmax(slow response) noise level, not to be exceeded for 95% of train passbys over any 24 hour period.
Note 2: The lower value of the range is most applicable where low internal noise levels are expected, such as in areas assigned to studying, listening and praying.
Note 3: NR (Noise Rating) curves are used for rating noise levels and are a set of octave band curves which provide limiting sound pressure level values. NR 15 is equivalent to approximately 20 dBA and NR 25 is approximately 30 dBA.

10.7.2 Ground-borne Noise and Vibration Modelling

A computer noise model was developed in order to predict the ground-borne noise and vibration levels within nearby buildings above or close to the underground NWRL alignment. The model takes into account the source vibration generated by trains operating in a similar railway tunnel environment (ECRL), the proposed track design and operating speeds, the characteristics of the ground, the tunnel depth and typical building characteristics. Ground-borne noise and vibration measurements have been used to validate and refine the model used to predict the impacts of the NWRL.

In the absence of specific data relating to the proposed single-deck trains, source vibration levels have been assumed to be equivalent to A-Set (Waratah) trains, which are the most modern trains currently operating on the Sydney rail network. This assumption is considered to be slightly conservative on the basis that the proposed single-deck passenger trains are likely to have reduced axle loads and unsprung mass compared with A-Set trains, resulting in marginally lower source vibration levels.

Mitigation of ground-borne noise and vibration in buildings near railway lines is usually achieved through the track form design, by the insertion of a resilient (rubber) layer between the rail and tunnel foundation. The resilient layer may take the form of resilient rail fasteners, booted sleepers, floating slab track or a combination of approaches.

In the NWRL ground-borne noise and vibration assessment, the following three track form options have been evaluated:

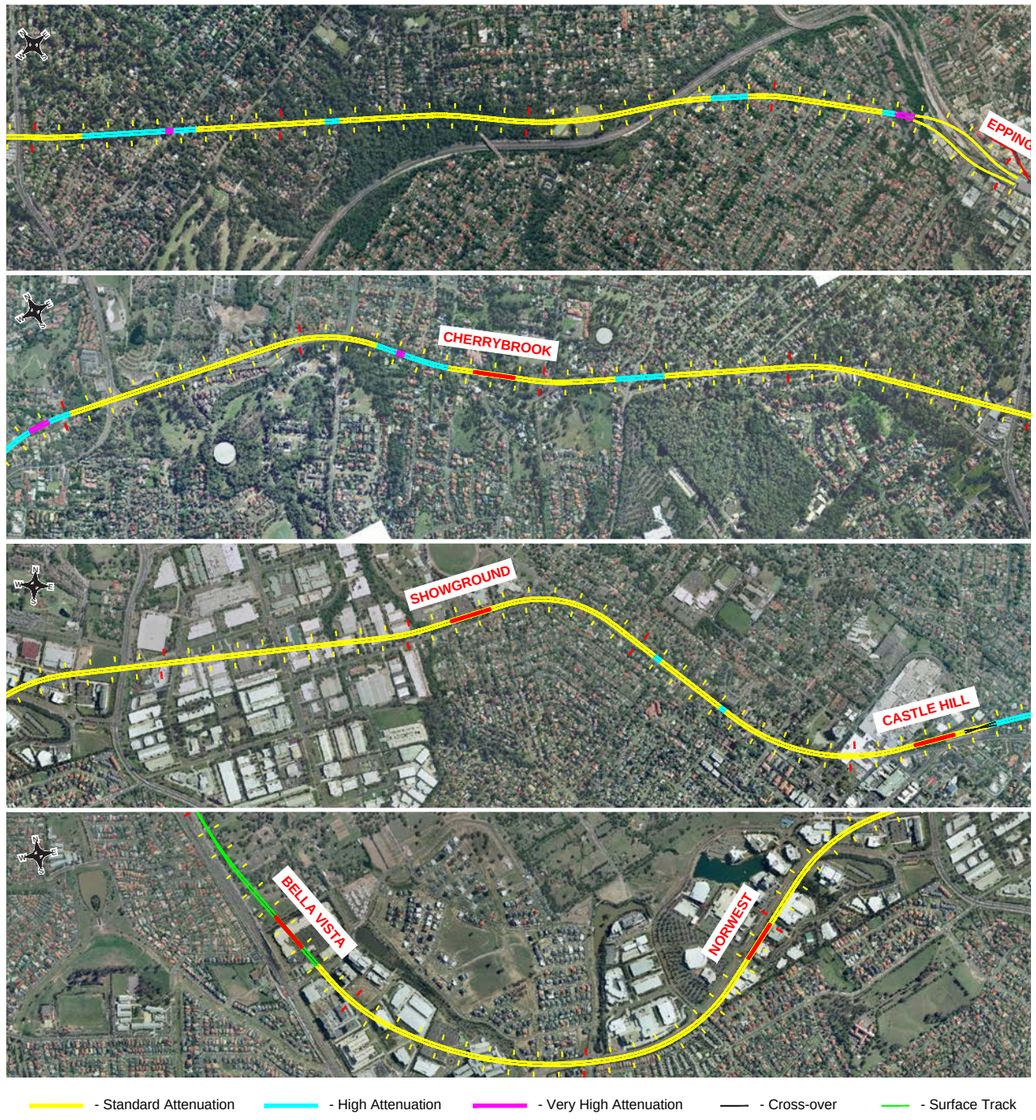
- **Standard Attenuation Track** – incorporating hard resilient baseplates. This track form is the standard specification for the NWRL and would be used in areas with low sensitivity to ground-borne noise and vibration impacts, or at locations where the diagonal distance between the track and residential receivers is approximately 25 metres or more.
- **High Attenuation Track** – incorporating medium resilient baseplates. This track form would be used in sensitive areas where the standard track is not sufficient to meet the design objectives and a higher performance track is required.
- **Very High Attenuation Track** – incorporating soft resilient baseplates or floating slab track. This track form would only be required in very sensitive areas where the depth of the tunnel is particularly shallow.

The ground-borne noise and vibration model was used to investigate the ground-borne noise and vibration levels and to identify the indicative track forms (or level of attenuation) required along the NWRL tunnels to meet the design objectives at residential receivers.

The assessment identified that for the majority of the tunnel alignment (89%), the standard attenuation track is predicted to achieve compliance with the ground-borne noise and vibration objectives. For the remaining tunnel sections, a combination of high attenuation and very high attenuation track is predicted to achieve compliance with the ground-borne noise and vibration objectives at all residential receivers.

The indicative track form for the current design of the NWRL tunnels, trains and operations are shown on an aerial map in **Figure 10.3**.

Figure 10.3 Extent of Indicative Track Forms in NWRL Tunnels



10.7.3 Ground-borne Vibration Predictions

Figure 10.4 presents a summary of the predicted ground-borne vibration levels for buildings located above or near the proposed rail alignment. The proposed indicative track form is illustrated on the graph by the yellow, turquoise and magenta bars at the top.

The predicted ground-borne vibration levels represent the maximum mid-floor vibration levels within multi-storey buildings. For a building with a slab on ground construction, the highest vibration levels would be expected to occur on Level 2 of the building, due the amplification resulting from the suspended slab.

At this stage in the assessment, it is not known whether any commercial facilities contain any highly sensitive measurement or fabrication equipment. For preliminary assessment purposes, it is assumed that all nearby medical facilities may contain highly sensitive equipment such as lithography or optical / electronic inspection equipment with high resolution. **Table 10.12** presents predicted ground-borne vibration levels for facilities that are located in proximity of the proposed alignment.

Figure 10.4 Predicted Ground-borne Vibration Levels (Indicative Track Form)

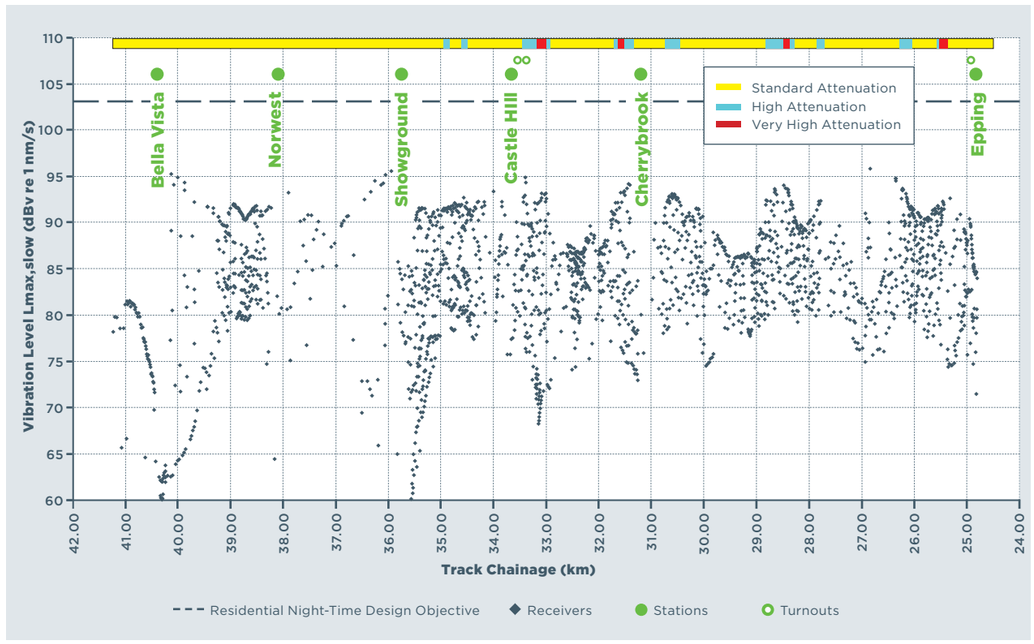


Table 10.12 NWRL Ground-borne Noise Design Objectives for Sensitive Receivers

Receiver	Chainage (km)	Maximum 1/3 Octave Band Vibration Level (dB_V)[1]	
		Design Objective	Predicted
Medical Centre and Dental Clinic 74 Rawson Street, Epping	25.120	82	85
Veterinary Hospital 138 Castle Hill Road, West Pennant Hills	30.575		89
Bella Vista Medical Centre 10 Century Circuit, Baulkham Hills	37.925		74
Norwest Medical Imaging 6 Meridian Place, Bella Vista	39.965		67
Sydney Animal Hospital 3 Celebration Drive, Bella Vista	40.130		83

Note 1: Vibration velocity levels are expressed in terms of decibels (dBV re 10-9 m/s). A level of 100 dB corresponds to 0.1 mm/s (RMS) and a level of 120 dB corresponds to 1 mm/s (RMS).

10.7.4 Ground-borne Vibration Assessment

The human comfort (perception) objectives for ground-borne vibration are more stringent than other possible design limits relating to building damage risk or the potential effects on building contents.

On the basis of the input data and modelling assumptions described in the previous sections, compliance with the ground-borne vibration objectives (and the human comfort vibration criteria from *Assessing Vibration: A Technical Guideline*) is predicted for all residential receivers and the majority of other sensitive receiver locations above or near to the proposed NWRL alignment.

For receivers which may contain highly vibration sensitive equipment, three potential minor exceedances of the design objective have been predicted. These establishments would already be subject to relatively high levels of ambient vibration due to their location adjacent to major roads.

10.7.5 Ground-borne Noise Predictions

Predictions of ground-borne noise levels for buildings located above or close to the proposed rail alignment have been undertaken and are provided in **Figure 10.5** for residential receivers and **Figure 10.6** for other sensitive receivers. The proposed track form is illustrated on the graph by the yellow, turquoise and magenta bars at the top.

The track is designed to meet the noise objectives at the nearest receivers to the alignment. The predictions are based on a 'best estimate' plus a 5 dB safety factor. On average, the predicted ground-borne noise levels (for the highest 1 in 20 trains) at the nearest locations above the tunnel alignment would be 30 dBA which is well below the noise trigger level in **Table 10.11**. At most locations the noise levels would be much lower.

Figure 10.5 Predicted Ground-borne Noise Levels-Residential Receivers

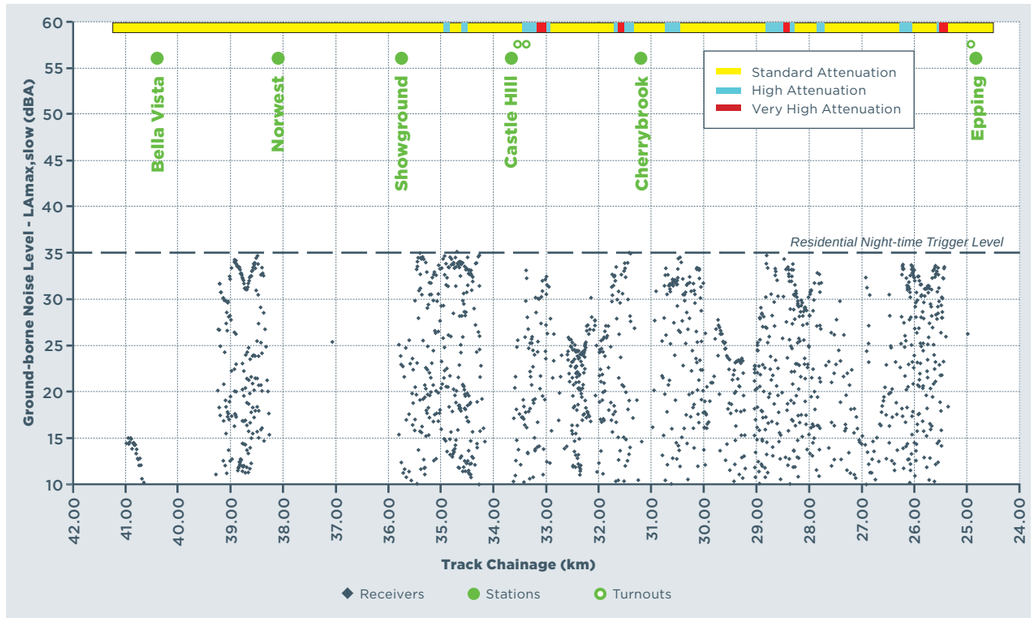
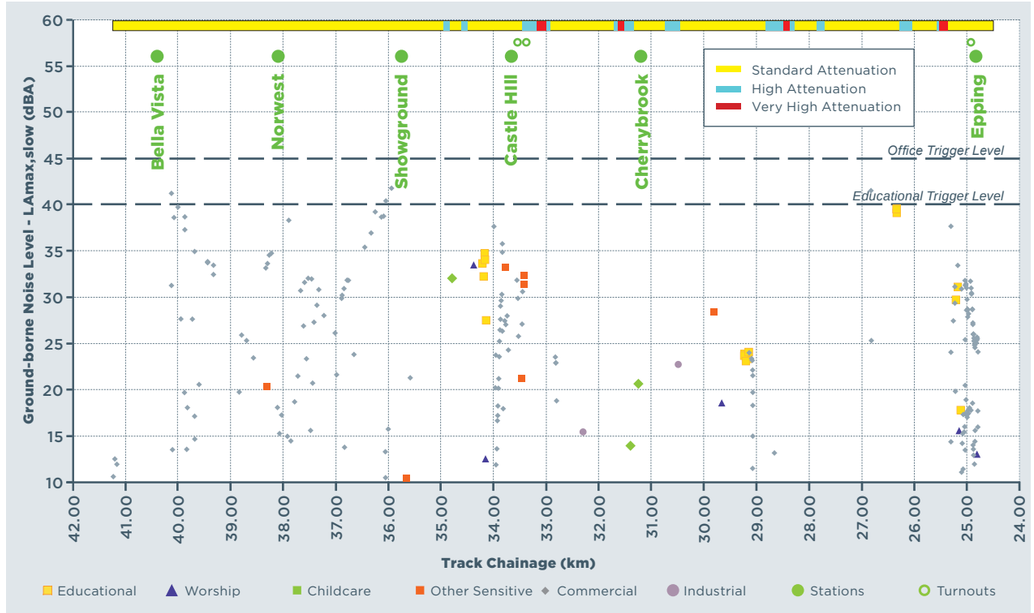


Figure 10.6 Predicted Ground-borne Noise Levels-Other Sensitive Receivers



10.7.6 Ground-borne Noise Assessment

On the basis of the proposed vertical alignment, the modelling assumptions described in the previous sections and the proposed track form in **Figure 10.3**, ground-borne noise levels are predicted to comply with the ground-borne noise design objectives at all locations.

10.8 Stabling Facility Noise

The Tallawong Stabling Facility is considered to be a fixed facility and as such, noise emissions are required to be assessed in accordance with the INP.

At opening, the Tallawong Stabling Facility would have capacity for 20 trains. For the future scenario, the capacity of the facility is anticipated to increase in line with the expected increase in train services. For this assessment, the noise impacts of the facility after opening and for the future scenario are assessed against criteria based on the anticipated noise environment.

The nearest existing sensitive receivers to the proposed stabling facility are residential. This assessment therefore considers only impacts on residential receivers as these give the controlling (lower) criteria. **Figure 10.7** shows the general location of the facility, the locations of ambient noise monitoring, and the nearest existing residential receivers around the facility.

10.8.1 Stabling Facility Noise Criteria

The INP sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. These criteria are to be met at the most-affected boundary of the receiver property. When determining project specific noise criteria, both the amenity and intrusive criteria are considered. The more stringent of these two criteria sets the project specific noise levels. For both amenity and intrusiveness, night-time criteria are more stringent than daytime or evening criteria. As the train stabling facility would operate 24 hours a day, the night-time period is likely to be the controlling period.

In addition to intrusiveness and amenity, the risk of sleep disturbance must be assessed. The current approach to assessing potential sleep disturbance is to apply an initial screening criterion of background plus 15 dB (as described in the Application Notes to the INP), and to undertake further analysis if the screening criterion cannot be achieved.

The INP notes that land uses can change as a result of urban-type residential developments in a village or rural area with few residences, or the encroachment of industrial developments near residential areas and vice versa. As developments introduce increased activities, they also increase environmental noise levels. Therefore, previously low ambient noise levels would not be maintained, and assessments of noise sources for control purposes should be made against the acceptable noise level relevant to the modified land use.

A summary of the operational noise goals for the facility is provided in **Table 10.13**. These goals have been determined from estimated background noise around the time of opening of the NWRL, with reference to measurements of existing background noise at two locations BG24 and BG25 shown in **Figure 10.7**.

Figure 10.7 Acquired Land, Monitoring Locations and Representative Receivers

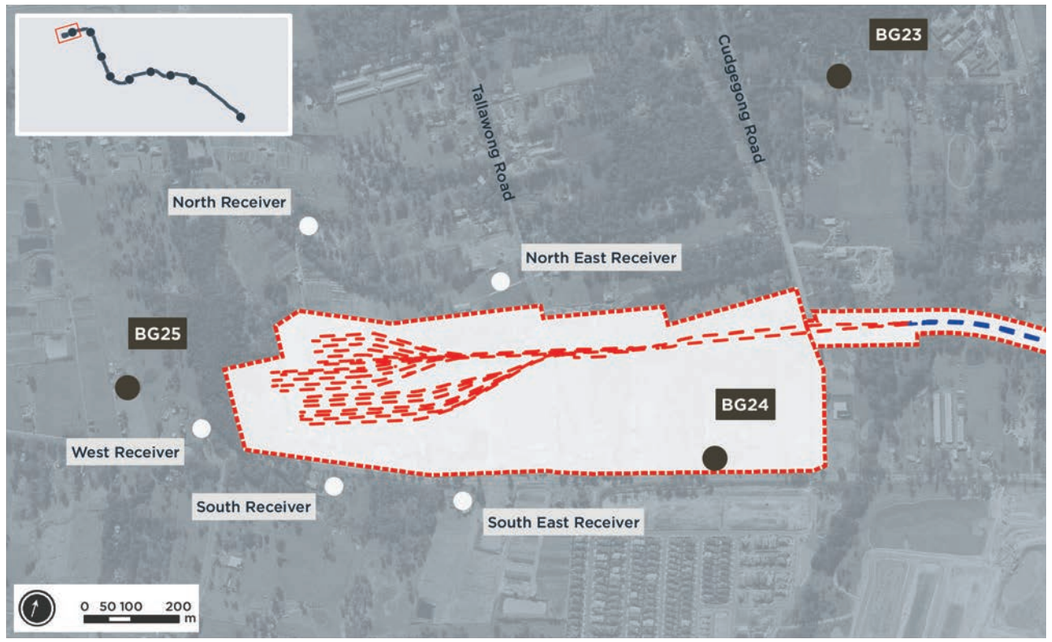


Table 10.13 Summary of Stabling Facility Noise Criteria

Scenario	Period	Estimated Rating Background Level[1] (dBA)	Operational Noise Criteria (dBA)		
			$L_{Aeq(15min)}$ Intrusive	$L_{Aeq(Period)}$ Amenity	$L_{A1(1minute)}$ Sleep Disturbance Screening Level
At Opening and for Future Capacity	Early Morning (5am to 7am)[2]	40	45	45	See Note 3 below
	Day (7am to 6pm)	45	50	55	-
	Evening (6pm to 10pm)	45	50	45	-
	Night (10pm to 5am)	35	40	40	50

Note 1: Daytime and night-time background noise levels are estimated from AS1055.2 noise area category R2. Evening levels are taken to be the same as daytime noise levels as no decrease in the evening period was recorded at either measurement location.
Note 2: The early morning shoulder period applies from 5:00 am to 7:00 am (the period when existing background noise levels are observed to be rising steadily). Noise criteria in this period are taken to be midway between the daytime and night-time criteria.
Note 3: The sleep disturbance screening level is the same throughout the night-time and early morning period (50 dBA).

10.8.2 Stabling and Maintenance Activities

There are several types of single deck trains which could be utilised for the NWRL. As part of the operational requirements, detailed specifications relating to the source noise level requirements would be provided to minimise environmental noise impacts. These specifications would be developed consistent with international best practice.

The following description of stabling activities is based on the typical requirements for modern trains and would be reviewed in more detail during the detailed design stage.

When trains are returning to the train stabling facility, some trains would enter the proposed train wash facility. This facility would be similar to a car wash facility, except on a larger scale. The train wash facility would be fully enclosed (except at the two ends). The train passes through the train wash at walking pace over a period of a few minutes. The design of the shed and washing equipment would include noise mitigation measures (as required) to comply with the noise criteria at the nearest noise sensitive receivers.

When a train enters a stabling facility, a number of activities occur. Once the train comes to a standstill, the brakes would be applied by exhausting the brake pipe and the parking brake is engaged. Exhausting the brake pipe releases compressed air to atmosphere, causing peak noise levels of short duration. The air typically exhausts from underneath the train at the two end carriages.

After the parking brake is applied, the trains would be stabled with all auxiliary equipment shut down, as is typical with modern rapid-transit trains. These trains can be shut down in a few minutes. While stabled, train interiors are cleaned.

Safety checks would be undertaken prior to the train entering service the following morning. Prior to the train departing, all auxiliary equipment is assumed to operate for up to 15 minutes. This equipment includes air-conditioning, air compressors and static inverters.

Train horn testing would not be required within the stabling facility. If required, an alternative warning system would be employed to alert staff of train movements. Such systems may be required inside the maintenance building.

Train movements within the facility would occur at low speeds and therefore $L_{Aeq(15minute)}$ noise emissions would be created by on-board equipment (such as air compressors and air-conditioners) rather than wheel-rail noise, including at crossovers and turnouts.

The majority of train maintenance activities would be undertaken within the proposed maintenance facility. Other activities with potential noise impacts include operation of a wheel lathe (to remove wheel defects), use of audible warning systems and PA systems, staff car park vehicle movements, and track maintenance activities such as rail grinding.

The design of the wheel lathe shed, PA system and audible warning systems would include noise mitigation measures (as required) to comply with the noise criteria at the nearest noise sensitive receivers. Traffic noise from Schofields Road would be likely to mask any noise emissions from the staff car park vehicle movements.

Rail grinding and major track maintenance of the NWRL would occur during night-time shutdown periods and would give rise to additional noise sources at the stabling facility. These activities (with the exception of routine inspection) are likely to be performed on an infrequent basis. The potential noise impacts associated with infrastructure maintenance would be managed as part of the proposed Operational Noise and Vibration Management Plan (ONVMP) to be prepared prior to commencement of operations.

10.8.3 Train Stabling Facility Noise Modelling

The approach to stabling facility noise modelling is first to assess the noise impacts with no specific noise mitigation apart from shielding provided by the proposed site buildings, natural terrain and site earthworks (the stabling facility is partially located in a cutting). This base case is assessed for both the at opening and future capacity scenarios. Where exceedances of the noise criteria are identified, reasonable and feasible noise mitigation measures are considered.

Brake air release noise was modelled as individual discrete noise events for assessment against the sleep disturbance screening criterion (due to its short duration and higher maximum noise levels). For this noise source, the predicted L_{Amax} noise levels represent the typical maximum levels that are likely to occur. Noise from auxiliary equipment, brake air release, train washing and maintenance operations was modelled to determine the worst-case $L_{Aeq(15minute)}$ noise levels during each assessment period. The noise sources are based on the train numbers shown in **Table 10.14**.

For the $L_{Aeq(15minute)}$ scenarios, it is assumed that the trains undergoing preparation and departing from the facility have been stabled on outside tracks, near to the affected receivers. This represents a worst case operating scenario and allows full operational flexibility of the facility. In the event that the first trains to depart in the early morning are those stabled on the inside tracks, reduced noise impacts would be expected due to shielding of some noise sources by the trains stabled on the adjacent tracks. The predicted L_{Amax} noise impacts represent a worst case at each affected receiver. This has been achieved by modelling the relevant noise source at a number of possible locations, and taking the maximum predicted noise level for each receiver from the various possible source locations.

The scenarios that have been modelled in the base case are summarised in **Table 10.15**. The following assumptions have been made about the maintenance building train access doors:

- During the night-time and early morning period, all maintenance building train access doors would be closed.
- During the evening period, half of the maintenance building train access doors would be closed.
- During the daytime period, all maintenance building train access doors would be open.

Table 10.15 shows the arrivals and departures in each time period for the opening and future scenarios.

For the purpose of noise assessment, the maximum number of trains in preparation is based on the assumption that auxiliary equipment would operate for 15 minutes before a train departs from the facility. The noise assessment also assumes preparation of the first train would begin at around 4:00 am.

Table 10.14 Train Arrivals, Preparation and Departures for the Purposes of Noise Assessment

Scenario	At Opening				Future Scenario			
	Early Morning	Day	Evening	Night	Early Morning	Day	Evening	Night
Train arrivals	9	90	34	18	11	130	52	18
Train departures	14	94	28	15	24	134	38	15
Maximum trains in preparation for departure [2]	2	3	2	2	4	5	3	2

Note 1: Early morning is from 5:00 am to 7:00 am, day 7:00 am to 6:00 pm, evening 6:00 pm to 10:00 pm, night 10:00 pm to 5:00 am.
Note 2: Based on the assumption that auxiliary equipment will operate for 15 minutes before a train departs from the facility.

Table 10.15 Train Stabling Facility Modelling Scenarios

Scenario	Parameter	Noise Sources	Time Period
1	L_{Amax}	Brake Air Release	All Periods, but potential impacts most significant during night-time period
2	$L_{Aeq(15minute)}$	▪ Three trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 4 doors open and 1 train inside with all auxiliary equipment operating.	Daytime, at opening
3	$L_{Aeq(15minute)}$	▪ Two trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating. ▪ Train wash facility. ▪ Maintenance facility with 4 doors closed and 1 train inside with all auxiliary equipment operating.	Early Morning, at opening
4	$L_{Aeq(15minute)}$	▪ Two trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 2 doors open, 2 doors closed and 1 train inside with all auxiliary equipment operating.	Evening, at opening
5	$L_{Aeq(15minute)}$	▪ Two trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 4 doors closed and 1 train inside with all auxiliary equipment operating.	Night-time, at opening
6	$L_{Aeq(15minute)}$	▪ Five trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 8 doors open and 2 trains inside with all auxiliary equipment operating.	Daytime, future capacity
7	$L_{Aeq(15minute)}$	▪ Four trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 8 doors closed and 2 trains inside with all auxiliary equipment operating.	Early Morning, future capacity
8	$L_{Aeq(15minute)}$	▪ Three trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 4 doors open, 4 doors closed and 2 trains inside with all auxiliary equipment operating.	Evening, future capacity
9	$L_{Aeq(15minute)}$	▪ Two trains undergoing preparation with air compressors, air-conditioners, brake air release and static inverters operating ▪ Train wash facility. ▪ Maintenance facility with 8 doors closed and 2 trains inside with all auxiliary equipment operating.	Night-time, future capacity

An indicative layout for the proposed stabling facility is shown in **Figure 10.7**. The most significant noise sources associated with the facility would include those associated with the train stabling area, maintenance shed and train wash plant.

10.8.4 Meteorological Conditions

The INP requires adverse meteorological conditions to be considered in some situations, where temperature inversions or prevailing winds may increase noise levels by focusing sound wave propagation paths at a single point.

At this stage a detailed analysis of seasonal weather data (wind and atmospheric stability) has not been undertaken. Annual wind rose data for the Rouse Hill area indicates that prevailing winds are not likely to be a feature of the area (based on the statistical wind speeds and directions).

The approach to this assessment has been to assess the impacts for all night-time and early morning scenarios with the adverse meteorological conditions described below. Neutral weather conditions have been assessed for daytime and evening scenarios.

The noise modelling results for the night-time and early morning period are inclusive of the following adverse weather conditions which increase noise levels by approximately 4 dB at the nearest receivers during the winter months:

Temperature inversion strength 3°C / 100 m.

Source to receiver drainage flow wind speed of 2 m/s.

10.8.5 Train Stabling Facility Noise Impacts

Table 10.16 lists the predicted noise level at the representative existing residential receivers (shown in **Figure 10.7**), for each scenario modelled. The noise impact assessment indicates exceedances of the noise goals at existing residential receivers in the controlling time period between 4:00 am and 7:00 am.

At the nearest sensitive receivers, the most significant contributors to the L_{Aeq} noise levels are those associated with the train stabling operations, namely the static inverters, air-conditioning, brake air release and air compressors.

Early morning period (5.00 am to 7.00 am) – Scenarios 3 and 7

No noise criterion exceedances are predicted during the early morning period for the at-opening scenario.

For the future scenario, an exceedance of the noise criterion of up to 2 dB is predicted at the nearest sensitive receiver to the north under adverse weather conditions. Compliance is predicted under neutral weather conditions.

Daytime period (7.00 am to 6.00 pm) – Scenarios 2 and 6

No noise criterion exceedances are predicted during the daytime period for the at-opening and future scenarios.

Evening period (6.00 pm to 10.00 pm) – Scenarios 4 and 8

No noise criterion exceedances are predicted during the evening period for the at-opening and future scenarios.

Table 10.16 Predicted Noise Levels at Representative Receivers

	Scenario and Description	Noise Criterion (dBA)[2]	North East Receiver	North Receiver	West Receiver	South Receiver	South East Receiver
1	Night-time L_{Amax} – Brake Air Release[1]	50	54	53	53	56	52
2	Daytime $L_{Aeq(15minute)}$ Opening	50	41	41	38	38	41
3	Early Morning (5am to 7am) $L_{Aeq(15minute)}$ Opening[1]	45	44	43	39	40	44
4	Evening $L_{Aeq(15minute)}$ Opening	45	40	38	34	38	41
5	Night-time $L_{Aeq(15minute)}$ Opening[1]	40	44	43	39	40	44
6	Daytime $L_{Aeq(15minute)}$ Future	50	42	44	41	40	43
7	Early Morning (5am to 7am) $L_{Aeq(15minute)}$ Future[1]	45	45	47	44	43	45
8	Evening $L_{Aeq(15minute)}$ Future	45	41	41	38	40	42
9	Night-time $L_{Aeq(15minute)}$ Future[1]	40	44	43	39	41	45

Note 1: Noise levels for these scenarios have been calculated under adverse meteorological conditions.

Note 2: Criteria as described in **Table 10.13**. Exceedances are shown in bold text.

Night-time period (10.00 pm to 5.00 am) – Scenarios 5 and 9

For the at-opening scenario with adverse weather conditions, exceedances of the noise criterion of up to 4 dB are predicted at the nearest sensitive receivers to the south east and north east, and an exceedance of up to 3 dB is predicted at the nearest receiver to the north. Compliance is predicted under neutral weather conditions.

For the future scenario with adverse weather conditions, exceedances of the noise criterion of up to 5 dB are predicted at the nearest sensitive receivers to the south east. Exceedances ranging from 1 dB to 4 dB are predicted for the nearest receivers to the north east, north and south. Under neutral weather conditions, the exceedance is predicted to reduce to a marginal 1 dB at the south east receiver.

Discussion of Worst-case L_{Amax} Noise Levels

The source noise levels assumed for brake air release are based on noise measurements results obtained for modern RailCorp trains. It is understood that for the proposed NWRL trains, it may be possible to incorporate silencers in the compressed air lines to reduce the noise levels associated with brake air release. This option would be investigated during the detailed design stage.

With the assumed unmitigated source levels, and under adverse meteorological conditions, brake air release noise is predicted to exceed the sleep disturbance screening criterion by up to 6 dB at the nearest sensitive receivers adjacent to the proposed stabling facility. In accordance with the Application Notes to the INP, this indicates the potential for sleep disturbance and requires further analysis, considering the levels of exceedance, how often the high noise events would occur, and whether the times of occurrence are during a period when there is a clear change in the noise environment.

For the 'at opening' scenario, 20 trains are likely to prepare for departure from the facility during each night-time period. The number of night-time events would increase in the future scenario in line with the expected increase in services. It is estimated that several brake air releases would be required for each train during the night-time period, divided between the train arrival at the facility and departure the next day.

There would be some variation in noise level from each of these events since brake air release is a variable source. Noise impacts would be significantly lower in the event that the train is shielded by other trains stabled on adjacent roads, and under neutral weather conditions.

From the noise logging conducted at BG24 and BG25 (refer to Chapter 8 of the Noise and Vibration Technical Paper) it can be seen that the existing noise environment in the early morning near the most exposed receiver includes average maximum (L_{A1}) noise levels around 60 dBA to 65 dBA. This also shows existing night-time L_{Amax} noise levels at Location BG24 ranging from 66 dBA to 71 dBA. The predicted maximum noise levels associated with brake air releases would therefore be lower than the existing L_{Amax} noise levels in this area. Short term external noise levels of this magnitude are also described as being "unlikely to cause awakening reactions" according to guidance provided in the *Road Noise Policy* (RNP – DECCW, 2011).

It is concluded that while noise associated with brake air release may be noticeable at the nearest existing receivers, the likelihood of potential sleep disturbance is considered to be low.

10.8.6 Stabling Facility Noise Mitigation Considerations

The investigation of noise mitigation begins with consideration of options to reduce the dominant contributors to L_{Aeq} noise levels. Examination of the noise modelling results indicates that the dominant noise sources would be associated with the train stabling operations, namely the train auxiliary systems: static inverters, air-conditioning and air compressors (including brake air releases).

Noise generated near the top of the train (air conditioners and possibly static inverter noise) is difficult to mitigate via noise barriers. A noise barrier would need to be around 5 metres high (above rail height) to provide effective attenuation to the south receivers, and would have high cost and visual impacts. The performance of any noise barriers would also be reduced under adverse weather conditions.

Brake air release and air-compressor noise would be generated at the bottom of the train. There is potential for these noise sources to be further reduced if required (eg via the inclusion of silencers in the compressed air lines or by operational measures to maximise the noise barrier effect from adjacent trains). Minimisation of all rolling stock auxiliary noise levels would be investigated during the procurement of rolling stock.

Under adverse meteorological conditions, the highest noise level exceedances are predicted to occur at the nearest sensitive receiver to the south east, with the highest $L_{Aeq(15minute)}$ noise level of 45 dBA occurring during the night-time. Under neutral weather conditions, the predicted noise levels are 4 dB lower. Whilst the predicted noise levels under adverse and neutral weather conditions exceed the intrusiveness criteria, the noise logging results in this area indicate that the existing L_{Aeq} noise levels are around 10 dB higher than the predicted noise levels associated with the train stabling facility.

The adverse meteorological conditions assumed in the noise modelling scenarios (temperature inversion and associated drainage flow winds) generally occur only during night-time periods in winter. Furthermore, the noise modelling results are considered to represent the typical worst-case scenario with noise sources located in the most exposed locations. On this basis, it is unlikely that noise levels associated with the proposed stabling facility would have an appreciable impact on the acoustic amenity at the nearest sensitive receivers.

No specific noise mitigation measures in the form of noise barriers or earth mounding are proposed for the stabling facility. The proposed noise mitigation measures include limiting the source noise levels of the proposed rolling stock (via the procurement process), designing the proposed maintenance buildings to contain noise levels and implementing operational procedures to minimise noise impacts at nearby sensitive receivers.

Further detailed assessment of the potential noise impacts would also be required during the detailed design stage.

10.9 Noise from Stations, Ancillary Facilities, Public Roads and Car Parks

10.9.1 Overview of Noise Assessment

The potential operational noise impacts of stations, Public Address (PA) systems, station car parks and ancillary equipment such as substations and tunnel ventilation systems have been assessed. The detailed design of these facilities is not available at this stage. The approach to the assessment was therefore to determine allowable noise emissions from stations and ancillary equipment, to inform the detailed design of the project and to provide an early indication on whether the noise criteria are able to be achieved. The noise design criteria for these sources are based on guidance in the INP.

Mitigation measures are likely to be required for some station and tunnel ventilation equipment / locations in order to comply with the INP design criteria. Mitigation measures that may need to be considered at some locations include appropriate equipment selection, in-duct attenuators, noise barriers, acoustic enclosures and the strategic positioning of critical plant away from sensitive receivers.

10.9.2 Station Noise

For the proposed open cut and above-ground stations, the main source of noise is likely to be associated with station announcements via the PA system(s). Noise from other sources such as air conditioning systems, electrical substation and other mechanical plant would be designed to achieve the INP criteria.

Noise from PA systems would also be required to achieve INP noise criteria. It is anticipated that this would be achieved with appropriate design measures including appropriate loudspeaker selection and placement, and installation of ambient noise sensing microphones to reduce the volume of any announcements during periods with lower ambient noise levels.

10.9.3 Draught Ventilation Shafts and Intermediate Services Facility

Train noise break-out through the draught ventilation shafts (at underground stations) is not expected to exceed the maximum noise level criteria of L_{Amax} 55 dBA for residential receivers and L_{Amax} 65 dBA for commercial receivers. In-duct noise attenuation measures are likely to be required at each station in order to comply with the applicable noise design criteria.

The proposed Cheltenham Services Facility would be utilised for emergency access and egress purposes only. At this stage, it is unlikely that any surface mechanical plant or tunnel ventilation would be required at this site. No noise impacts are therefore predicted during operations.

10.9.4 Operational Noise from Car Parks

Operational noise from proposed car parks has been assessed and in most cases is predicted to comply with the INP noise criteria at all sensitive receivers with the exception of Cherrybrook Station and Showground Station.

Cherrybrook Station

At Cherrybrook Station, two car parks are proposed: a car park above the south-east end of the station box, and a second at-grade car park in the east corner of the Cherrybrook Station precinct bordering Franklin Road and the residences on Kayla Way.

Noise associated with the proposed south-east car park is predicted to meet the noise criteria at the nearby residences on Castle Hill Road without specific noise mitigation measures. For the proposed at-grade car park, specific noise mitigation measures may be required due to a predicted possibility of sleep disturbance for occupants at the adjacent residences on Kayla Way and predicted exceedances of the INP intrusiveness criteria of up to 4 dB.

Possible mitigation measures at Cherrybrook Station include the construction of a 4 metre high noise barrier along the north-east boundary of the east car park or closing the east at-grade car park during the night-time period. During the daytime peak period, $L_{Aeq(15minute)}$ noise levels are predicted to exceed the INP intrusiveness criterion by up to 4 dB. A 2 metre high noise barrier would reduce noise levels on the ground floor of residences to well below the intrusiveness criterion with only minor exceedances at the upper levels.

Showground Station

At Showground Station, a three level car park is proposed in the south-west corner of the station precinct, alongside Carrington Road. During the night-time, $L_{Aeq\ (15minute)}$ noise levels are predicted to exceed the night-time intrusiveness criterion by up to 4 dBA at the nearest two residences on the opposite side of Carrington Road. Possible mitigation measures include enclosing the car park at the south-east corner or installing sound absorptive panels on the roof of each car park level near the south end.

10.9.5 Road Traffic Noise on New and Upgraded Public Roads

New or upgraded public roads are proposed in the vicinity of the station precincts at Cherrybrook, Showground, Bella Vista, Kellyville, and Cudgegong Road to provide access to car parking, bus, taxi, and kiss-and-ride facilities. The noise impact of the proposed new and upgraded roads has been assessed in accordance with the RNP.

For the proposed new roads within the station precincts, noise criteria of $L_{Aeq(1hour)}$ 55 dBA (daytime) and $L_{Aeq(1hour)}$ 50 dBA (night-time) are applicable at the nearest residential facades. For land use developments (ie new station precincts) with the potential to generate additional traffic on existing roads, the RNP requires an assessment of the increase in total traffic noise level. Any increase in the total traffic noise as a result of the NWRL project should be limited to 2 dB above that of the corresponding "no build option".

Road traffic noise levels associated with the proposed new and upgraded roads near the station precincts were calculated in accordance with the methodology contained in the Calculation of Road Traffic Noise (CoRTN) 1988. Input data on the number of traffic movements have been estimated based on information contained in the Operational Traffic and Transport Technical Paper (Technical Paper 2).

Cherrybrook Station

At Cherrybrook Station, a new access road connecting Robert Road and Franklin Road is proposed to provide access to car parking, bus, taxi, and kiss-and-ride facilities. The nearest sensitive receivers to the new road are residences to the north on Oliver Way and Kayla Way, approximately 40 metres away.

The $L_{Aeq(1hour)}$ noise due to traffic on the proposed station access road is predicted to exceed the RNP criterion of 55 dBA at the closest residences by up to 5 dB during the morning peak period. The night-time criterion may also be exceeded by up to 2 dB.

Options for reducing the potential noise impacts include design measures (ie road alignment, speeds and traffic management), noise barriers (ie from natural terrain, landscaping or solid barriers) or at-property treatments. A detailed assessment of the potential road traffic noise impacts and preferred mitigation measures would be undertaken during the detailed design stage.

Vehicles travelling to and from Cherrybrook Station are expected to increase the existing traffic volumes on the existing roads in the vicinity of the station, particularly near the access points to the station precinct.

Road traffic noise levels on Castle Hill Road are predicted to increase by approximately 1 dB as a result of additional traffic associated with the new station precinct. An increase in noise level of 1 dB is typically considered to be a minor increase and is below the RNP increase criteria of 2 dB.

During the morning peak period, traffic noise levels at building facades 10 metres from the edge of either Franklin Road or Robert Road are predicted to be approximately 65 dBA, compared with existing $L_{Aeq(1hour)}$ noise levels of approximately 55 dBA. The predicted worst case noise increase on these roads may therefore be up to 10 dB. However, most residences are set back more than 10 metres from the road and some residential properties have boundary fences which may provide some noise attenuation.

No road improvements on Franklin Road and Robert Road north of the station are associated with the station development and the potential for noise

control is therefore limited. Possible noise control strategies include quieter buses, noise barriers and property treatments. A more detailed assessment of the potential road traffic noise impacts and preferred mitigation measures would be undertaken during the detailed design stage.

Castle Hill Station

For Castle Hill Station, the increase in road traffic noise levels on existing access roads is predicted to be less than 2 dB at all receivers. Mitigation of traffic noise is therefore not required.

Showground Station

A network of new internal roads is proposed for Showground Station precinct to provide access to the station and the proposed three level car park in the south-west corner of the precinct and linking Doran Drive to Showground Road.

The nearest sensitive receivers to the proposed new roads are residences on the south side of Carrington Road and on the east side of Showground Road. At these receivers, noise from traffic on the new internal roads is not expected to be significant compared to the existing traffic noise on Showground Road and Carrington Road.

Vehicles visiting Showground Station are expected to increase the existing traffic volumes on the roads in the vicinity of the station including Showground Road and Carrington Road. The predicted increase in road traffic noise levels on these roads is less than 2 dB at all receivers. Mitigation of traffic noise is therefore not required.

Norwest Station

For Norwest Station, the increase in road traffic noise levels on existing access roads is predicted to be less than 2 dB at all receivers. Mitigation of traffic noise is therefore not required.

Bella Vista Station

A number of new roads at Bella Vista are proposed to provide access to kiss-and-ride areas, bus and taxi zones, and the commuter car parks. The proposed roads include extensions of Celebration Drive and Lexington Drive to the north, two link roads running east to west connecting Celebration Drive and Lexington Drive, and an east to west road linking Celebration Drive and Lexington Drive to Old Windsor Road.

The nearest sensitive receivers to the new roads are residences to the east of Celebration Drive on Waterstone Crescent and Jardine Terrace. Traffic noise from internal roads at Bella Vista Station is not expected to be significant at residences to the west of Old Windsor Road due to the high existing traffic volume on Old Windsor Road.

At the nearest sensitive receivers, the predicted road traffic noise levels on the new roads in the Bella Vista Station precinct comply with the $L_{Aeq(1hour)}$ assessment criteria of 55 dBA daytime and 50 dBA night-time. The increase in road traffic noise levels on existing access roads is also predicted to be less than 2 dB at all receivers. Mitigation of traffic noise is therefore not required.

Kellyville Station

New roads proposed at Kellyville comprise access roads to provide access to kiss-and-ride areas, bus and taxi zones, and the commuter car parks and several internal roads on the eastern side of the proposed station.

The nearest sensitive receivers to the closest new road are residences to the east on Landy Place and Wenden Avenue, approximately 65 metres away. Traffic noise from internal roads at Kellyville Station is not expected to be significant at residences to the west of Old Windsor Road due to the high existing traffic volume on Old Windsor Road.

The predicted $L_{Aeq(1hour)}$ noise levels associated with road traffic on the proposed access road east of the Kellyville Station precinct is predicted to exceed the RNP criterion of $L_{Aeq(1hour)}$ 55 dBA (daytime) at the nearest residences by up to 3 dB during the morning peak period. The noise predictions do not take into account possible acoustic shielding between the new access road and the nearest residences. The terrain is likely to provide some acoustic shielding in places and a significant proportion of traffic is likely to turn onto the precinct connecting roads.

Consistent with the Cherrybrook Station precinct, noise mitigation options for reducing the potential noise impacts at the Kellyville Station precinct include design measures (ie road alignment, speeds and traffic management), noise barriers (ie from natural terrain, landscaping or solid barriers) or at-property treatments. A detailed assessment of the potential road traffic noise impacts and preferred mitigation measures would be undertaken during the detailed design stage.

For Kellyville Station, the increase in road traffic noise levels on existing access roads is predicted to be less than 2 dB at all receivers. Mitigation of traffic noise on existing roads is therefore not required.

Rouse Hill Station

For Rouse Hill Station, the increase in road traffic noise levels on existing access roads is predicted to be less than 2 dB at all receivers. Mitigation of traffic noise is therefore not required.

Cudgegong Road Station

For the Cudgegong Road precinct, new access roads are proposed either side of the rail corridor at Cudgegong Road Station. The south spine road is proposed to link Cudgegong Road and Tallawong Road and provides access to the on-street and off-street park-and-ride areas. Kiss-and-ride spaces and bus zones are proposed to be located on the north spine road, accessed from Cudgegong Road.

The nearest sensitive receivers to the new roads are residences to the north on Cudgegong Road and Tallawong Road. The nearest residence to the north spine road is approximately 65 metres to the north and the nearest residences to the south spine road are approximately 110 metres to the north.

Traffic noise levels from the proposed new roads within the Cudgegong Road Station precinct are not expected to exceed the $L_{Aeq(1hour)}$ assessment criteria of 55 dBA daytime and 50 dBA night-time, and specific noise mitigation measures are therefore not likely to be required.

The $L_{Aeq(1hour)}$ noise levels during the morning peak period are predicted to increase by up to 3 dB at residences on Schofields Road compared with 2011 levels. However, substantial development is expected around Schofields Road and traffic numbers would be expected to increase significantly without the proposed Cudgegong Road Station (ie as a result of natural growth). RMS has plans to upgrade Schofields Road from west of Windsor Road to the intersection with Hambledon Road, with construction works expected to commence toward the end of 2012.

10.10 Operational Noise and Vibration Associated with Rapid Transit Operations on ECRL

As part of the Rapid Transit Network trains would operate on the NWRL through to Chatswood using the existing ECRL. In relation to potential noise and vibration impacts, additional train movements (compared with the existing CityRail timetable) would occur on ECRL. Train operations for the tunnel and surface sections may also occur at higher speeds (up to 100 km/h where possible), compared with the current maximum speed of 80 km/h for ECRL.

The assessment considered the noise and vibration approval conditions for the ECRL project and how noise and vibration levels are anticipated to change. The review identified two areas where Rapid Transit operations on the ECRL may generate higher airborne noise levels or higher ground-borne noise and vibration levels.

10.10.1 Potential Airborne Noise Impacts – Surface Track at Chatswood

For the section of surface track between Chatswood Station and the ECRL tunnel portals, $L_{Aeq(9hour)}$ night-time noise levels are anticipated to remain relatively unchanged as a result of Rapid Transit operations. If maximum train speeds are increased from 80 km/h to 90 km/h on the existing ECRL tracks, the change in maximum noise levels (L_{Amax}) associated with individual passbys is not likely to be noticeable (ie less than 2 dB) at the nearest residences.

During the daytime period, $L_{Aeq(15hour)}$ noise levels are predicted to increase by approximately 0.8 dB between Year 2017 and Year 2021 and a further 1.0 dB between Year 2021 and Year 2031. This increase is a result of natural growth and signalling systems which facilitate more frequent train operations. If maximum train speeds are increased from 80 km/h to 90 km/h on the existing ECRL tracks, the change in maximum noise levels (L_{Amax}) associated with individual passbys is not likely to be noticeable (ie less than 2 dB) at the nearest residences.

10.10.2 Potential Ground-borne Noise and Vibration Impacts – Above Tunnels between Epping and Chatswood

For the section of tunnel track between Epping and Chatswood, the Rapid Transit operations would result in a more frequent single deck train service, with trains potentially travelling at higher speeds (up to 100 km/h where possible).

For single deck rapid transit trains, the key factors which are likely to produce a change in the ground-borne noise and vibration levels are the unsprung mass and axle load of the proposed trains and the train speed. These factors would likely result in marginally lower source vibration levels for single deck rapid transit trains. Other factors including the wheel and rail condition, track fasteners, rail type and tunnel design are the same or not likely to change as a result of Rapid Transit operations.

The corresponding increase in ground-borne noise and vibration levels is estimated be approximately 2 dB at locations where the maximum train speed increases from 80 km/h to 100 km/h. A change of 1 dB or 2 dB in maximum noise or vibration level is difficult for most people to detect.

In relation to the ground-borne noise and vibration criteria which formed part of the ECRL approval, the assessment noted that compliance with the ground-borne noise and vibration criteria was achieved at all locations. Furthermore, apart from one complaint received in Year 2009 (shortly after project opening – which was investigated by RailCorp), no other complaints have been received by RailCorp in relation to ground-borne noise and vibration from train operations in the ECRL tunnels.

The assessment concluded that it is unlikely that higher speed single deck train operations within the ECRL tunnels would result in a noticeable increase in ground-borne noise and vibration levels within sensitive occupancies above the tunnel alignment.

10.11 Construction Noise and Vibration

10.11.1 Overview

People are usually more tolerant to noise and vibration during the construction phase of projects than during full operations. This response results from recognition that the construction emissions are of a temporary nature – especially if the most noise-intensive construction impacts occur during the less sensitive daytime period.

The construction noise and vibration impact assessment outlined in this section covers construction activities not assessed in the Environmental Impact Statement for Major Civil Construction Works (EIS 1). An overview of the activities included in this EIS is as follows:

- Station fit out works, including construction of station buildings.
- Track construction, including overhead wiring construction.
- Construction of roads for the NWRL (except those which were included in EIS 1).
- Construction of the Tallawong Stabling Facility, with the exception of earthworks (which were included in EIS 1).

Further details regarding Stage 2 construction works and the duration of works at each of the construction sites are provided in Chapter 7.

10.11.2 Construction Noise Management Levels

Airborne noise would occur at all construction sites and is primarily associated with surface activities or underground activities where there is an airborne noise path between the source and receiver (ie not fully shielded).

Construction noise management levels (NMLs) are based on the *Interim Construction Noise Guideline* (ICNG – DECC 2009), administered by the EPA. The interim guideline contains NMLs for sensitive land uses including residential, commercial and industrial receivers. These are provided in **Table 10.17** and **Table 10.18** for residential and other sensitive receivers respectively.

At locations where the construction noise levels are predicted to exceed the NMLs, consideration must be given to applying all feasible and reasonable work practices for each site and activity to minimise the potential noise impacts.

In addition to identifying feasible and reasonable work practices, a CNVS has been developed for the NWRL project. The CNVS documents the best-practice techniques specific to the NWRL project for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures.

The strategy includes a standard suite of mitigation measures which would be implemented across all NWRL construction sites (such as periodic notification of proposed works, adherence to construction respite periods and use of non-tonal reversing alarms). It also includes additional mitigation and management measures which would be implemented when construction noise is predicted to exceed the NMLs (such as noise monitoring, individual briefings, respite offers and in some instances at night, alternative accommodation). These measures are primarily aimed at pro-active engagement with affected sensitive receivers.

Table 10.17 Airborne NMLs for Residential Receivers (from ICNG)

Time of Day	Noise Management Level (NML) $L_{Aeq(15minute)}$	How to Apply
Recommended standard hours: **Monday to Friday 7.00 am to 6.00 pm** **Saturday 8.00 am to 1.00 pm** **No work on Sundays or public holidays**	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	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 proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the *Interim Construction Noise Guideline*.

Table 10.18 Airborne NMLs for Sensitive Land Uses (other than Residential) (from ICNG)

Land Use	Management Level, $L_{Aeq(15minute)}$ (Applies when Land Use is being Utilised)
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
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 dBA
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 dBA
Community Centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

10.11.3 Construction Vibration – Safe Working Distances

The effects of vibration in buildings can be divided into the following three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed.
- Those where the building contents may be affected.
- Those in which the integrity of the building or the structure itself may be prejudiced.

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion).

As a guide, safe working distances for typical items of vibration intensive plant are provided in the CNVS. The safe working distances are quoted for both "cosmetic" damage (based on British Standard BS 7385:2-1993) and human comfort (based on *Assessing Vibration - a technical guideline*). Cosmetic damage is very minor in nature and readily repairable. It does not affect the structural integrity of the building.

To ensure that buildings in close proximity to the proposed construction activities are not damaged by the proposed construction works, the following control measures would be put in place:

- If there is a risk that a building or structure may be damaged, building condition surveys would be undertaken prior to and following construction to measure any change in building condition as a result of the construction activities.
- The safe working distances for cosmetic damage would be complied with at all times, unless otherwise approved by the relevant authority.
- Attended vibration measurements would be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.

A conservative vibration damage screening (trigger) level of 7.5 mm/s has been adopted for the NWRL project and has been established with reference to the minor cosmetic damage criteria in British Standard BS 7385 Part 2-1993. The vibration levels specified in this standard are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure.

The recommended screening level of 7.5 mm/s is also applicable to heritage structures, unless it is known that the structure is already structurally unsound – in which case, a lower screening level may be applicable. At this stage in the assessment, no heritage structures have been identified in close proximity to the NWRL alignment which are known to be structurally unsound.

Consistent with the airborne noise assessment, consideration must be given to identifying all feasible and reasonable work practices, and implementing the mitigation and management measures identified in the CNVS.

10.11.4 Construction Traffic Noise Goals

Construction activities would result in additional heavy vehicle movements on public roads. Whilst specific guidance on acceptable noise levels associated with construction traffic is not provided by the EPA, the potential noise impacts have been identified using guidance in the RNP.

One of the objectives of the RNP is to protect against excessive decreases in amenity as the result of a project by applying relevant noise increase criteria. In this respect, the RNP notes that a noise level increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person. On this basis, construction traffic NMLs set at 2 dB above the existing road traffic noise levels during the daytime and night-time periods are considered appropriate to identify the onset of potential noise impacts. At locations where the predicted construction traffic noise levels are more than 2 dB above the existing levels, consideration has been given to identifying all feasible and reasonable work practices to minimise the potential impacts.

Sleep disturbance

The EPA's most recent approach considers sleep disturbance as the emergence of the maximum level ($L_{A1(1minute)}$ or L_{Amax}) above the $L_{A90(15minute)}$ background level at the time. The appropriate screening criterion for sleep disturbance is determined to be a maximum level 15 dB above the RBL, normally during the night-time period (10.00 pm to 7.00 am). Where this criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

Additional guidance is provided in the RNP which contains a section on sleep disturbance that includes a summary of current literature. The RNP concludes that:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

On the basis of the above guidance, a sleep disturbance NML of 55 dBA (internal) has been adopted, which equates to an external noise level of 65 dBA (assuming open windows).

10.11.5 Proposed Construction Activities

The NWRL project is a major construction project which would include a large number of construction sites across the project area. The activities assessed in this EIS would be concentrated around the stations, but with some activities required along the alignment and at the Train Stabling Facility.

Station construction works would typically involve concrete trucks and vibrators, machinery, cranes and hand tools and include:

- Station platform construction and station buildings.
- Elevator support structures, lifts and fire stairs.
- Completion of concrete support structures (including the 'cover' of the underground stations).
- Car park construction.
- Landscaping works.

Rail systems construction works would take place along the alignment to complete the rail operational infrastructure following the civil works handover. Rail systems works would typically involve delivery trucks, machinery, cranes and hand tools and include:

- Tunnel and station ventilation systems.
- Tunnel fire and safety systems.
- Track formation and track works.
- Installation of overhead wire systems and cable support.

Stabling facility construction works would include:

- Track formation and track works.
- Installation of overhead wire systems and cable support.
- Construction of buildings.

10.11.6 Summary of Assessment Methodology

For each construction scenario, a computer noise model was developed to assist in predicting the noise and vibration levels within the nearest sensitive receiver areas. The noise model was developed using a software program (SoundPLAN – Version 7) to calculate noise levels at specific locations.

The computer noise model incorporates a comprehensive range of acoustic parameters; the source noise levels from various items of construction plant, the location of sensitive receivers, the three dimensional ground topography, the height of noise sources and receivers, the noise shielding effects of intervening noise barriers, structures or acoustic sheds and the likely operating patterns of construction plant. The calculation process is consistent with the requirements of Australian Standard AS2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites.*

Construction noise and vibration emissions have been assessed for each of the major worksites and proposed construction activities. For each worksite, a noise and vibration modelling scenario was developed to assist in calculating the likely noise and vibration levels. These scenarios are considered representative of the typical worst case impacts for each scenario.

For the station sites, the major civil construction works assessment (EIS 1) proposed the use of noise barriers (hoardings) around the perimeters of a number of construction sites (3 metres high). This 3 metre site perimeter solid timber fence has been assumed in the calculations where appropriate.

The ICNG recommends that the realistic worst-case or conservative noise levels from the source should be predicted for assessment locations representing the most noise-exposed residences or other sensitive land uses. For each construction site, residences and other sensitive receivers have been grouped together into receiver areas or 'catchments', which comprise those receivers which would experience a similar level of construction noise. For each of these receiver areas the noise levels are predicted at the most noise-exposed location, which would usually be the closest receiver.

Other sensitive receivers within the catchment would generally experience lower noise levels compared with the most noise-exposed location, with levels decreasing by typically 6 dB as the distance from the source to the receiver is doubled, and by up to 10 dB or 15 dB when the receiver is shielded by other structures, buildings or rows of housing.

The noise assessment for the major civil construction works (EIS 1) included predictions of the likely ground-borne noise and vibration associated with the bulk excavation of the underground and cut and cover stations, surface section and stabling / maintenance area. The potential ground-borne noise and vibration impacts associated with the proposed EIS 2 construction activities would be much lower compared with the EIS 1 activities. For EIS 2, the construction activities likely to generate potential vibration impacts are those associated with ground improvement works using vibratory rollers.

The assessment of road traffic noise on public roads addressed noise levels based on existing traffic movements on local and arterial road network, the typical noise levels associated with heavy vehicle movements and the proposed number of truck movements, particularly during the sensitive night-time period.

For each construction site and activity, consideration has been given to reducing the potential noise and vibration impacts through the implementation of feasible and reasonable mitigation measures. These measures comprise a three-part approach including:

1. Site specific mitigation measures.
2. Standard mitigation measures to be implemented across all NWRL construction sites.
3. Additional mitigation and management measures to be implemented where the construction noise and vibration levels remain above the noise and vibration management levels.

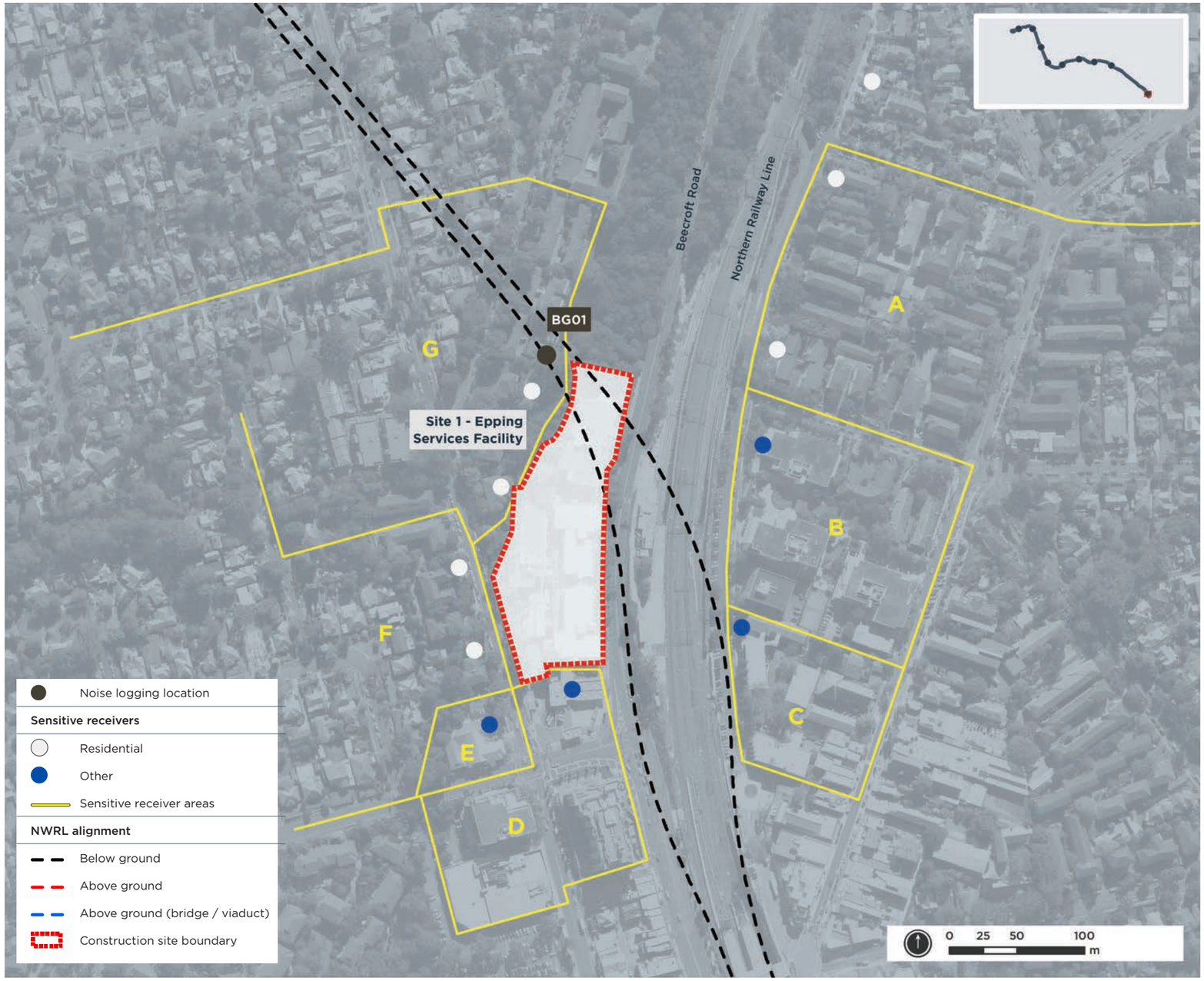
Approaches 2 and 3 are described in greater detail in the CNVS developed by the NWRL project team and which would be adopted by all contractors to manage construction noise and vibration across the various construction sites. In preparing this strategy, consideration has been given to several guideline documents including the ICNG, *'Construction Noise Strategy'* developed by the former Transport Construction Authority, Australian Standard AS 2436-2010 *'Guide to noise and vibration control on construction, demolition and maintenance sites'* and the RNP.

The CNVS documents the best-practice techniques specific to the NWRL project for managing construction noise and vibration, and implementing feasible and reasonable mitigation measures.

In addition to the site specific mitigation measures identified in this report, the CNVS includes a standard suite of mitigation measures which would be implemented across all NWRL construction sites including periodic notification of proposed works, adherence to construction respite periods and use of non-tonal reversing alarms. Additional mitigation and management measures would be implemented when construction noise is predicted to exceed the NMLs (such as noise monitoring, individual briefings, respite offers and in some instances alternative accommodation). These measures are primarily aimed at pro-active engagement with affected sensitive receivers.

In addition to the mitigation measures described in the CNVS, contractors may introduce further measures or mitigation strategies to reduce noise and vibration impacts at sensitive receivers.

Figure 10.8 Epping Services Facility and Receiver Areas



10.11.7 Identification of Airborne Noise Impacts

Epping Services Facility

The Epping Services Facility construction site is proposed to be a tunnel ventilation and emergency access and egress facility. The proposed construction works would include delivery of material and transportation to the rail tunnels, construction of the services facility building and the installation of rail systems equipment. Access and egress to and from the site would be via a left-in, left-out arrangement directly from Beecroft Road, and a right-in, left-out arrangement from Ray Road.

An aerial photograph of the proposed Epping Services Facility and the surrounding receiver areas is provided in **Figure 10.8**, with the nearest noise sensitive receivers identified in **Table 10.19**. The Epping Services Facility is located to the west of Beecroft Road.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.19**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Location BG01. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Beecroft Road and rail traffic on the Main North Rail Line.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.20** for each construction scenario.

The noise levels for each scenario have been considered separately. The findings of the construction noise impact assessment at the Epping Services Facility indicate the following:

- The predicted noise levels for delivery of materials indicate compliance with the NMLs at all residential receivers.
- At the nearest commercial receivers, the school and church, compliance with the NMLs is predicted during the delivery of materials.

Table 10.19 Nearest Noise Sensitive Receivers – Epping Services Facility

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Residences Cambridge Street	Residential	110	55	46	37
B	Commercial Cambridge Street	Commercial	105	70	N/A	N/A
C	School	Educational (School)	105	55	N/A	N/A
D	Commercial adjacent	Commercial	5	70	N/A	N/A
E	Epping Baptist Church	Church	30	65	65	-
F	Residences Ray Road	Residential	20	55	46	37
G	Residences Edensor Street / Ray Road	Residential	5	55	46	37

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.20 Predicted noise level exceedances at Epping services facility and decline

Receiver Area		Noise Modelling Scenario		
		Epping services facility – services facility building construction	Epping services facility – rail systems installation	Epping decline tunnel – delivery of materials
A	Residences Cambridge Street			
B	Commercial Cambridge Street			
C	School			
D	Commercial adjacent			
E	Epping Baptist Church			
F	Residences Ray Road			
G	Residences Edensor Street / Ray Road			

Note: Approximate durations: building construction 12 months, rail systems installation 15 months (followed by testing and commissioning), and delivery of materials 24 months.

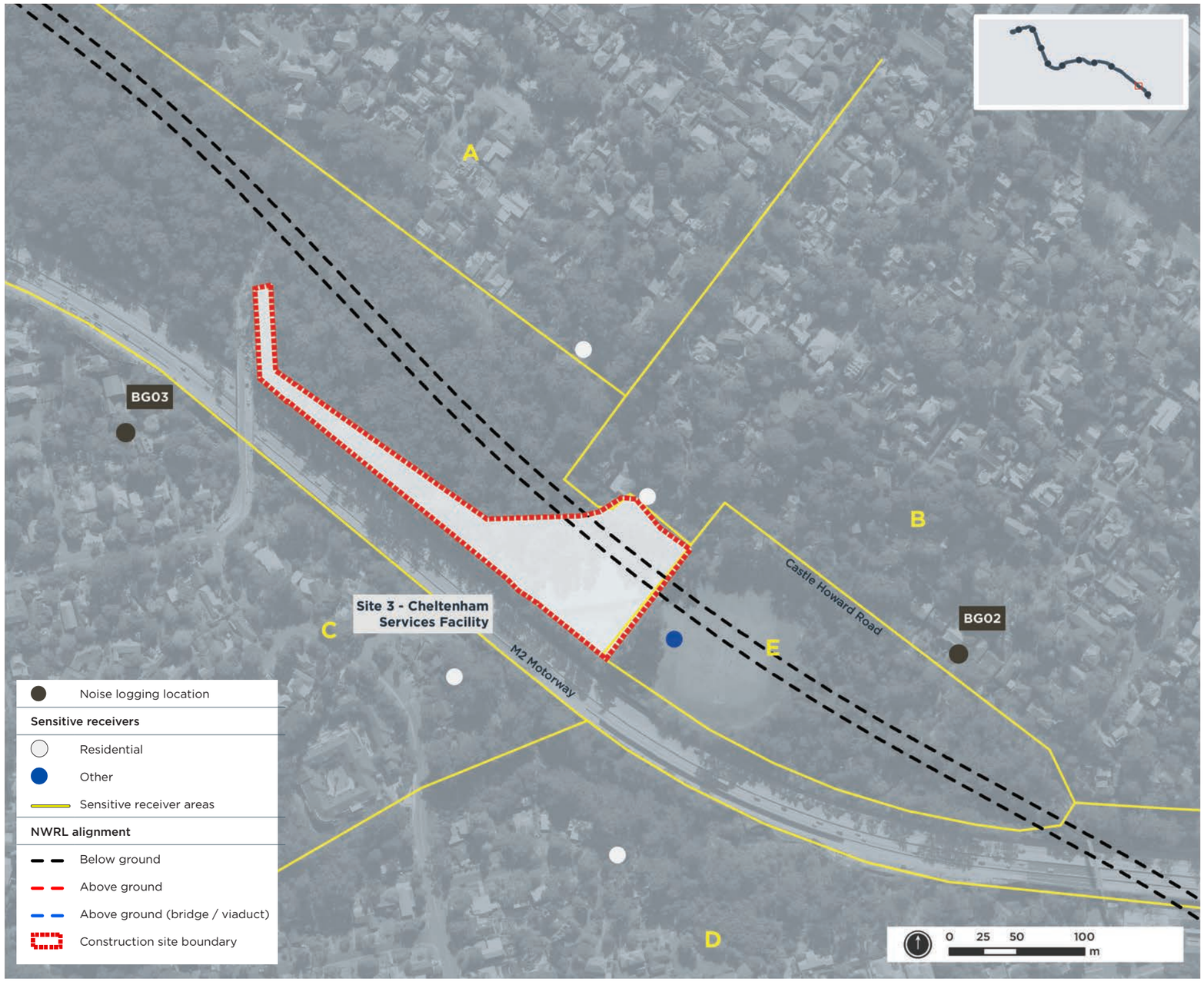
- The predicted noise levels for the services building and supporting structure construction indicate exceedances of the NMLs for construction of between 10 dB and 20 dB at the nearest receivers in Area G. At all other residential receivers, compliance with the NMLs is predicted.
- During the installation of rail services, there is a predicted exceedance of the NML of up to 10 dB at Area F. At all other residential receivers, compliance with the NMLs is predicted.

At the nearest commercial receivers, the school and church, compliance with the NMLs is predicted during both services building construction and supporting structure construction, as well as during the installation of rail systems.

Vibration impacts associated with major civil construction works (eg bulk excavation works) were assessed and reported within EIS 1. For the works proposed for EIS 2, no vibration impacts are predicted for the Epping Services Facility construction site.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Epping Services Facility. In this instance, the access and egress to and from the site would be via Carlingford and Beecroft Roads which are sub-arterial roads as well as via Ray Road which is a local road. Carlingford Road, Beecroft Road and Ray Road have daytime flows significantly higher than the traffic generated by the site resulting in predicted traffic noise level increases of less than 0.1 dB. The assessment results in compliance with the 2 dB allowance.

Figure 10.9 Cheltenham Services Facility and Receiver Areas



Cheltenham Services Facility

The Cheltenham Services Facility would be used as a tunnel ventilation site and emergency access and egress facility during construction. Construction activities would include construction of the services facility building, the installation of rail systems equipment and reinstatement of recreational facilities.

Light vehicle access and egress is proposed to be directly on and off Castle Howard Road. Two options are currently being investigated for heavy vehicle access and egress, which are:

- On and off Kirkham Road. This option would require a new intersection to be developed on Kirkham Road and the establishment of an access road through bushland to the proposed site.
- Directly on and off the M2 Motorway. This option would require the construction of new on and off ramps to the motorway.

It is anticipated an acoustic enclosure would be constructed to house the construction ventilation system which would remain while rail systems and infrastructure works continue in the tunnel below.

An aerial photograph of the proposed Cheltenham Services Facility and the surrounding receiver areas is provided in **Figure 10.9**, with the nearest noise sensitive receivers identified **Table 10.21**. The Cheltenham Services Facility is located to the west of Cheltenham Oval and north of the M2 Motorway.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.21**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG02 and BG03. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on the M2 Motorway, local roads and natural sources.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.22** for each construction scenario.

Table 10.21 Nearest Noise Sensitive Receivers to Cheltenham Services Facility

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Residences north east of Castle Howard Road, between Oaklands Road and Murray Road	Residential	125	59	46	36
B	Residences north east of Castle Howard Road, between Murray Road and Lyne Road, in addition to the residences on the south west of Castle Howard Road, adjacent to the tennis courts	Residential	30	59	46	36
C	Residences south of the M2 Motorway, south and east of vegetated area bordering Kerry Avenue and Merinda Avenue	Residential	155	65	57	40
D	Residences south of the M2 Motorway, north and west of the vegetated area bordering Kerry Avenue and Merinda Avenue	Residential	110	65	57	40
E	Cheltenham Oval	Active Recreational (Oval)	15	65	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.22 Predicted noise level exceedances at Cheltenham services facility

Receiver Area		Noise Modelling Scenario	
		Cheltenham – services facility building construction	Cheltenham – rail systems installation
A	Residences north east of Castle Howard Road, between Oaklands Road and Murray Road		
B	Residences north east of Castle Howard Road, between Murray Road and Lyne Road, in addition to the residences on the south west of Castle Howard Road, adjacent to the tennis courts		
C	Residences south of the M2 Motorway, south and east of vegetated area bordering Kerry Avenue and Merinda Avenue		
D	Residences south of the M2 Motorway, north and west of the vegetated area bordering Kerry Avenue and Merinda Avenue		
E	Cheltenham Oval		

Note: Approximate durations: building construction 12 months, rail systems installation 12 months (followed by testing and commissioning).

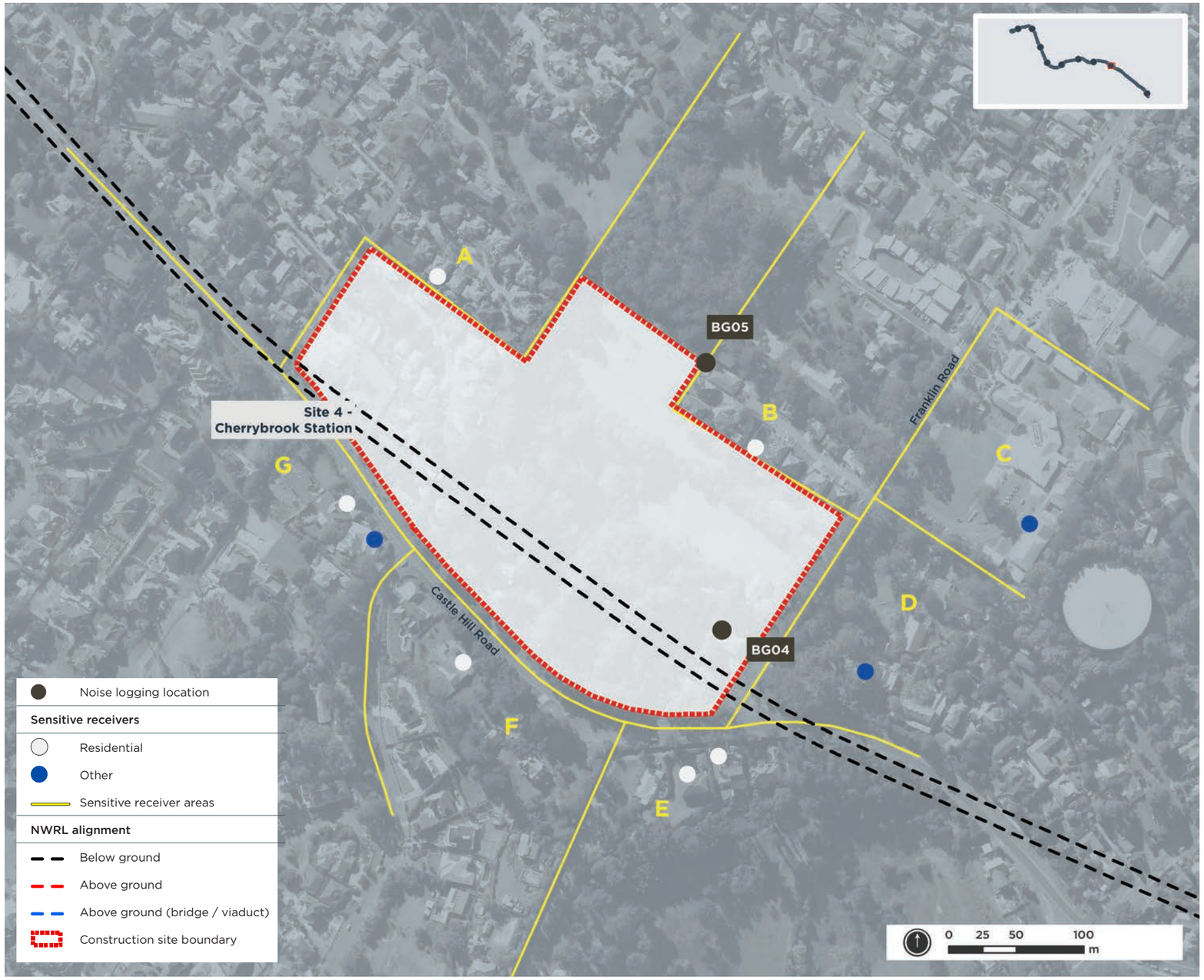
The findings of the construction noise impact assessment at Cheltenham Services Facility indicate:

- The predicted noise levels for construction of the services building and supporting structure, and for the installation of rail systems equipment, indicate exceedances of the NMLs of up to 10 dB for these 2 scenarios at the nearest receivers in Area B.
- At all other receivers, compliance with the NMLs is predicted.

Vibration impacts associated with bulk excavation works were assessed and reported within EIS 1. For the works proposed for EIS 2, no vibration impacts are predicted for the Cheltenham Services Facility site.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Cheltenham Services Facility. In this instance, the access and egress to and from the site would be via either the M2 motorway or Kirkham Roads which are arterial and sub-arterial roads with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.10 Cherrybrook Station Construction Site and Receiver Areas



Cherrybrook Station

Cherrybrook Station construction site would be located adjacent to Castle Hill Road between Robert Road and Franklin Road.

Works at the Cherrybrook Station site would include the station platform, support structure and building construction. In addition, car parking areas would be constructed north of the station. Rail systems works would include installation of track work, overhead wiring and station and tunnel ventilation equipment.

An aerial photograph of the proposed Cherrybrook Station site and the surrounding receiver areas is provided in **Figure 10.10**, with the nearest noise sensitive receivers identified in **Table 10.23**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.23**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG04 and BG05. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Castle Hill Road, other local roads and natural sources.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.24** for each construction scenario.

The findings of the construction noise impact assessment at Cherrybrook Station indicate:

- The predicted noise levels for construction of the car park indicate high exceedances of the NMLs at the residential areas adjacent to the site. The NMLs are exceeded by more than 20 dB at Areas A and B.
- There are minor exceedances during station platform supporting structure and station building construction at residential Areas A, B, G and at the Kindalin childcare centre. Compliance is predicted at the remaining residential areas and the two schools.
- During the installation of rail systems equipment, predicted noise levels indicate minor exceedances of the NMLs during the daytime period at residential Areas A, B, G and the Kindalin childcare centre. Compliance is predicted at the remaining residential areas, as well as at the two schools.

Table 10.23 Nearest Noise Sensitive Receivers – Cherrybrook Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Residences on Robert Road and Oliver Way to the east and north	Residential	7	47	43	35
B	Residences on Kayla Way to the north-east	Residential	7	47	43	35
C	Tangara School	Educational (School)	130	55	N/A	N/A
D	Inala School	Educational (School)	80	55	N/A	N/A
E	Residences on and south of Castle Hill Road, east of Staley Circuit	Residential	35	55	46	39
F	Residences south of Castle Hill Road, between Staley Circuit and Glenhope Road	Residential	35	55	46	39
G	Residences south of Castle Hill Road, west of Glenhope Road	Residential	30	55	46	39
H	Kindalin Childcare Centre	Childcare	30	50	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.24 Predicted noise level exceedances at Cherrybrook Station

Receiver Area		Noise Modelling Scenario		
		Station platform supporting structure, station building construction	Car park construction	Installation of rail systems equipment
A	Residences on Robert Road and Oliver Way to the West and North			
B	Residences on Kayla Way to the north-east			
C	Tangara School			
D	Inala School			
E	Residences on and south of Castle Hill Road, east of Staley Circuit			
F	Residences south of Castle Hill Road, between Staley Circuit and Glenhope Road			
G	Residences south of Castle Hill Road, west of Glenhope Road			
H	Kindalin Childcare Centre			

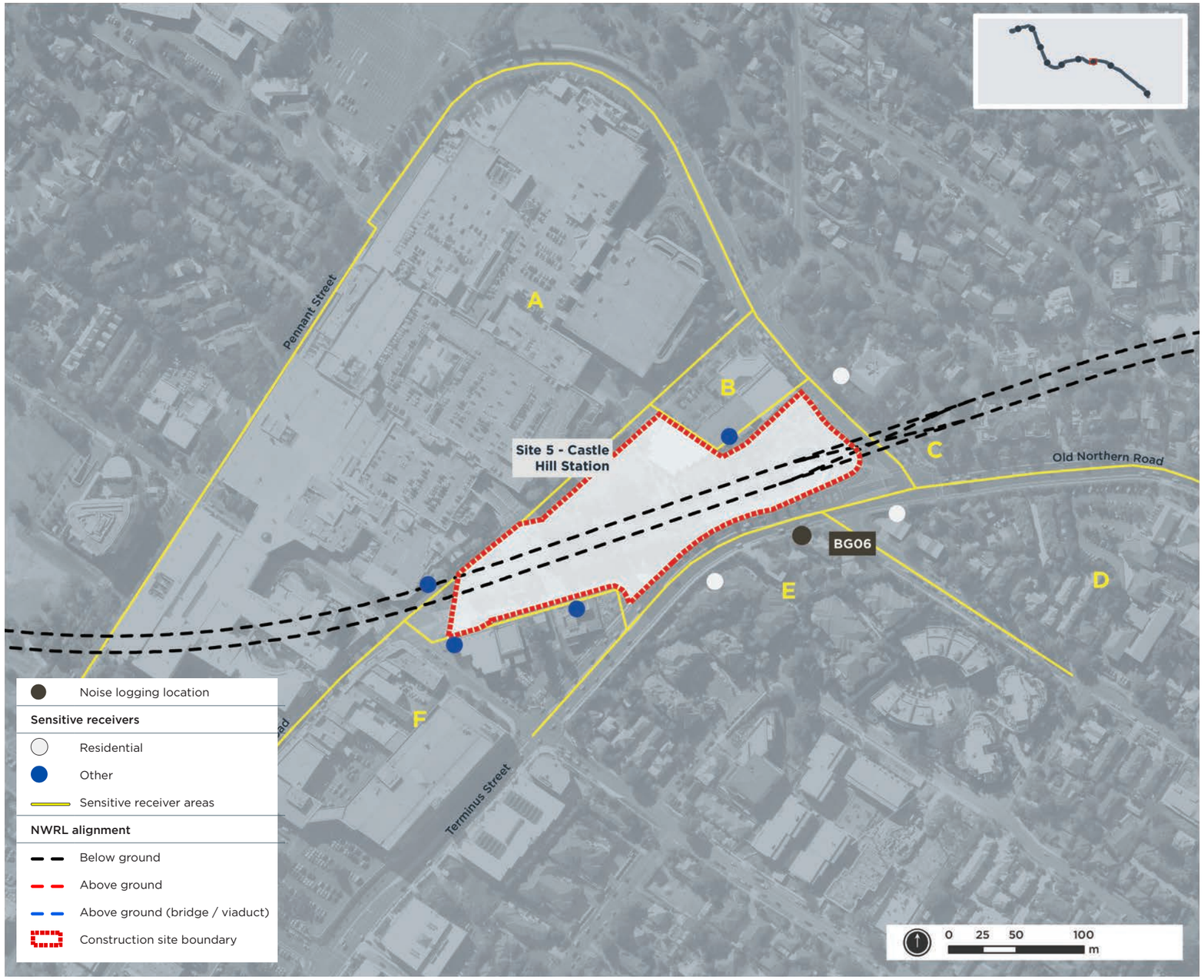
Note: Approximate durations: station structural works 12 months, car park and precinct works 12 months, rail systems installation 12 months (followed by testing and commissioning).

❖ Where receivers are "highly noise affected" (ie where the predicted noise levels exceed 75 dBA) or the NMLs are exceeded by more than 20 dB, the proponent may need to implement respite periods and liaise with the community as outlined in Section 11.2 of the Noise and Vibration Technical Paper (Technical Paper 3). The CNVS would be implemented to manage the potential noise impacts. At Cherrybrook Station this is anticipated to occur during the construction of the car parks north of the station.

During vibratory roller activities at the Cherrybrook Station car park sites, vibration levels may be perceptible at the nearest residential receivers. On the basis that the nearest residential buildings are approximately 15 metres from the proposed car park areas, vibration levels are anticipated to be remain well below the safe vibration levels associated with minor cosmetic building damage.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Cherrybrook Station site. In this instance the access and egress to and from the site would be via Castle Hill Road which is a sub-arterial road with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.11 Castle Hill Station Construction Site and Receiver Areas



Castle Hill Station

Castle Hill Station construction site would be located within Arthur Whitling Park and part of Old Northern Road reserve.

Works at the Castle Hill Station site would include the station platform, support structure and building construction. In addition there would be works associated with the re-instatement of Old Northern Road and bus parking to be constructed south of the station. Rail systems works would include installation of track work, overhead wiring and station and tunnel ventilation equipment to the north east of the station.

An aerial photograph of the proposed Castle Hill Station site and the surrounding receiver areas is provided in **Figure 10.11**, with the nearest noise sensitive receivers identified in **Table 10.25**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.25**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Location BG06. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Northern Road, other surrounding roads and mechanical plant at nearby shopping centres.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.26** for each construction scenario.

The findings of the construction noise impact assessment at Castle Hill Station indicate:

- The predicted noise levels for construction of the station platform supporting structure and station building indicate a minor exceedance of up to 10 dB at commercial Area B. Compliance is predicted at the other commercial receivers and all residential areas.
- During the installation of rail systems equipment compliance is predicted at all residential and commercial receivers.

Table 10.25 Nearest Noise Sensitive Receivers – Castle Hill Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Commercial NW Castle Hill Shopping Centre	Commercial	20	70	N/A	N/A
B	Commercial adjoining North	Commercial	2	70	N/A	N/A
C	Residences McMullen Avenue North East	Residential	30	60	52	36
D	Residences Brisbane Road South East	Residential	46	60	52	36
E	Residences Old Northern Road South	Residential	35	60	52	36
F	Commercial Old Northern Road South	Commercial	10	70	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.26 Predicted noise level exceedances at Castle Hill Station

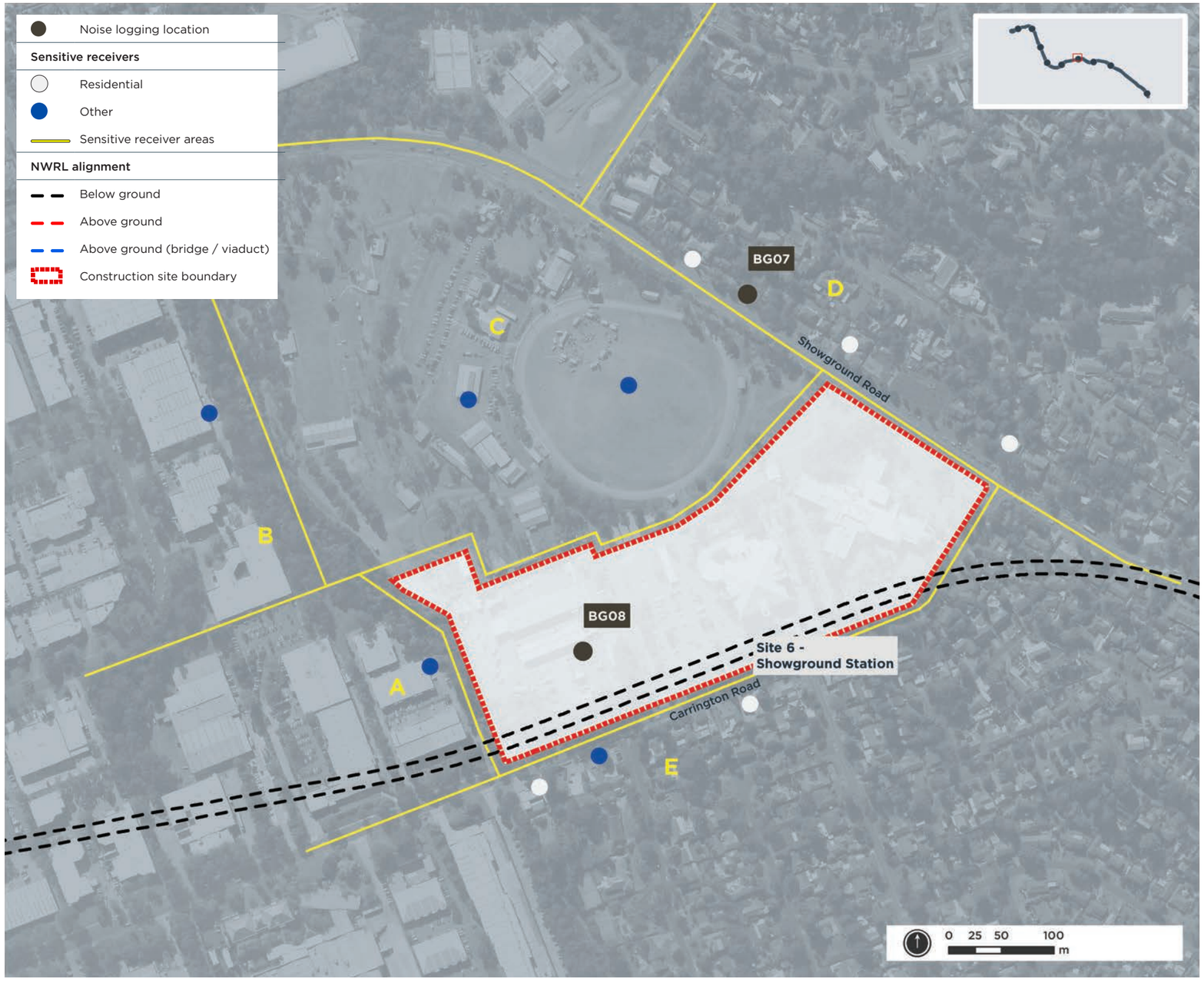
Receiver Area		Noise Modelling Scenario	
		Station platform supporting structure, station building construction and roadworks	Installation of rail systems equipment
A	Commercial NW Castle Hill Shopping Centre		
B	Commercial adjoining North		
C	Residences Garthowen Crescent and Old Northern Road North East		
C	Commercial McMullen Avenue North East		
D	Residences Brisbane Road South East		
E	Residences Old Northern Road South		
F	Commercial Old Northern Road South		

Note: Approximate durations: station structural works 9 months, rail systems installation 12 months (followed by testing and commissioning).

During vibratory roller activities associated with the reinstatement of bus parking and old northern road at the Castle Hill Station, vibration levels may be perceptible at the nearest commercial receivers. On the basis that the nearest buildings are approximately 10 metres from the proposed works, vibration levels are anticipated to remain below the safe vibration levels associated with minor cosmetic building damage.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Castle Hill Station Site. In this instance the access and egress to and from the site would be via Old Northern Road and Terminus Street, which are sub-arterial roads with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.12 Showground Station Construction Site and Receiver Areas



Showground Station

Showground Station construction site would be located within the existing Castle Hill Showground complex and The Hills Shire Council depot.

Works at the Showground Station site would include the station platform, support structure and building construction. In addition a multilevel car park would be constructed west of the station. Rail systems works would include installation of track work, overhead wiring and station and tunnel ventilation equipment.

An aerial photograph of the proposed Showground Station site and the surrounding receiver areas is provided in **Table 10.12**, with the nearest noise sensitive receivers identified in **Table 10.27**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.27**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG07 and BG08. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Carrington Road, Showground Road and other local roads.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.28**.

The findings of the construction noise impact assessment at Showground Station indicate:

- The predicted noise levels for construction of the station platform supporting structure, station building and car park as well as for the installation of rail systems indicate compliance with the NMLs at both the commercial and residential areas adjacent to the site.
- At the childcare centre there is a moderate exceedance of 11 dB during construction of the station platform supporting structure, station building and car park and a minor exceedance of 6 dB during the installation of rail systems.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.27 Nearest Noise w Receivers – Showground Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Commercial adjoining South West	Commercial	35	70	N/A	N/A
B	Commercial adjoining North West	Commercial	140	70	N/A	N/A
C	Active Recreation – Castle Hill Showground	Active Recreation	5	65	N/A	N/A
D	Residences Showground Road North East	Residential	40	64	53	35
E	Residences Carrington Road South	Residential	30	64	50	39
F	Childcare Carrington Road South	Childcare	30	50	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Table 10.28 Predicted noise level exceedances at Showground Station

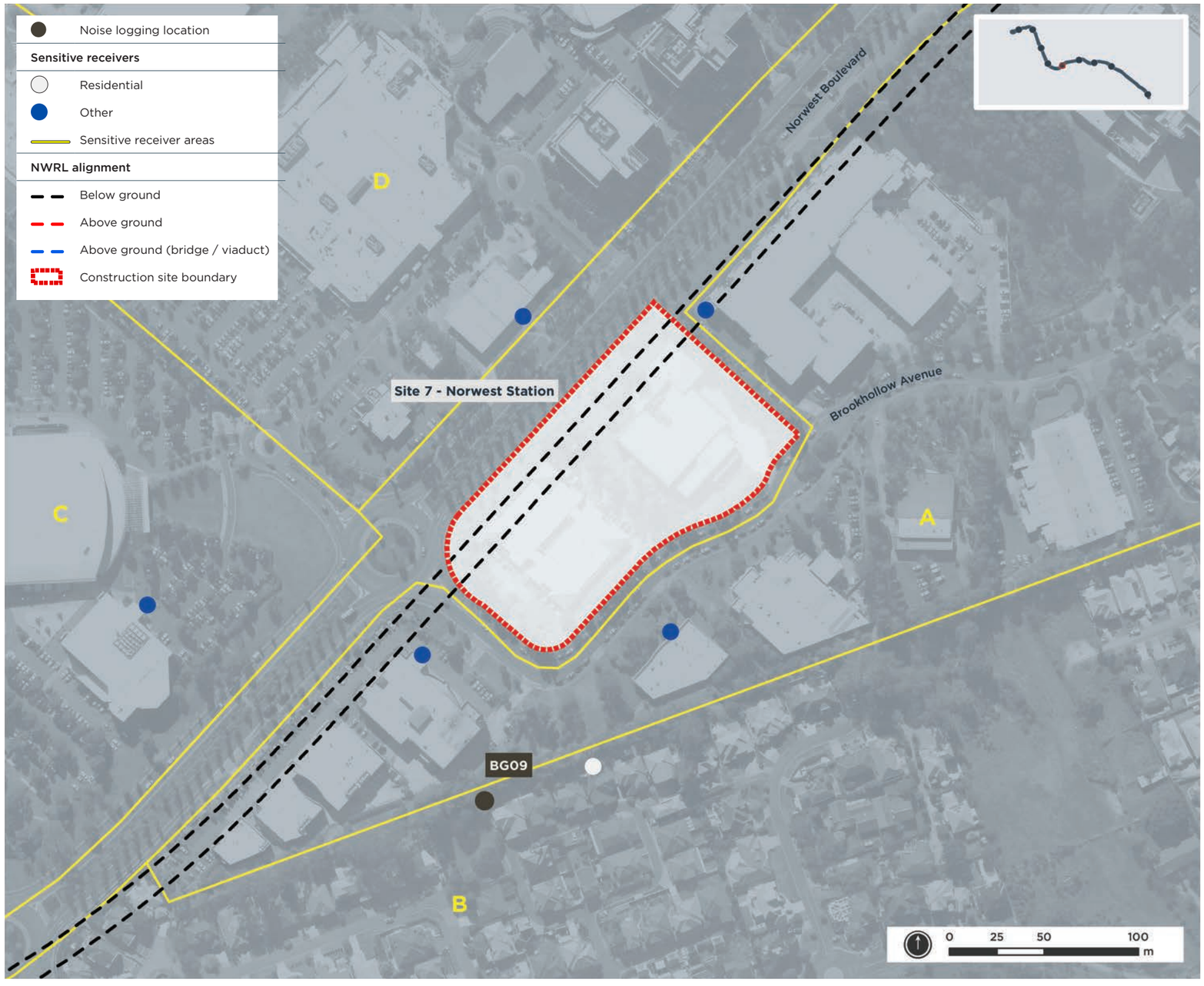
Receiver Area		Noise Modelling Scenario	
		Station platform supporting structure, station building construction and car park	Installation of rail systems equipment
A	Commercial adjoining SW		
B	Commercial adjoining NW		
C	Active Recreation – Castle Hill Showground		
D	Residences Showground Road North East		
E	Residences Carrington Road South		
F	Childcare Carrington Road South		

Note: Approximate durations: station structural works 9 months, rail systems installation 12 months (followed by testing and commissioning).

During vibratory roller activities at the Showground Station access roads, vibration levels may be perceptible at the nearest commercial receivers. On the basis that the nearest buildings are approximately 10 metres from the proposed access roads, vibration levels are anticipated to be below the safe vibration levels associated with minor cosmetic building damage.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Showground Station site. In this instance, the access and egress to and from the site would be via Showground Road and Carrington Road, which are sub-arterial roads with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.13 Norwest Construction Site and Receiver Areas



Norwest Station

Norwest Station construction site would be located adjacent to Norwest Boulevard opposite the Norwest Shopping Centre.

Works at the Norwest Station site would include the station platform, support structure and building construction. Access to the excavation would be via the services / support access at each end of the station box, with concreting and rail systems activities at these areas. Rail systems works would include installation of track work, overhead wiring and station and tunnel ventilation equipment south east of, and at each end of the station.

An aerial photograph of the proposed Norwest Station site and the surrounding receiver areas is provided in **Figure 10.13**, with the nearest noise sensitive receivers identified in **Table 10.29**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.29**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Location BG09. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Norwest Boulevard and mechanical services noise from the nearby shopping centre and commercial buildings.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.30** for each construction scenario

The findings of the construction noise impact assessment at Norwest Station indicate:

- The predicted noise levels for construction of the station building and support structure as well as for the installation of rail systems equipment indicate compliance with the NMLs at the nearest residential and commercial receivers and at the Hillsong church.

Table 10.29 Nearest Noise Sensitive Receivers – Norwest

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Commercial	Commercial	15	70	N/A	N/A
B	Residences	Residential	65	57	50	43
C	Hillsong Church site (church)	Other (Church)	150	65	65	-
C	Hillsong Church site (recording studio)	Other (Church)	150	65	65	-
D	Commercial	Commercial	15	70	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.30 Predicted noise level exceedances at Norwest Station

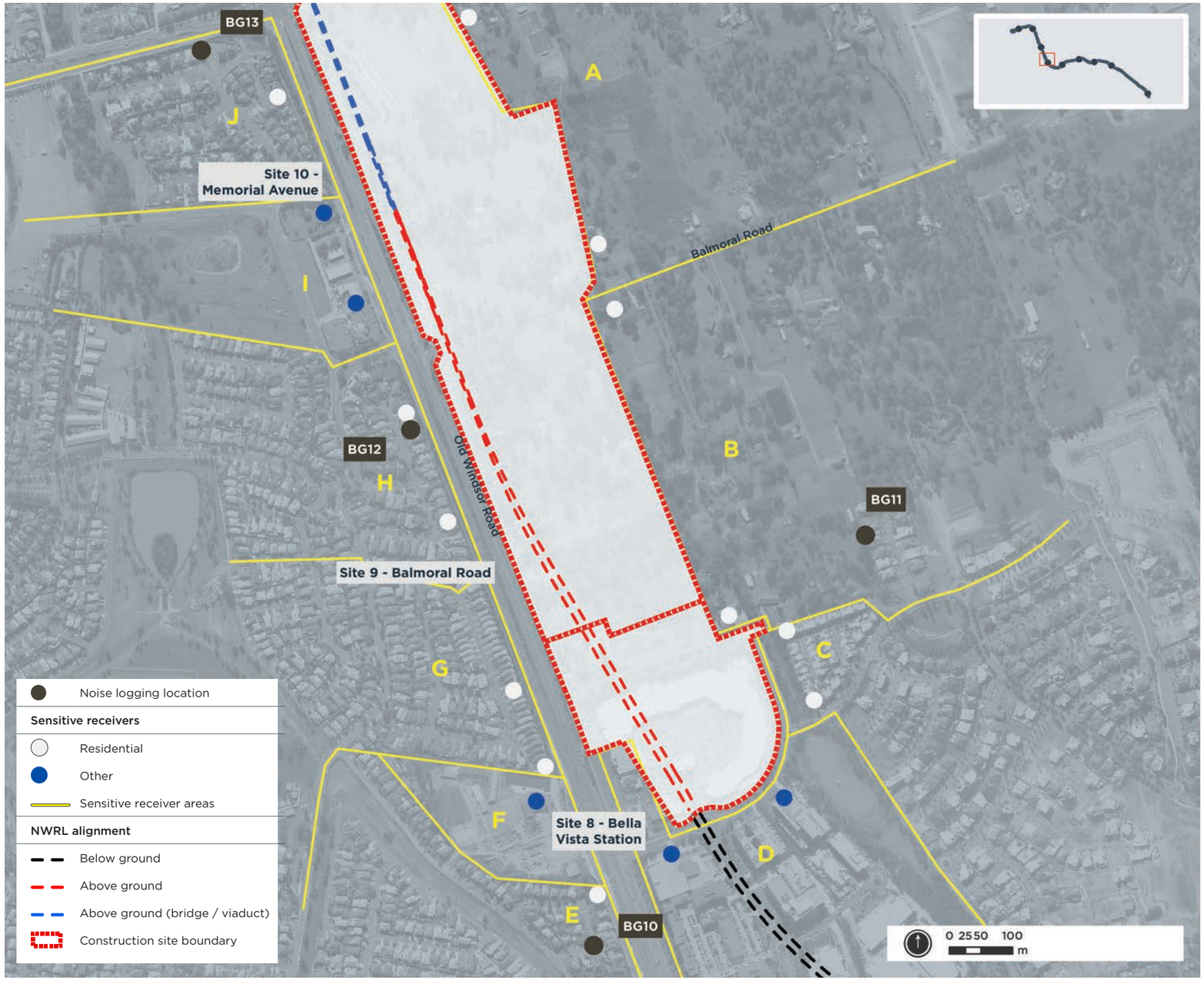
Receiver Area		Noise Modelling Scenario	
		Station platform supporting structure, station building construction	Installation of rail systems equipment
A	Commercial adjoining south		
B	Residences to the south		
C	Hillsong Church including recording studio		
D	Commercial adjoining north		

Note: Approximate durations: station structural works 12 months, rail systems installation 12 months (followed by testing and commissioning).

Vibration impacts associated with bulk excavation works were assessed and reported within EIS 1. For the works proposed for EIS 2, no vibration impacts are predicted for the Norwest Station site.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Norwest Station site. In this instance, the access and egress to and from the site would be via Norwest Boulevard and Windsor Road which are sub-arterial roads with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.14 Bella Vista Station and Receiver Areas



Bella Vista Station

Bella Vista Station construction site would be located on the corner of Old Windsor Road and Celebration Drive.

Works at the Bella Vista station site would include the station platform, support structure and building construction, as well as the station roof structure. Rail systems works would include installation of track work, overhead wiring and station and tunnel ventilation equipment.

An aerial photograph of the proposed Bella Vista Station site and the surrounding receiver areas is provided in **Figure 10.14**. The nearest noise sensitive receivers are identified in **Table 10.31**. Whilst the site extends to Memorial Avenue to the north west, activities would be primarily at the station.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.31**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG10, BG11, BG12 and BG13. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Windsor Road and other local roads.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.32** for each construction scenario.

The findings of the construction noise impact assessment at the Bella Vista site indicate:

- The predicted noise levels for construction of the station platform, supporting structures and station building construction as well as for the installation of rail systems equipment indicate compliance with the NMLs at the nearest residential and commercial receivers.

Vibration impacts associated with the major civil construction works (eg bulk excavation works) were assessed and reported within EIS 1. For the works proposed for EIS 2, no vibration impacts are predicted for the Bella Vista Station site.

Table 10.31 Nearest Noise Sensitive Receivers – Bella Vista

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Residential adjoining east	Residential	570	46	40	36
B	Residential adjoining east	Residential	25	46	40	36
C	Residential east of Celebration Drive (Waterstone Crescent and Jardine Terrace)	Residential	15	46	40	36
D	Commercial on Old Windsor Road adjacent to the south west	Commercial	10	70	N/A	N/A
E	Residential on Old Windsor Road to the south west	Residential	20	56	50	41
F	Other (church) on Old Windsor Road to the south west	Other (Church)	30	65	65	-
G	Residential on Old Windsor Road to the west (Sharrock Avenue)	Residential	75	61	53	38
H	Residential on Old Windsor Road to the west (Emmanuel Terrace)	Residential	175	61	53	38
I	Commercial on Old Windsor Road to the west (Amona Street)	Commercial	610	70	N/A	N/A
J	Residential on Old Windsor Road to the west (Rothwell Circuit)	Residential	800	61	55	39

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

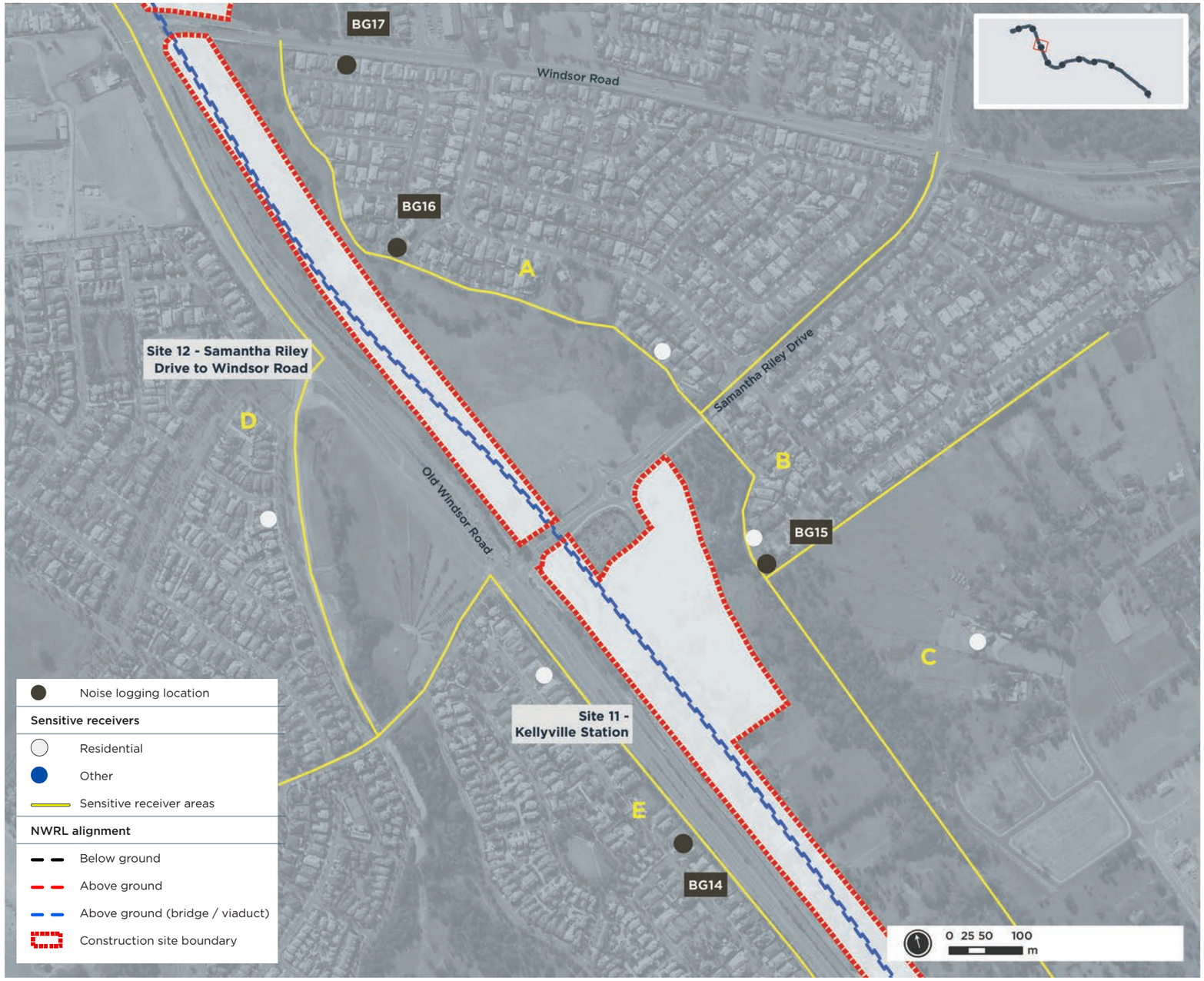
Table 10.32 Predicted noise level exceedances at Bella Vista Station

Receiver Area		Noise Modelling Scenario	
		Station platform supporting structure, station building construction	Installation of rail systems equipment
A	Residential adjoining east		
B	Residential adjoining east		
C	Residential on Celebration Drive		
D	Commercial on Old Windsor Road adjacent to the south west		
E	Residential on Old Windsor Road to the south west		
F	Other (church) on Old Windsor Road to the south west		
G	Residential on Old Windsor Road to the west (Sharrock Avenue)		
H	Residential on Old Windsor Road to the west (Emmanuel Terrace)		
I	Commercial on Old Windsor Road to the west (Amona Street)		
J	Residential on Old Windsor Road to the west (Rothwell Circuit)		

Note: Approximate durations: station structural works 9 months, rail systems installation 12 months (followed by testing and commissioning).

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Bella Vista Station site. In this instance the access and egress to and from the site would be via Celebration Drive and Windsor Road which are local and sub-arterial roads, noting the relevant section of Celebration Drive is north of the Brighton Drive roundabout. The existing flows on Celebration Drive north of Brighton Drive are not available however they are estimated to be low, as only two or three residential properties are accessed. The noise level from daytime movements to the site has been predicted to comply with the local road criterion of 55 dBA to the residences on Celebration Drive.

Figure 10.15 Kellyville Station Construction Site and Receiver Areas



Kellyville Station

The Kellyville Station construction site currently encompasses a T-Way car park, bus station and open space. The station would be located within the viaduct with escalators, lifts and fire stairs providing access to the ground level.

Works at the Kellyville Station site would include the station platform, escalator, lift, fire stairs and building construction. In addition, there would be works associated with the T-Way car park and new car parks west of the station. Rail systems works would include installation of tracks and overhead wiring.

An aerial photograph of the proposed Kellyville Station site and the surrounding receiver areas is provided in **Figure 10.15**, with the nearest noise sensitive receivers identified in **Table 10.33**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.33**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG14, BG15 and BG16. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Windsor Road.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.34** for each construction scenario.

The findings of the construction noise impact assessment at the Kellyville Station site indicate:

- The predicted noise levels for construction of the station platform supporting structure, station building, escalator / lift / stair and car park indicate a minor exceedance of up to 10 dB at residential Area B. Compliance is predicted at all the other residential receiver areas.
- During the installation of rail systems equipment compliance is predicted at all residential receivers.

Table 10.33 Nearest Noise Sensitive Receivers – Kellyville Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Residences on Bridget Place north	Residential	140	49	44	44
B	Residences on Landy Place east	Residential	75	49	44	44
C	Residences on Arnold Avenue east	Residential	315	49	44	44
D	Residences on Ludlow Street west	Residential	335	55	50	42
E	Residential on Old Windsor Road west	Residential	80	55	50	42

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.34 Predicted noise level exceedances at Kellyville Station

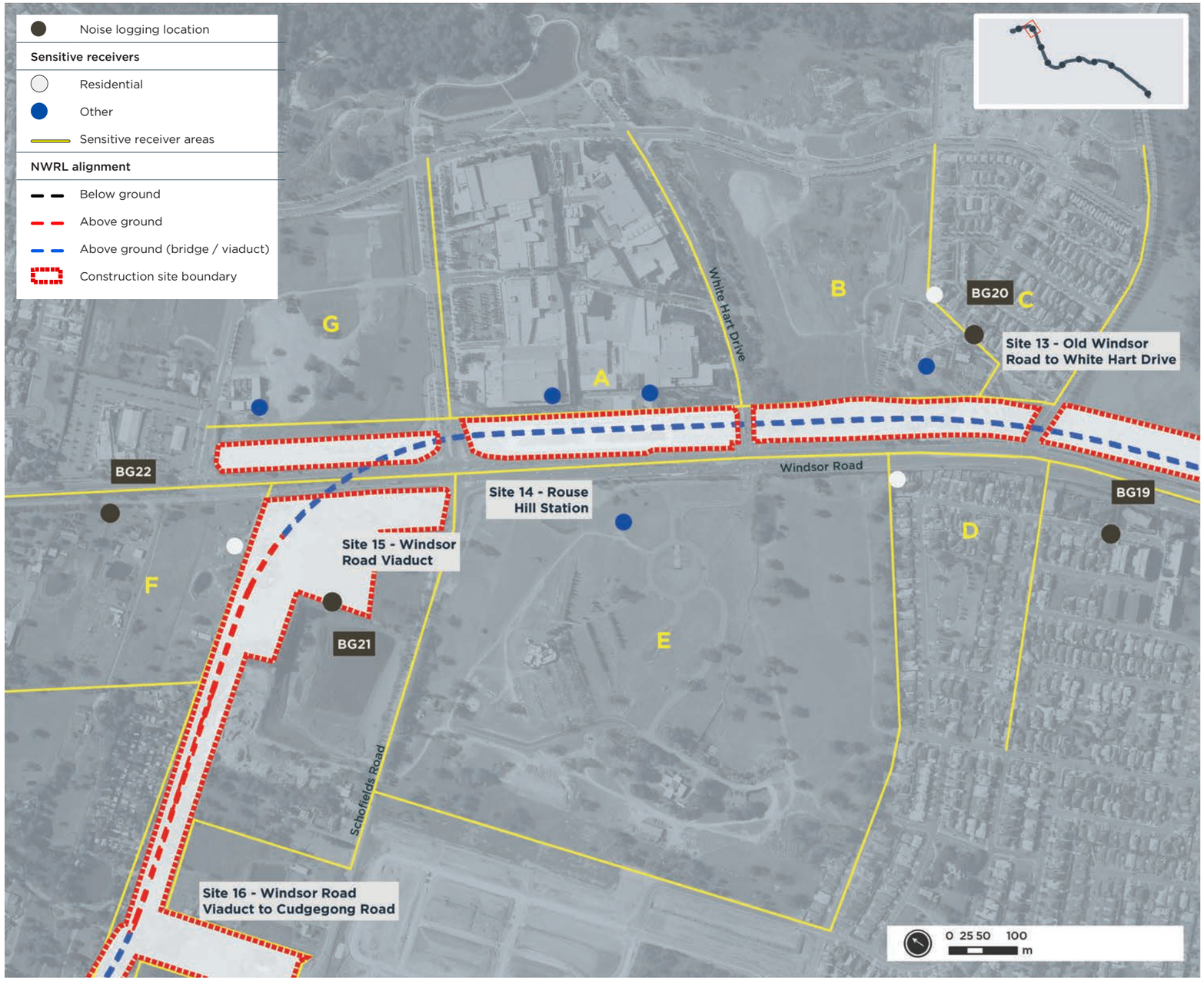
Receiver Area		Noise Modelling Scenario	
		Station platform supporting structure, station building construction and escalator / lift / stairs	Installation of rail systems equipment
A	Residential on Bridget Place north		
B	Residential on Landy Place east		
C	Residential on Arnold Avenue east		
D	Residential on Ludlow Street west		
E	Residential on Old Windsor Road west		

Note: Approximate durations: station structural works 12 months, rail systems installation 12 months (followed by testing and commissioning).

Vibration impacts associated with major civil works (eg bulk excavation works) were assessed and reported within EIS 1. For the works proposed for EIS 2, no vibration impacts are predicted for the Kellyville Station site.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Kellyville Station site. In this instance the access and egress to and from the site would be via Samantha Riley Drive and Windsor Road which are sub-arterial roads with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.16 Rouse Hill Station Construction Site and Receiver Areas



Rouse Hill Station

The Rouse Hill Station construction site currently encompasses a T-Way bus station and car park. The station would be located within the viaduct with escalators, lifts and fire stairs providing access to the ground level.

Works at the station site would include the station platform, escalator, lift, fire stairs and building construction. In addition there would be works associated with the reinstatement of the T-Way bus station and car park. Rail systems works would include installation of tracks and overhead wiring.

Access and egress to and from the site would be via Windsor Road, with one point located near White Hart Drive and one near Rouse Hill Drive. An internal access road would be provided between these two points.

An aerial photograph of the proposed Rouse Hill Station site and the surrounding receiver areas is provided in **Figure 10.16**, with the nearest noise sensitive receivers identified in **Table 10.35**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.35**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG19, BG20, BG21 and BG22. The ambient noise environment at the nearest sensitive receivers is primarily controlled by road traffic on Old Windsor Road.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.36** for each construction scenario.

The findings of the construction noise impact assessment at the Rouse Hill Station site indicate:

- The predicted noise levels for construction of the station platform supporting structure, station building, escalator / lift / stair and car park as well as for the installation of rail systems equipment indicate compliance with the NMLs at the nearest residential and commercial receivers.

Table 10.35 Nearest Noise Sensitive Receivers – Rouse Hill Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Commercial adjacent north east	Commercial	20	70	N/A	N/A
B	Active recreation south east	Active Recreational (tennis & playground)	260	65	65	N/A
C	Residential south east	Residential	370	51	46	38
D	Residential south	Residential	240	62	54	37
E	Passive recreation Cemetery south	Other (passive recreation)	160	60	N/A	N/A
F	Residential north west	Residential	380	61	56	44
G	Commercial to the north	Commercial	300	70	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Table 10.36 Predicted noise level exceedances at Rouse Hill Station

Receiver Area		Noise Modelling Scenario	
		Station platform supporting structure, station building construction and escalator / lift / stairs	Installation of rail systems equipment
A	Commercial adjacent north east		
B	Active recreation south east		
C	Residential south east		
D	Residential south		
E	Passive recreation Cemetery south		
F	Commercial to the north		
G	Commercial to the north		

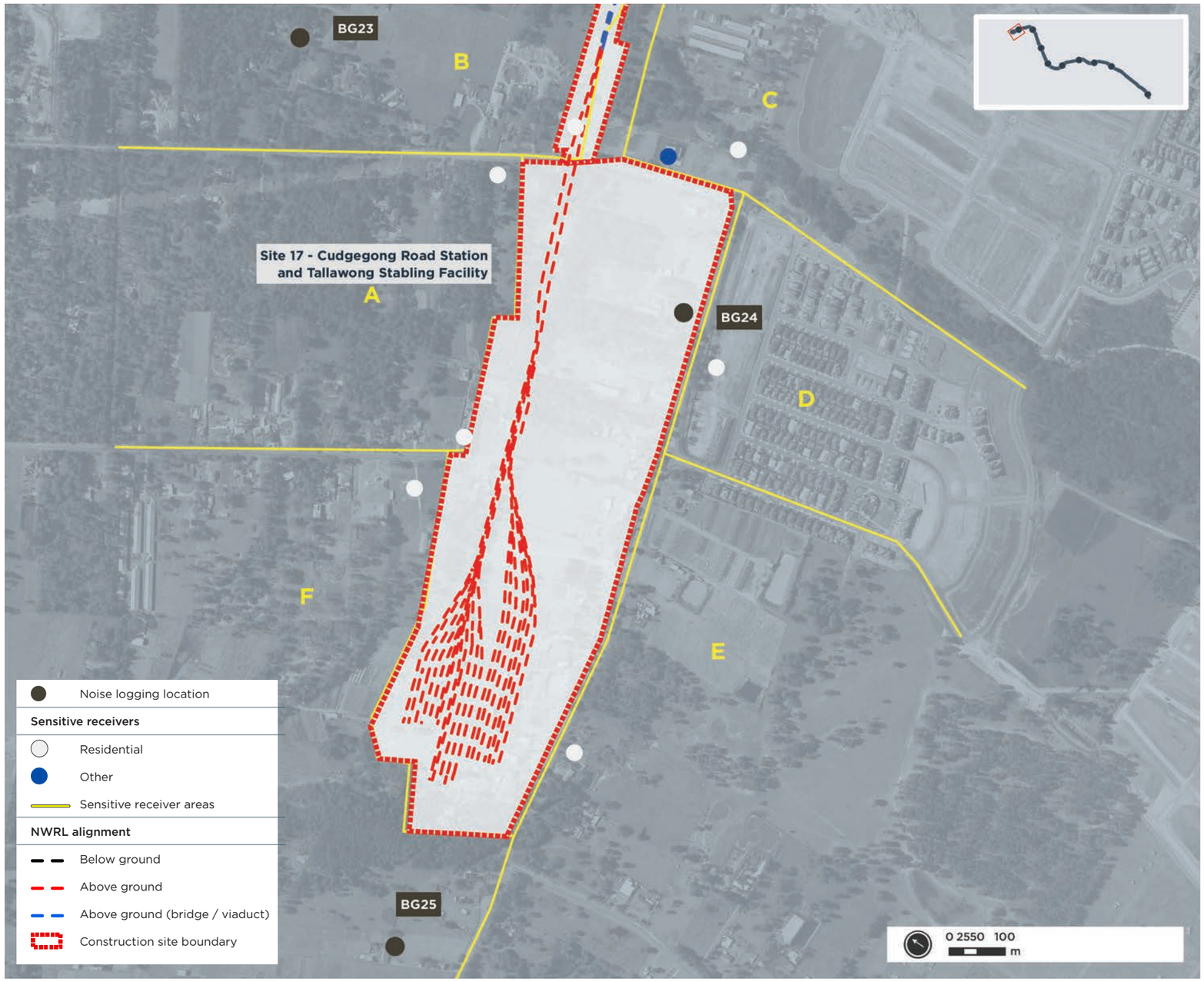
Note: Approximate durations: station structural works 12 months, rail systems installation 15 months (followed by testing and commissioning).

Vibration impacts are not anticipated to be appreciable at the nearest residential and commercial receivers.

The Reading cinema complex is located approximately 40 metres from the proposed construction works at the closest point. The highest ground-borne noise levels are anticipated to be associated with vibratory roller activities. Ground-borne noise levels from the operation of vibratory rolling equipment may be audible within the cinemas and it is recommended that measurements be conducted to assist in evaluating and managing impacts in conjunction with the cinemas when the works commence.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Rouse Hill Station site. In this instance, the access and egress to and from the site would be via Windsor Road which is a sub-arterial road with significant existing daytime flows, hence project increases result in compliance with the 2 dB allowance.

Figure 10.17 Cudgegong Road Station and Train Stabling Facility Construction Site and Receiver Areas



Cudgegong Road Station and Train Stabling Facility

The Cudgegong Road Station / train stabling facility construction site is currently predominantly rural. Construction works at the train stabling facility would involve installation of ballast, tracks and buildings as well as overhead wiring. Landscaping works would occur at the completion of the train stabling facility construction works.

Works at the Cudgegong Road Station site would include the station platform, escalator, lifts, fire stairs and building construction. In addition there would be works associated with the new car parks to the south of the station. Rail systems works would include installation of tracks and overhead wiring.

Access and egress to and from the sites would be directly on and off Cudgegong Road, Tallawong Road and Schofields Road. Internal access roads would be established along the entire length of the site adjacent to the alignment.

An aerial photograph of the proposed Cudgegong Road Station site, train stabling and facility site and the surrounding receiver areas is provided in **Figure 10.17**, with the nearest noise sensitive receivers identified in **Table 10.37**.

A summary of the nearest sensitive receiver areas and NMLs is provided in **Table 10.37**. At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG23, BG24 and BG25 (to the west of the stabling facility. The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.38** for each construction scenario.

The findings of the construction noise impact assessment for construction of the Cudgegong Road Station and train stabling facility indicate:

- During the installation of ballast, tracks, the construction of buildings and the rail systems installation works at the train stabling facility, predicted noise levels indicate compliance with the NMLs at all receivers.

Table 10.37 Nearest Noise Sensitive Receivers – Cudgegong Road Station and Tallawong Stabling Facility

Receiver Area		Receiver Type	Location Relative to Works (m)[1]		$L_{Aeq(15minute)}$ (dBA) Construction NMLs		
			Train Stabling Facility	Cudgegong Road Station	Daytime	Evening	Night-time
A	Residences north of the site, between Tallawong Road and Cudgegong Road	Residential	70	135	54	48	39
B	Residences north of the site, between Cudgegong Road and Terry Road	Residential	55	55	54	48	39
C	Residences south of the site, between Cudgegong Road and the west border of Castlebrook Lawn Cemetery and Crematorium	Residential	210	210	55	54	43
D	Residences south of Schofields Road, between Cudgegong Road and the west border of 80 Schofields Road	Residential	135	250	55	54	43
E	Residences south of Schofields Road and west of the west border of 80 Schofields Road	Residential	75	800	53	49	35
F	Residences North of Schofields Road and west of Tallawong Road	Residential	140	420	53	49	35

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.38 Predicted noise level exceedances at Cudgegong Road Station and Tallawong Stabling Facility

Receiver Area		Noise Modelling Scenario			
		Installation of ballast, tracks and construction of buildings - train stabling facility	Rail systems installation – train stabling facility	Station construction including car parks - Cudgegong Road Station only	Station rail systems - Cudgegong Road Station only
A	Residences north of the site, between Tallawong Road and Cudgegong Road				
B	Residences north of the site, between Cudgegong Road and Terry Road				
C	Residences south of the site, between Cudgegong Road and the west border of Castlebrook Lawn Cemetery and Crematorium				
D	Residences south of Schofields Road, between Cudgegong Road and the west border of 80 Schofields Road				
E	Residences south of Schofields Road and west of the west border of 80 Schofields Road				
F	Residences North of Schofields Road and west of Tallawong Road				

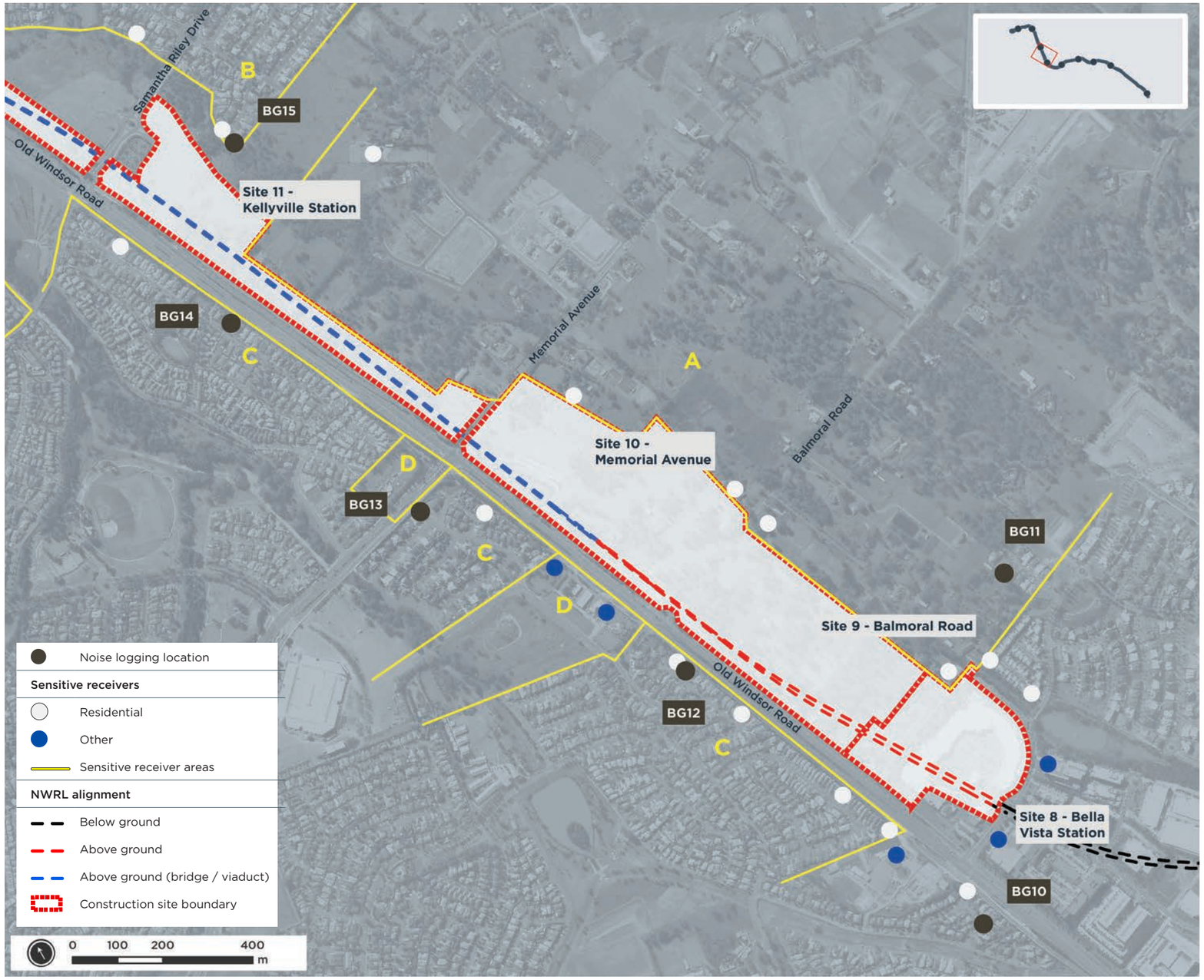
Note: Approximate durations: stabling facility installation 18 months, station structural works 12 months, rail systems installation 15 months (followed by testing and commissioning).

During Cudgegong Road Station construction and the installation of rail systems, predicted noise levels indicate compliance at all receivers.

During vibratory roller activities at the Cudgegong Road Station car park sites, vibration levels are anticipated to be well below the safe vibration levels associated with minor cosmetic building damage.

Traffic noise levels have been predicted for residential receivers located on the proposed access and egress routes to and from the Cudgegong Road Station and Tallawong Stabling Facility site. In this instance the access and egress to and from the site would be via Schofields Road which is a sub-arterial road with significant daytime flows. The assessment results in compliance with the 2 dB allowance.

Figure 10.18 Bella Vista Station to Kellyville Station Construction Site and Receiver Areas



Bella Vista Station to Cudgegong Road Station – Surface Construction Works

The Bella Vista Station to Cudgegong Road Station section of the route would comprise cuttings, embankments and above ground sections of track. The civil works assessed in this section include rail placement and rail systems installation, noting that the major civil works (including the viaduct construction) would have already been completed.

The assessment of this section has been separated into three sub-sections, Bella Vista Station to Kellyville Station, Kellyville Station to Rouse Hill Station and Rouse Hill Station to Cudgegong Road Station.

Bella Vista Station to Kellyville Station

An aerial photograph of the surface track section between Bella Vista Station and Kellyville Station, and the surrounding receiver areas is provided in **Figure 10.18**, with the nearest noise sensitive receiver areas and NMLs provided in **Table 10.39**.

At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG13, BG14 and BG15. The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.40** for each construction scenario.

The findings of the construction noise impact assessment for Bella Vista to Kellyville Station indicate:

- At residences in the Areas A, B and C similar noise levels are predicted, and these noise levels for concrete pouring, installation of stanchions and track construction exceed the NMLs by 8 dB, 4 dB and 7 dB for the Areas A, B and C respectively. This is considered to be a minor exceedance. During overhead wiring installation compliance is predicted at all residential areas.

Table 10.39 Nearest Noise Sensitive Receivers – Bella Vista Station to Kellyville Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Residences east of Old Windsor Road, from the north section of Arnold Avenue to the corner of Old Windsor Road and Celebration Drive	Residential	160	49	46	44
B	Residences east of Old Windsor Road and south of Samantha Riley Drive	Residential	205	49	46	44
C	Residences west of Old Windsor Road, between Newbury Avenue and the north border of the Emmanuel Baptist Church	Residential	85	57	53	43
D	Commercial sites west of Old Windsor Road, on Sunnyholt Road and on Old Windsor Road	Commercial	85	70	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

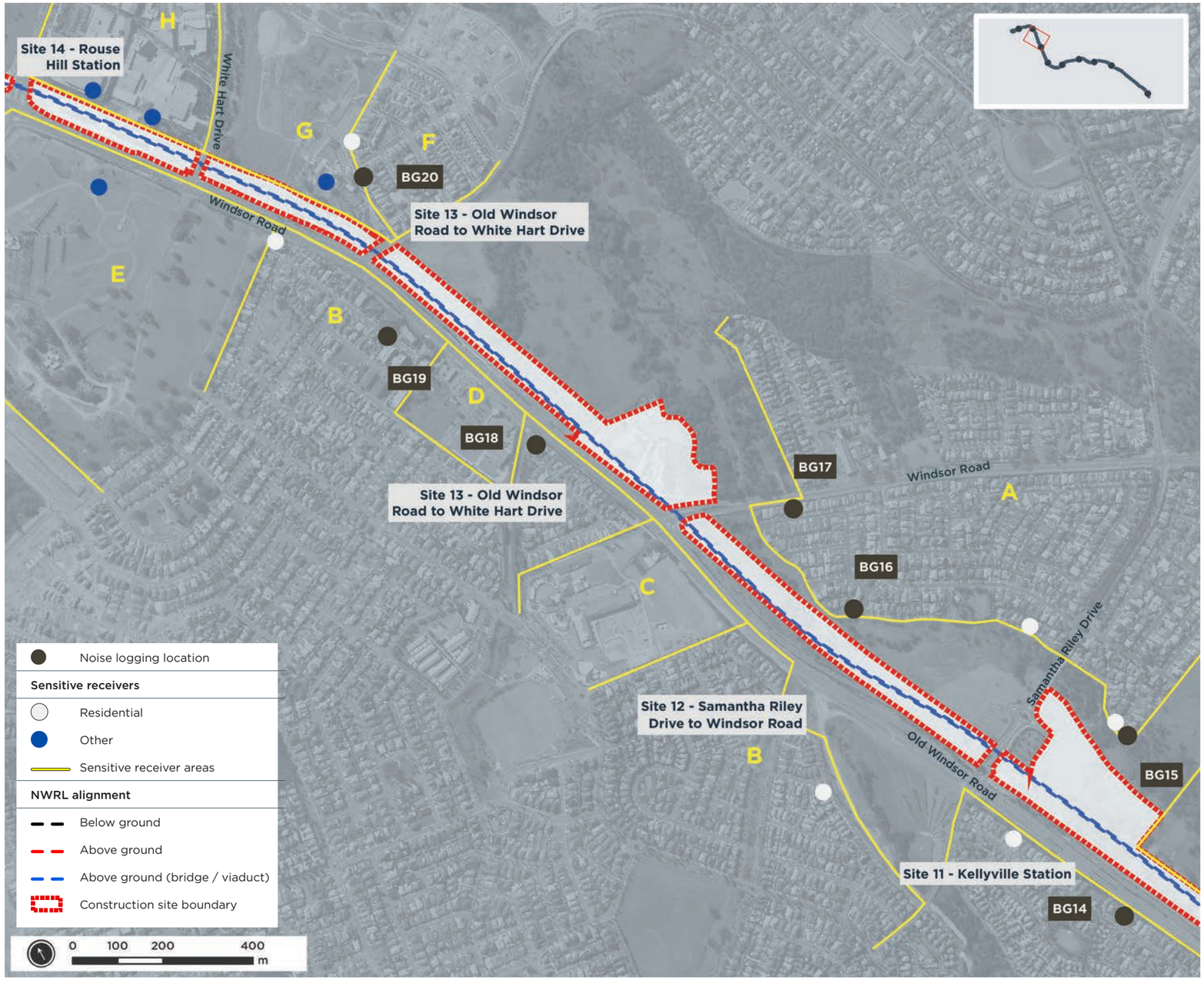
Table 10.40 Table 1040 Predicted noise level exceedances Bella Vista Station to Kellyville Station

Receiver Area		Noise Modelling Scenario	
		Concrete pouring, installation of stanchions and track construction	Overhead wiring installation
A	Residences east of Old Windsor Road, from the north section of Arnold Avenue to the north border of the Celebration Drive shopping centre		
B	Residences east of Old Windsor Road and south of Samantha Riley Drive		
C	Residences west of Old Windsor Road, between Newbury Avenue and the north border of the Emmanuel Baptist Church		
D	Commercial sites west of Old Windsor Road, on Sunnyholt Road and on Old Windsor Road		

Note: Approximate durations: Exceedances of the construction NMLs during track construction and overhead wiring works are expected to be of relatively short duration, in the order to 2 to 4 weeks in total.

- Residences in Area C are adjacent to Old Windsor Road and existing traffic noise levels are generally similar in level to those predicted for construction activities. No appreciable construction noise impact is therefore predicted in this area.
- At the commercial receivers for Area D compliance is predicted for all scenarios.

Figure 10.19 Kellyville Station to Rouse Hill Station Construction Site and Receiver Areas



Kellyville Station to Rouse Hill Station

An aerial photograph of the surface track section between Kellyville Station and Rouse Hill Station, and the surrounding receiver areas is provided in **Figure 10.19**, with the nearest noise sensitive receiver areas and NMLs provided in **Table 10.41**.

At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG16, BG19, BG20, BG21 and BG22. The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.42** for each construction scenario.

The findings of the construction noise impact assessment indicate:

- Residential Area A – there are high exceedances of up 17 dB during concrete pouring, installation of stanchions and track construction and up to 10 dB during overhead wiring installation. These exceedances are due to the nearest residences being relatively close to the works.
- Residential Area B – there are minor exceedances of up 2 dB during concrete pouring, installation of stanchions and track construction, and no exceedance during overhead wiring installation. These residences are also predicted to experience construction noise levels that would be similar to those from existing traffic on Old Windsor Road, hence construction noise would be less noticeable. No appreciable construction noise impact is therefore predicted in this area.
- Educational Area C – there are no exceedances during concrete pouring, installation of stanchions and track construction, and during overhead wiring installation. The school is also predicted to experience construction noise levels that would be similar to those from existing traffic on Old Windsor Road, hence construction noise would be less noticeable. No appreciable construction noise impact is therefore predicted in this area.

Table 10.41 Nearest sensitive receivers to Kellyville Station to Rouse Hill Station Viaduct

	Receiver Area	Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ (dBA) Construction NMLs		
				Daytime	Evening	Night-time
A	Residences east of Old Windsor Road, between the group of residences north east of the Windsor Road / Old Windsor Road junction and Samantha Riley Drive	Residential	30	55	51	42
B	Residences west of Old Windsor Road, between Newbury Avenue and the south border of Castlebrook Lawn Cemetery and Crematorium	Residential	80	62	54	37
C	John XXIII Catholic Primary School	Educational (School)	185	55	N/A	N/A
D	Commercial sites west of Windsor Road, on Windsor Road and on Old Windsor Road	Commercial	85	70	N/A	N/A
E	Castlebrook Lawn Cemetery and Crematorium	Other (passive recreation)	280	60	N/A	N/A
F	Residences east of Windsor Road, between Bellcast Road and Sanctuary Drive	Residential	35	51	46	38
G	Recreation area east of Windsor Road, between White Hart Drive, Sanctuary Drive and Bellcast Road	Active Recreational (tennis & playground)	60	65	65	N/A
H	Commercial site east of Windsor Road, between Rouse Hill Drive and White Hart Drive	Commercial	45	70	N/A	N/A

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.42 Predicted noise level exceedances Kellyville Station to Rouse Hill

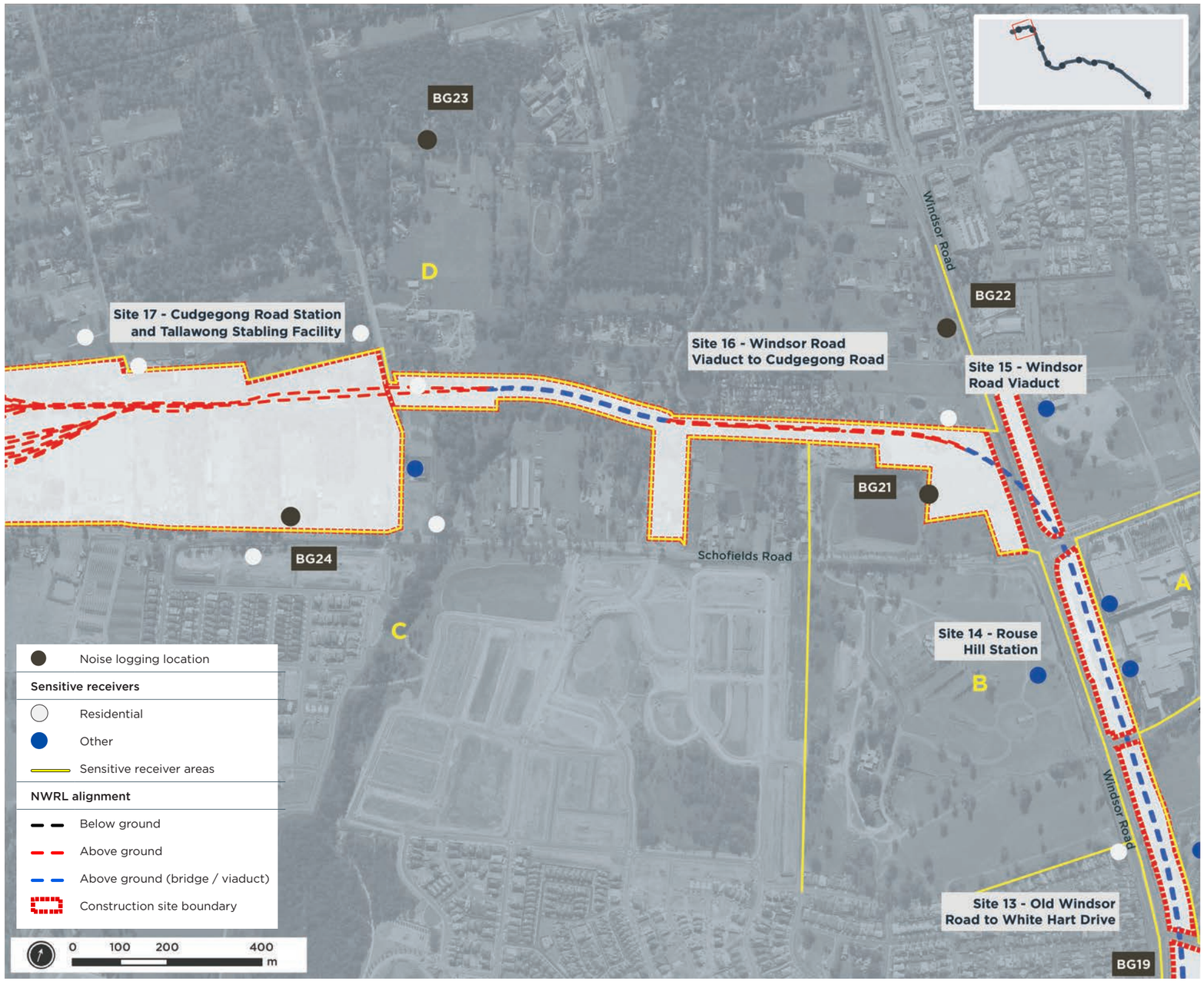
	Receiver Area	Noise Modelling Scenario	
		Station platform supporting structure, station building construction	Installation of rail systems equipment
A	Residences east of Old Windsor Road, between the group of residences north east of the Windsor Road / Old Windsor Road junction and Samantha Riley Drive		
B	Residences west of Old Windsor Road, between Newbury Avenue and the south border of Castlebrook Lawn Cemetery and Crematorium		
C	John XXIII Catholic Primary School		
D	Commercial sites west of Windsor Road, on Windsor Road and on Old Windsor Road		
E	Castlebrook Lawn Cemetery and Crematorium		
F	Residences east of Windsor Road, between Bellcast Road and Sanctuary Drive		
G	Recreation area east of Windsor Road, between White Hart Drive, Sanctuary Drive and Bellcast Road		
H	Commercial site east of Windsor Road, between Rouse Hill Drive and White Hart Drive		

Note: Approximate durations: exceedances of the construction NMLs during track construction and overhead wiring works are expected to be of relatively short duration, in the order to 2 to 4 weeks in total.

- At commercial Area D compliance is predicted, as well as at passive recreation Area E. There is a minor exceedance of 2 dB predicted during concrete pouring, installation of stanchions and track construction, and compliance during overhead wiring installation.
- Residential Area F – there are high exceedances of up to 22 dB during concrete pouring, installation of stanchions and track construction, and up to 14 dB during overhead wiring installation. These exceedances are due to the nearest residences being relatively close to the works.
- At passive recreation Area G there is a minor exceedance of 2 dB predicted during concrete pouring, installation of stanchions and track construction, and compliance during overhead wiring installation.
- At commercial Area H compliance is predicted during concrete pouring, installation of stanchions and track construction, and during overhead wiring installation.

Where receivers are "highly noise affected" (i.e. where the predicted noise level exceeds 75 dBA) or the NMLs are exceeded by more than 20 dB, the proponent may need to implement respite periods and liaise with the community as outlined in Section 11.2 of the Noise and Vibration Technical Paper (Technical Paper 3). The CNVS would be implemented to manage the potential noise impacts. For the Kellyville Station to Rouse Hill section this is anticipated to occur during concrete pouring, installation of stanchions and track construction for Residential Area E.

Figure 10.20 Rouse Hill Station to Cudgegong Road Station Construction Site and Receiver Areas



Rouse Hill Station to Cudgegong Road Station

An aerial photograph of the surface track section between Rouse Hill Station and Cudgegong Road Station, and the surrounding receiver areas is provided in **Figure 10.20**, with the nearest noise sensitive receiver areas and NMLs provided in **Table 10.43**.

At this site, the NMLs were established on the basis of the ambient noise monitoring undertaken at Locations BG21, BG22 and BG23. The ambient noise environment at the nearest sensitive receivers is primarily controlled by traffic movements on local roads and other natural noise sources.

A summary of the predicted noise level exceedances at the nearest sensitive receivers is provided in **Table 10.44** for each construction scenario.

The findings of the construction noise impact assessment for the Rouse Hill Station to Cudgegong Road Station section indicate:

- At commercial Area A, there is a moderate exceedance of 5 dB during concrete pouring, installation of stanchions and track construction, and compliance during overhead wiring installation.
- At passive recreation Area B there are no predicted exceedances.
- At residential Area C there are no predicted exceedances.
- Residential Area D – there are high exceedances of up 36 dB during concrete pouring, installation of stanchions and track construction, and up to 33 dB during overhead wiring installation. These exceedances are due to the nearest residences (including the OK Caravan Park) being relatively close to the works.

Table 10.43 Nearest sensitive receivers Rouse Hill Station to Cudgegong Road Station

Receiver Area		Receiver Type	Location Relative to Works (m)[1]	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
				Daytime	Evening	Night-time
A	Commercial sites east of Windsor Road, north of White Hart Drive	Commercial	25	70	N/A	N/A
B	Castlebrook Lawn Cemetery and Crematorium	Other (passive recreation)	280	60	N/A	N/A
C	Residences south of the site and west of Windsor Road	Residential	200	61	56	44
D	Residences north of the site and west of Windsor Road	Residential	5	54	48	39

Note 1: The relative distance to works shown is that from the nearest sensitive receiver to the closest location of construction activity.

Compliance

≤ 10 dB exceedance

10 dB to ≤ 20 dB exceedance

> 20 dB exceedance or LAeq(15minute) > 75 dBA

Table 10.44 Predicted noise level exceedances Rouse Hill Station to Cudgegong Road Station

Receiver Area		Noise Modelling Scenario	
		Concrete pouring, installation of stanchions and track construction	Overhead wiring installation
A	Commercial sites east of Windsor Road, north of White Hart Drive		
B	Castlebrook Lawn Cemetery and Crematorium		
C	Residences south of the site and west of Windsor Road		
D	Residences north of the site and west of Windsor Road		

Note: Approximate durations: exceedances of the construction NMLs during track construction and overhead wiring works are expected to be of relatively short duration, in the order to 2 to 4 weeks in total.

As discussed above, the CNVS would be implemented to manage the potential noise impacts where receiver are "highly noise affected". For the Rouse Hill Station to Cudgegong Road section this is anticipated to occur during concrete pouring, installation of stanchions and track construction, and overhead wiring installation for the residences in Area D (residences north of the site and west of Windsor Road).

No vibration impacts are predicted for the existing buildings and structures adjacent to the proposed rail alignment between Bella Vista Station and Tallawong Road Stabling Facility.

10.11.8 Road Bridge Construction Works

The civil work assessed in this section is the construction of the road bridge over the rail corridor at Balmoral Road. The proposed bridges at Tallawong Road and Cudgegong Road were included in the assessment for EIS 1.

The Balmoral Road Bridge would be located approximately 45 metres east of Old Windsor Road and north of Bella Vista Station.

The nearest residential receivers are located on Emmanuel Terrace to the west and on Balmoral Road to the east, with the works 90 metres and 240 metres from these receivers respectively. There are also commercial receivers to the west typically 90 metres from the works.

Site Specific Construction Noise Management Levels

With reference to the project NMLs and the ambient noise survey results, the site specific construction NMLs are presented in **Table 10.45**.

Table 10.45 Balmoral Road Bridgeworks Construction NMLs

Receiver Area	Receiver Type	Relevant Monitoring Location	$L_{Aeq(15minute)}$ Construction NMLs (dBA)		
			Daytime	Evening	Night-time
A	Residential west	BG14	57	53	43
B	Residential east	BG15	49	46	44
C	Commercial west	BG14	70	N/A	N/A

Noise Assessment at the Nearest Noise Sensitive Receivers

A scenario corresponding to the nosiest construction phase was modelled. The predicted $L_{Aeq(15minute)}$ noise levels at the nearest noise sensitive receivers (at ground floor level) are summarised in **Table 10.46**.

Table 10.46 Balmoral Road Bridgeworks Predicted $L_{Aeq(15minute)}$ Construction Noise Levels

Receiver Area	Receiver Type	$L_{Aeq(15minute)}$ Construction Noise Levels (dBA)
A	Residential west	54
B	Residential east	43
C	Commercial west	54

The findings of the construction noise impact assessment for construction of the viaduct from Bella Vista to Kellyville Station indicate:

- At the nearest residences and commercial receivers, compliance with the NMLs is predicted at all residential areas. No appreciable construction noise impact is therefore predicted for the Balmoral Road Bridge construction works.

10.11.9 Construction Works in Tunnels

EIS 1 assessed the potential noise and vibration impacts from the construction of the twin tunnels from Epping to Bella Vista. As part of EIS 2, construction activities related to the fit out of the twin tunnels, including construction of the tunnel floor concrete slab, installation of the permanent rail tracks, installation of the overhead wiring system and all other associated mechanical and electrical systems.

It is assumed that construction would first commence with the tunnel floor concrete slab and then progress to the installation of the permanent rail tracks. This would likely be used to transport construction equipment and workers through the tunnels using hi-rail vehicles or work trains.

As the design of the permanent rail tracks includes operational ground-borne noise and vibration mitigation (ie higher attenuation track form in areas where the alignment is shallower – see Section 10.7), the potential impacts from the use of construction work vehicles, which would be travelling at considerably slower speeds than the passenger trains, are likely to be minimal.

After construction of the track form all of the remaining tunnel systems would be fitted out. This would likely require the use of handheld equipment such as drills, grinders and saws for the majority of the required activities. When considering the type of equipment necessary for these works and given that the works would likely only be in a certain location for a short duration, the potential impacts are likely to be minimal for the majority of the alignment. Notwithstanding, these works would need to consider all feasible and reasonable mitigation measures at locations where a risk that adverse ground-borne noise and / or vibration impacts may occur.

10.12 Summary of Mitigation Measures

10.12.1 Operation

An OEMP will be developed detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures in **Table 10.47** have been developed to avoid, reduce and manage identified potential operational impacts.

Table 10.47 Noise and Vibration Operational Mitigation Measures

No.	Mitigation Measure	Applicable Areas
OpNV1	The implementation of feasible and reasonable noise and vibration mitigation measures such as: ▪ One metre high noise barriers with absorptive facing provided between Bella Vista Station and Cudgegong Road Station, except where the track is in cutting. ▪ For the viaduct section, noise barriers located on the outer edge of both sides of the structure. ▪ For the surface track, noise barriers positioned as close as possible to the train taking into account access and safety requirements.	Bella Vista Station to Cudgegong Road Station
OpNV2	The implementation of feasible and reasonable noise and vibration mitigation measures such as: ▪ A two metre high noise barrier with absorptive facing provided on the side adjacent to the OK Caravan Park. Noise barriers positioned as close as possible to the train taking into account access and safety requirements. ▪ A two metre high noise barrier provided opposite OK Caravan Park in the vicinity of the crossovers.	Rouse Hill Station to Cudgegong Road Station
OpNV3	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Rail dampers provided between Kellyville Station and Cudgegong Road Station, except in the immediate vicinity of stations where train speeds are lower.	Kellyville Station to Cudgegong Road Station
OpNV4	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Resilient rail fasteners provided on the viaduct and rail bridges.	Viaduct and bridges
OpNV5	During detailed design, options would be investigated to reduce airborne noise along the viaduct and surface track sections where exceedances have been predicted.	Bella Vista Station to Cudgegong Road Station
OpNV6	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Investigate the option of managing train speeds between Kellyville Station and Rouse Hill Station. The investigation would consider factors such as the impact to journey times and the receivers existing noise exposure from road traffic.	Kellyville Station to Rouse Hill Station
OpNV7	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Standard, high and very high track attenuation provided through the tunnel section as shown indicatively in **Figure 10.3**.	Tunnels
OpNV8	The implementation of feasible and reasonable noise and vibration mitigation measures such as: The design of the sheds and equipment for the train wash and wheel lathe facilities would include noise mitigation as required in order to comply with the applicable noise criteria at the nearest noise sensitive receivers.	Tallawong Stabling Facility
OpNV9	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Investigate the option to incorporate silencers in the compressed air lines of the rolling stock to reduce noise associated with brake air release events.	Tallawong Stabling Facility
OpNV10	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Investigate methods to minimise rolling stock auxiliary noise levels during procurement.	Tallawong Stabling Facility
OpNV11	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Noise sources at stations such as PA systems, air conditioners, substations and mechanical plant would be designed to meet the INP noise criteria.	Stations
OpNV12	The implementation of feasible and reasonable noise and vibration mitigation measures such as: Options would be investigated as part of the detailed design to reduce noise impacts from the operational car parks at Cherrybrook and Showground.	Cherrybrook and Showground Stations
OpNV13	A detailed assessment of the road traffic noise impacts, including identification of preferred mitigation measures for the station access roads at Cherrybrook and Kellyville would be undertaken during detailed design.	Cherrybrook and Kellyville Stations

10.12.2 Construction

The Construction Environmental Management Framework, provided in Appendix B, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Mitigation measures have been developed to avoid, reduce and manage identified potential operational and construction traffic impacts. These mitigation measures and their application to the NWRL are presented in **Table 10.48** below.

As discussed above in Section **10.11.6**, a threefold approach to mitigating noise and vibration impacts is proposed for the construction phase of the NWRL. This approach includes the identification of feasible and reasonable mitigation measures at each construction site. The effects of these measures are included in the noise modelling results in the previous sections.

In addition to the site specific measures, a standard suite of mitigation measures would be implemented across all NWRL construction sites via the CNVS (refer Appendix J of Technical Paper 3). Where noise and vibration levels are predicted to remain above the noise and vibration management levels, the final approach is to implement the additional mitigation and management measures documented in the CNVS.

Table 10.48 Noise and Vibration Construction Mitigation Measures

No.	Mitigation Measure	Site*
Construction		
NV1	Noise and vibration mitigation measures described in the Construction Noise and Vibration Strategy would be implemented (refer Appendix J of Technical Paper 2).	All
NV5	Three metre high noise barriers (site hoardings) would be constructed around the perimeter of construction sites.	1 – 3, 5 – 7 and 14
NV6	Six metre high barriers would be constructed at Cherrybrook to manage night-time spoil truck movements.	4
NV7	Three metre high noise barriers (site hoardings) would be constructed at Bella Vista Station site on the north and eastern side of the main construction site and to the west of the station box.	8
NV8	Attended vibration monitoring would be undertaken at the nearest commercial building during high vibration activities to ensure vibration levels remain below safe limits.	1 and 5 – 7
NV9	Attended vibration monitoring would be undertaken at the nearest residential buildings during high vibration activities to ensure vibration levels remain below safe limits.	1, 3 and 4
NV10	Noise measurements in the Gold Class cinema complex at Castle Hill during high vibration activities would be undertaken to determine ground-borne noise levels. Depending on the results of this monitoring, discussions would be held with the cinema managers to identify additional feasible and reasonable mitigation measures such as respite period and use of alternative equipment.	5
NV13	Night-time truck access at Bella Vista Station site would be via the Celebration Drive roundabout to the south of the site.	8
NV16	Noise attenuation measures would be implemented where reasonable and feasible on tunnel ventilation equipment and other items of fixed plant (eg pumps, water treatment plant, diesel generators) that would be required to operate on a 24 hour per day, seven day per week basis in support of the underground works (eg ventilation fan enclosures and silencers, and additional enclosures and silencers for diesel generating equipment). At each site, the combined L_{Aeq} noise from the operation of this equipment would aim to not exceed the rating background level at nearest residential receivers.	1-10
NV18	A site management and / or physical mitigation solution would be implemented at the Epping Services Facility to ensure noise levels from onsite heavy vehicle movements during the night-time period comply with the sleep disturbance NML. This may include restricting night-time heavy vehicle access from Beecroft Road directly into the acoustic sheds and the establishment of a dedicated unloading bay directly adjacent to Beecroft Road for night-time deliveries.	1

Site 1 - Epping Services Facility, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility, and Tunnels

CHAPTER 11

EUROPEAN HERITAGE

11 EUROPEAN HERITAGE

11.1 Introduction

A European Heritage Report was prepared by Godden Mackay Logan (GML) which assessed the impacts on European heritage from the construction and operation of the stations and rail infrastructure associated with the NWRL project (refer to Technical Paper 4).

11.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 11.1 sets out the Director-General's Requirements, the Conditions of Approval and Statement of Commitments as they relate to European Heritage, and where in the project these have been addressed.

Table 11.1 Director-General's Requirements, Conditions of Approval and Statements of Commitment

Reference	Description	Addressed
Director General's Requirements		
Director-General's Requirements **31 August 2012**	Potential visual and cultural landscape impacts on historic heritage items.	Section 11.5
Conditions of Approval		
3.15	The Proponent shall review the European Heritage impacts of the project, describing measures to minimise and / or appropriately manage impacts.	Section 11.5 and 11.6
Statement of Commitments		
30	Additional research would be undertaken to determine the history and potential heritage significance of the sites identified in Castle Hill. Site-specific archaeological assessments would be undertaken in the event that they are found to have heritage significance.	EIS1 Section 11.5
31	Site-specific archaeological assessments would be undertaken for the two archaeological sites identified along Old Windsor Road and Windsor Road.	EIS1 Section 11.5
32	A view analysis would be undertaken to and from Rouse Hill House and its estate and the Glenhope property. If required appropriate mitigation measures would be identified	Section 11.5, 11.6 and Section 16

11.3 Assessment Methodology

The methodology for the European Heritage Report undertaken for the project included:

- Review of heritage reports previously prepared for the NWRL project.
- Review of statutory heritage lists, including the State Heritage Register, heritage schedules on Local Environmental Plans (LEPs) and Regional Environmental Plans (REPs), State Agency Section 170 heritage and conservation registers and the Register of the National Estate, National Heritage List and Commonwealth Heritage List.
- Review of non-statutory heritage lists, including the National Trust Register and the Royal Australian Institute of Architects Register of Significant 20th Century Buildings.
- Review of relevant archaeological assessments and zoning plans as available.
- Desktop research and historical research, including a review of relevant conservation management plans and plans of management.
- Consultation with heritage advisors at local councils and state agencies regarding items on their heritage registers.
- Assessments of heritage significance for the assessed heritage items, including heritage curtilages and assessments of condition, based on the NSW heritage criteria as set out in the NSW Heritage Manual guideline Assessing Heritage Significance, prepared by the NSW Heritage Council 2002.
- Site inspections of the NWRL route undertaken by GML.

It should be noted that for the purpose of this assessment, existing environmental conditions are assumed to be those that exist upon completion of the major civil construction works (assessed in EIS 1).

11.4 Existing Environment

The European Heritage Report provides an historical overview of the districts through which the route of the NWRL passes as well as historically important areas close by. It also outlines the historical context, including a brief history of settlement and land use in those regions where the NWRL is to be built. Refer to Technical Paper 4 for details of the historical and heritage context for each site.

The heritage items and items of archaeological potential assessed as having the potential to be impacted by the NWRL for each site are outlined in **Table 11.2**.

Heritage items located within the broader vicinity of the NWRL corridor were assessed as being unlikely to be affected by the proposed construction and operations due to the nature of existing development in the vicinity and their distance from the works.

The existing European Heritage environment remains unchanged from EIS 1- Major Civil Construction Works and is described in **Table 11.2**.

Table 11.2 Potentially impacted heritage items and items of archaeological potential in the vicinity of the NWRL

No.	Item	Address	Listing	Archaeological Remains	Archaeological Potential
Epping Services Facility					
Heritage Item					
357	Bushland	Road Reserve, Beecroft Road between Carlingford Road and Kandy Avenue, Epping	Local (Hornsby LEP)	-	-
403	'Woodlands' House	25 Ray Road, Epping	Local (Hornsby LEP)	-	-
Archaeological Potential					
-	Stone causeway over Devlins Creek	Beecroft Road, Epping	Local (Hornsby LEP)	Aligned sandstones	High
Cheltenham Service Facility					
Heritage Item					
70	Bushland Reserve, Beecroft / Cheltenham Park	Castle Howard Road, Beecroft	Local (Hornsby LEP)	-	-
69	Street trees	Castle Howard Road, Beecroft	Local (Hornsby LEP)	-	-
-	Beecroft / Cheltenham Heritage Conservation Area	Area generally bounded by Boundary Road, Hull Road, Beecroft and Castle Howard Bushland Reserves and the suburb boundaries of Epping and North Epping	Local (Hornsby LEP)	-	-
Cherrybrook Station					
Heritage Item					
197	Glenhope	113 Castle Hill Road, west Pennant Hills	Local (Baulkham Hills LEP)	-	-
303	Inala School	160-168 Castle Hill Road, Cherrybrook	Local (Hornsby LEP)	-	-
Archaeological Potential					
-	House Site	Franklin Road, Cherrybrook	Noted in Casey and Lowe (2006)	Structural remains (postholes, timber posts), wells/cisterns, privies, refuse dumps, sand pits, scattered domestic and other artefacts, evidence of land cultivation.	Low
	House Site	Franklin Road, Cherrybrook	Noted in Casey and Lowe (2006)	Structural remains (postholes, timber posts), wells/cisterns, privies, refuse dumps, sand pits, scattered domestic and other artefacts, evidence of land cultivation.	Low
Castle Hill Station					
Heritage Item					
-	Arthur Whitling Park	Old Northern Road, Old Castle Hill Road and McMullen Avenue	Not listed	-	-
-	The White House Gallery (demolished mid 2012)	6 Mc Mullen Avenue, Castle Hill	Not listed	-	-

No.	Item	Address	Listing	Archaeological Remains	Archaeological Potential
Archaeological Potential					
	Parramatta to Castle Hill Tramway	Arthur Whitling Park	Noted in Casey and Lowe (2006)		It is considered unlikely that archaeological evidence associated with the former tramway and terminus still survives at the site.
Showground Station					
Heritage Item					
-	**Castle Hill Showground**	Showground Road, Castle Hill	Not listed	-	-
Archaeological Potential					
-	**House Site**	Off Carrington Road, Castle Hill	Noted in Casey and Lowe (2006)	Structural remains (remnant footings, postholes), services, wells/ cisterns, privies, refuse dumps and pits with artefacts.	Low-medium
-	**House Site**	Off Carrington Road, Castle Hill	Noted in Casey and Lowe (2006)	Structural remains (remnant footings, postholes), services, wells/ cisterns, privies, refuse dumps and pits with artefacts.	Low-medium
Norwest Station					
No heritage items or items of archaeological potential were identified within the Norwest Station area.					
Bella Vista Station					
Heritage Item					
-	**Bella Vista Farm**	Elizabeth Macarthur Drive, Bella vista	State Heritage Register	-	
Balmoral Road					
Heritage Item					
3252	**House**	36 Old Windsor Road (more recently 18 Cumberlege Lane), Kellyville	Not listed. Noted in *Windsor and Old Windsor Roads Conservation Management Plan* (Clive Lucas, Stapleton and Partners, 2005), however, has since been demolished.		
Memorial Avenue					
Archaeological Potential					
A number of boundary stones along Old Windsor Road were identified in the *Windsor Road and Old Windsor Road Conservation Management Plan* (Clive Lucas, Stapleton and Partners, 2005) to the north of Memorial Avenue. These boundary stones were most likely buried during construction of the North west T-way in the past decade.					

No.	Item	Address	Listing	Archaeological Remains	Archaeological Potential
Kellyville Station					
Heritage Item					
-	**Windsor Road and Old Windsor Road Heritage Precincts (Stanhope Farm Alignment)**	Windsor Road and Old Windsor Road	RTA S170 Heritage and Conservation Register (State significance)	-	-
Archaeological Potential					
-	**Archaeological site (Archaeological site item 74 or RH/35 or site no. 49- RTA European Heritage Item 4227)**	South from Samantha Riley Drive, Kellyville	Noted in Casey and Lowe (2006)	Structural remains (remnant footings, postholes), services, brick wells/cisterns, privies, refuse dumps and pits with artefacts.	Low-medium
-	**Pair of Boundary Markers**	80m south from Samantha Riley Drive, Kellyville	Noted in *Windsor and Old Windsor Roads Conservation Management Plan* (Clive Lucas, Stapleton and Partners, 2005)	Have been removed / reburied as part of North-West T-way (RTA comments)	Nil
-	**Pair of Boundary Markers**	Immediately South of Samantha Riley Drive, Kellyville	Windsor and Old Windsor Roads Conservation Management Plan (Clive Lucas, Stapleton and Partners, 2005	Have been removed/ reburied as part of North-West T-way (RTA comments)	Nil
-	**Site of the Battle of Vinegar Hill**	Kellyville	Memorial site listed in Blacktown LEP	Three possible locations: cemetery, the corner of Windsor and Old Windsor Roads, or on Old Windsor Road near Rouse Hill House. Potential scattered/lost personal and other artefacts	Low–nil
Samantha Riley Drive					
Heritage Item					
-	**Eucalyptus trees**	Old Windsor Road, north of Samantha Riley Drive	Windsor and Old Windsor Roads Conservation Management Plan (Clive Lucas, Stapleton and Partners, 2005)	-	-
Archaeological Potential					
	Boundary stones	Old Windsor Road, north of Samantha Riley Drive	*Windsor and Old Windsor Roads Conservation Management Plan* (Clive Lucas, Stapleton and Partners, 2005) Windsor Road and Old Windsor Road CMP (Clive Lucas, Stapleton and Partners, 2005)	-	The boundary stones were not visible during recent field surveys for EIS 1. GML determined that it is likely that they were buried or removed during construction of the North-West T-way.

No.	Item	Address	Listing	Archaeological Remains	Archaeological Potential
Old Windsor Road					
Heritage Item					
-	**Windsor Road and Old Windsor Road Heritage Precincts (WR 14—Caddies Creek Alignment)**	Windsor Road and Old Windsor Road	State (RTA S170 Heritage and Conservation Register)	-	-
183	**Mungerie**	Windsor Road (south of White Hart Drive), Rouse Hill	Local (Baulkham Hills LEP and DoP S170 Heritage and Conservation Register)	-	-
Archaeological Potential					
-	**Archaeological site, former Swan Inn (RH/36)**	Eastern side of Windsor Road, north of the intersection with Old Windsor Road	Local (Baulkham Hills LEP)	Structural remains (remnant footings, postholes), services, brick wells/cisterns, privies, refuse dumps and pits with artefacts.	Low – medium
Rouse Hill Station					
Heritage Item					
23	**Battle of Vinegar Hill (memorial)**	712 Windsor Road	Local (Blacktown LEP)	-	-
Windsor Road Viaduct					
Heritage Item					
23	**Battle of Vinegar Hill (memorial)**	712 Windsor Road	Local (Blacktown LEP)	-	
185	**Royal Oak Inn (former) (now Mean Fiddler Hotel)**	2 Commercial Road, Rouse Hill	State Heritage Register	-	
-	**Rouse Hill House and Farm**	Windsor Road, Rouse Hill	State Heritage Register	-	
Windsor Road Viaduct to Cudgegong Road					
No heritage items in the vicinity of the Windsor Road viaduct were assessed as having the potential to be impacted by the NWRL. In addition, there are no known archaeological sites within the area.					
Tallawong Stabling Facility					
Heritage Item					
-	**Rouse Hill House and Farm**	Windsor Road, Rouse Hill	State Heritage Register	-	-
Archaeological Potential					
-	**Rouse Hill Estate**	Originally extended as far south as Schofields Road and 250 m west of Tallawong Road (to the west).	-	If any remains do survive in situ, they would generally include internal tracks/roads and post holes from old fence lines enclosing earlier paddocks.	There is little potential for subsurface archaeological remains to exist on site.

11.5 Potential impacts

11.5.1 Operational and Construction impacts

The potential operational and construction impacts of the NWRL on heritage items and items of archaeological potential are detailed in **Table 11.3**.

Table 11.3 Potential Impacts

Heritage/ Archaeological Site	Potential Impacts	
	Operation	**Construction**
Epping Services Facility		
Bushland	No heritage-listed bushland would be removed as part of the construction and operation of the Epping Services Facility.	
Woodlands House	No impact on Woodlands House is anticipated.	
Stone Causeway over Devlin's Creek	The stone causeway over Devlins Creek is located outside the facility site and would not be affected by the NWRL operations.	There is the possibility of indirect impacts on the causeway from erosion and sedimentation associated with the construction works. Erosion and sedimentation control measures are detailed in Chapter 18.
Cheltenham Services Facility		
Bushland	No operational impact on this bushland area is anticipated.	No additional vegetation, other than that assessed in EIS1, would be removed for the proposed construction works.
Street trees	No operational impact on these street trees is anticipated.	Four trees located on the road island on Castle Howard Road would be removed for the proposed construction works.
Conservation area	The operation of the Cheltenham Services Facility would have a minor visual impact on the conservation area.	No additional vegetation, other than that assessed in EIS1, would be removed for the proposed construction works.
Cherrybrook Station		
Glenhope	Glenhope is situated on the southern side of Castle Hill Road, directly opposite the proposed station site. The house, which faces the road, is set back within a landscaped garden setting and extensive grounds. The outlook from Glenhope to the north is of trees and bushland on the northern side of Castle Hill Road and provides an appropriate setting for the house.	The construction works would have some temporary adverse impacts upon the setting of (and the outlook from) the heritage-listed Glenhope, which is directly opposite the access road to Cherrybrook Station construction site. No additional vegetation, other than that assessed in EIS1, would be removed for the proposed construction works.
	Existing vegetation on the northern side of the road (within the construction site) forms part of the visual setting for Glenhope house. Much of this vegetation would be removed for the proposed Stage 1 civil construction works, as assessed in EIS1, resulting in the proposed station operations having a moderate adverse impact on the visual setting of Glenhope.	
Inala	The operation of Cherrybrook Station would have a minor visual impact on Inala.	No additional vegetation, other than that assessed in EIS1, would be removed for the proposed construction works. Therefore, no additional impact on the visual setting of this property is anticipated.
House Site, Franklin Road, Cherrybrook	No impact on archaeological remains is anticipated.	
Castle Hill Station		
Arthur Whitling Park	Arthur Whitling Park would receive additional pedestrian activity as a result of the proposed operations. In addition there would be a visual impact on the park due to the station infrastructure being located within the park.	The entire area of Arthur Whitling Park would be directly affected by the proposed construction works, as assessed in EIS1. No additional impacts to Arthur Whitling Park, other than those assessed in EIS1, would result from the proposed construction.
White House Gallery	The White House Gallery was demolished in mid 2012.	
Archaeological remains – Parramatta to Castle Hill Tramway	No impacts on potential archaeological remains are anticipated.	
Showground Station		
Castle Hill Showground	The proposed operation of the Showground Station would have potential adverse impacts upon parts of the Castle Hill Showground, in the form of visual impacts and increased pedestrian and vehicular activity.	No additional impacts to the Castle Hill Showground, other than those assessed in EIS1, would result from the proposed construction.
House sites, off Carrington Road, Castle Hill	Potential archaeological remains associated with the two pre-1920s buildings identified on historic plans and aerials would be located within the area designated for earthworks construction of the Showground Station, which was assessed as part of EIS 1. No additional impacts would result from the proposed construction and operations.	

Heritage/ Archaeological Site	Potential Impacts	
	Operation	Construction
Norwest Station		
No heritage items or items of archaeological potential identified	No impacts on potential European heritage items are anticipated.	
No heritage items or items of archaeological potential identified	No archaeological potential was identified within the construction zone. Consequently it is anticipated that the proposed construction works and operation of the Norwest Station are unlikely to result in any archaeological impacts.	
Bella Vista Station		
Bella Vista Farm	The station site is unlikely to be visible from anywhere within the State heritage listed property of Bella Vista Farm which is located approximately one km from the construction zone.	
Archaeological item	No archaeological potential was identified within the construction zone. Consequently the construction works and operations of Bella Vista Station are unlikely to result in any archaeological impacts.	
Balmoral Road		
Weatherboard house	This house has already been demolished, therefore no impacts would occur.	
Archaeological item	No items of archaeological potential were identified within the construction zone Consequently the construction works and proposed operations are unlikely to result in any archaeological impacts.	
Memorial Avenue		
Heritage item	No impacts on potential European heritage items are anticipated	
Boundary stones	The boundary stones along Old Windsor Road, if extant, would be located outside the Memorial Avenue construction works zone and as a result, the proposed construction works and operations are unlikely to have any archaeological impacts.	
Kellyville Station		
Old Windsor Road Heritage Precinct	As the proposed station site would be located adjacent to one of the identified historic precincts along Old Windsor Road, there may be some impacts upon this historic roadway precinct. Since there have been numerous physical changes to this part of Old Windsor Road in recent times, any heritage impacts are likely to be of a relatively minor nature.	

Heritage/ Archaeological Site	Potential Impacts	
	Operation	Construction
Archaeological site (Archaeological site item 74 or RH/35 or site no. 49- RTA European Heritage Item 4227) and boundary markers.	The two cisterns/wells, recorded by Casey and Lowe (2006), are located within the perimeters of the ground disturbance works required for the construction of the proposed above-ground Kellyville Station, which was assessed as part of EIS 1. There is the potential that other known and potential archaeological features associated with the former house still remain within the area designated for the construction of the station. However additional operational and construction impacts other than those assessed in EIS1 are not anticipated.	
Site of the Battle of Vinegar Hill	Given that the exact location of the site of the battle of Vinegar Hill has not been accurately identified there is the potential, although minor, of survival of archaeological evidence associated with this significant event. As no earthworks in addition to those assessed in EIS1 are proposed, no construction or operational impacts are anticipated.	
Samantha Riley Drive to Windsor Road		
A series of eucalyptus trees along Old Windsor Road, to the north of Samantha Riley Drive	The eucalyptus trees are located outside the construction works zone and there would be no operational impacts.	
A series of boundary stones along Old Windsor Road	The boundary stones, if extant, would be located outside the construction works zone. As no other archaeological sites were identified within the proposed Samantha Riley Drive to Old Windsor Road construction site, the proposed operations and construction works are unlikely to result in archaeological impacts.	
Old Windsor Road to White Hart		
Windsor Road Heritage Precinct	As the proposed construction works site is located adjacent to one of the identified historic precincts along Old Windsor Road, there may be some impacts upon this historic roadway precinct. Since there have been numerous physical changes to this part of Windsor Road in recent times, any negative heritage impacts resulting from the proposed construction or operations are likely to be of a relatively minor adverse nature.	
Mungerie	The proposed operations would have a visual impact upon the setting and curtilage of Mungerie. The proposed rail corridor cuts across the original entrance driveway into the Mungerie property and the viaduct structure would dominate views to the west and interrupt important traditional links between the main road and this 1890s house. Refer to Chapter 16 for a visual assessment of the proposed operations and construction on Mungerie.	The impacts of the Major Civil Construction Works upon the setting and curtilage of Mungerie were assessed in EIS 1. No additional construction impacts are anticipated.

Heritage/ Archaeological Site	Potential Impacts	
	Operation	**Construction**
Former Swan Inn (RH/36)	The proposed operations would have an adverse visual impact as the viaduct structure would dominate views to the west.	The site of the former Swan Inn (RH/36) is located within the proposed Old Windsor Road to White Hart Drive construction site. The Major Civil Construction Works would result in a major impact on the site of the former Swan Inn as was assessed as part of EIS 1. No additional construction impacts are anticipated.
Rouse Hill Station		
Battle of Vinegar Hill Memorial	The Battle of Vinegar Hill Memorial is located in an elevated position within the Castlebrook Cemetery at 712 Windsor Road, Rouse Hill. However, the actual place where the skirmish occurred has not been determined with certainty. Although the proposed construction works and operations may be visible in views from the Battle of Vinegar Hill Memorial it is considered that these impacts would be of a relatively minor and of a temporary nature.	
-	As no archaeological potential has been identified within the proposed Rouse Hill Station site, it was determined that the proposed construction works and operations are unlikely to result in any archaeological impacts.	
Windsor Road Viaduct		
Royal Oak Inn (now Mean Fiddler Hotel)	Removal of trees in views south along Windsor Road from the hotel could result in an impact on the visual setting of the former Royal Oak Inn. However, the trees to be removed are a substantial distance from the hotel, and therefore this impact is considered neutral, as assessed in EIS 1. No additional construction or operational impacts are anticipated.	
Archaeological item	As no archaeological potential has been identified within the construction site, it was determined that the proposed construction works and operations are unlikely to result in archaeological impacts.	
Windsor Road Viaduct to Cudgegong Road		
Heritage item	Due to the topography of the area and the existing vegetation on either side of the proposed construction site, it is considered that no heritage items in the vicinity of the construction site would be impacted by the proposed construction works or operations.	
Archaeological item	Since the potential for archaeological remains to survive in situ within the construction site is low, the construction works and operations are unlikely to result in any archaeological impacts.	

Heritage/ Archaeological Site	Potential Impacts	
	Operation	**Construction**
Cudgegong Road Station and Tallawong Stabling Facility		
Rouse Hill House and Farm	Analysis of the topography of the land that lies between Rouse Hill House and Rouse Hill Town Centre suggests that the potential impact of the NWRL upon the Rouse Hill House property or its extended visual curtilage would be very low. The property lies approximately 1.5 km to the north of the Cudgegong Road Station site, and is further away (about 2 km distant) from the Tallawong Stabling Facility construction site. The Rouse Hill Estate is separated from these two construction sites by an undulating landscape including forested areas. It is considered therefore that the Cudgegong Station and Tallawong Stabling Facility construction works and operations would barely be visible from the Rouse Hill Estate, and that the possibility of these works resulting in any appreciable negative heritage impacts upon this historic property and its curtilage would be very low. Refer to Chapter 16 for a visual assessment of the proposed operations and construction on Rouse Hill House and Farm.	
Rouse Hill Estate	As the archaeological potential of the area is considered to be low, this is considered to be a minor adverse impact.	

11.6 Management and Mitigation Measures

11.6.1 Operation

An OEMP would be developed in the future detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures have been developed to avoid, reduce and manage identified potential operational impacts. These mitigation measures are presented in **Table 11.4**.

Heritage specialists would work with the construction teams and design documentation team to ensure that the recommended mitigation measures are implemented and impacts on heritage items minimised. Heritage specialists would also be able to assist by identifying opportunities for enhancing the significance of heritage items and archaeological sites.

In the event that archaeological remains are encountered during operation or construction works in the areas of the designated route not specifically identified as archaeological sites or areas of archaeological potential, the NSW Heritage Branch (OEH) would be advised and the measures set out in the Heritage Act for the management of archaeological remains would be implemented.

11.6.2 Construction

The Construction Environmental Management Framework, provided in Appendix B, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Mitigation measures have been developed to avoid, reduce and manage identified potential construction impacts. These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 11.4**.

Table 11.4 European Heritage Operational Mitigation Measures

No.	Mitigation Measures	Applicable Sites*
OpEH1	Maintain the vegetation retained, reinstated and planted during the construction phase.	3, 4, 5, 6, 11, 13
	Construction	
	Heritage Items	
EH3	Where feasible and reasonable, retain or reinstate an adequate buffer of vegetation along the northern side of Castle Hill Road opposite the Glenhope property to preserve the character of its setting and to screen the visual impacts of the station construction site in the northern outlook from the Glenhope property.	4
EH4	Where feasible and reasonable, retain or reinstate a buffer of vegetation along the western side of Franklin Road opposite Inala School.	4
EH5	If feasible, the existing mature plantings along the Old Northern Road edge of Arthur Whitling Park would be retained and protected during construction.	5
EH6	Reinstate key elements of Arthur Whitling Park in consultation with The Hills Shire Council, the Hills District Historical Society and the Castle Hill sub-branch of the RSL, where feasible and reasonable.	5
EH7	Reinstate the landscaped public parkland (Arthur Whitling Park) following completion of construction.	5
EH8	Reinstate or rejuvenate any areas of the Showground disturbed for construction works following completion of the works.	6
EH9	Re-establish planted vegetation along the eastern side of the North-West T-way following completion of the construction works.	11 and 13
EH11	A buffer of trees between Mungerie and the rail corridor would be maintained. Any trees removed to facilitate construction would be reinstated on completion of works.	13
EH13	Replacement planting of trees of the same species as those removed as part of the site landscaping works.	3
	Archaeological Sites	
EH17	The two identified brick cisterns / wells at the Kellyville Station site would be retained in situ if feasible and reasonable.	11
EH20	Results and recommendations of the further research undertaken as per the EIS1 mitigation measures regarding areas of archaeological potential would be followed.	4, 5, 6, 11, 13, 16 and 17

Site 1 - Epping Services Facility, Site 2 – NOT USED, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5- Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8- Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12- Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility

CHAPTER 12

INDIGENOUS HERITAGE

12 INDIGENOUS HERITAGE

12.1 Introduction

An assessment of the potential impacts on Indigenous Heritage within and surrounding the NWRL project was prepared by Godden Mackay Logan (GML) and Jo McDonald Cultural Heritage Management (CHM) to support the EIS and has been included as Technical Paper 5. The Indigenous Heritage Report identifies Aboriginal heritage sites in the area, the potential impacts of the proposed construction and operations on these sites and recommends mitigation measures.

12.2 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 12.1 sets out the Director General's Requirements, the Conditions of Approval and Statement of Commitments as they relate to Indigenous Heritage, and where in the project these have been addressed.

Table 12.1 Director-General's requirements, Conditions of Approval and Statements of Commitment

Reference	Description	Addressed
Conditions of Approval		
3.14	The Proponent shall review the indigenous heritage impacts of the project considering cumulative impacts from surrounding development, consistent with: a. Steps 1 to 4 of the *Protocol for Aboriginal Stakeholder Involvement in the Assessment of Aboriginal Cultural Heritage in the Sydney Growth Centres* (Context Pty Ltd, 2006a) and the *Precinct Assessment Method for Aboriginal Cultural Heritage in the Sydney Growth Centres* (Context Pty Ltd, 2006a), for land within the North West Growth Centre; and b. *Guideline for Aboriginal Cultural Heritage Impacts Assessment and Community Consultation* (DECC July 2005), for all other areas. The Proponent shall identify mitigation priorities with consideration to the regional significance of impacts.	Section 12.3 and 12.6.
Statement of Commitments		
33	The Indigenous Heritage protocol and methodology developed for the Growth Centres would continue to be applied as the project progresses, in consultation with DECC and relevant Indigenous groups	Section 12.3 and 12.6.
34	A detailed assessment would be undertaken in the vicinity of Aboriginal sites identified to have moderate to high archaeological potential. The assessment would identify areas to be avoided, construction related impacts and how these can be managed; and, where required, salvage excavation prior to any subsurface impact on the deposit. Advertising for interested parties would need to be undertaken prior to any subsurface investigation, in accordance with DECC requirements.	Section 12.5 and 12.6.

12.3 Assessment Methodology

The methodology for the Indigenous Heritage Report undertaken for the project included:

- Review of previous Aboriginal Archaeological Assessments, which were prepared during the preliminary stages of the project, including:
  - An initial impact assessment for the NWRL undertaken by Mills Archaeological and Heritage Services Pty Ltd in 2003.
  - A second preliminary assessment for the NWRL undertaken by Jo McDonald CHM Pty Ltd (*Archaeological Assessment of Indigenous Heritage for the North West Rail Link*) in 2006.

  These reports identified a number of Aboriginal sites associated with the proposed route of the NWRL. Background information from these prior studies was used during the preparation of the Indigenous Heritage Report.
- Aboriginal consultation in line with the following policy documents:
  - DEC (2005) *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation*.
  - DECCW (2010) *Aboriginal cultural heritage consultation requirements for proponents*.

  This consultation process involved:
  - **Stage 1:** Notification of potential stakeholders and the registration of interested Aboriginal stakeholders. Details regarding the Aboriginal people or organisations identified in Stage 1 and a list of the Registered Aboriginal Parties (RAPs) are found in Table 12.1 and Table 12.2 of Technical Paper 5.
  - **Stage 2:** Presentation of information to all RAPs in the form of a project briefing, and written details of the proposed project, the proposed assessment methodology and background information. RAPs were requested to provide comments on the methodology. Those who responded indicated their agreement either verbally or in writing (refer Appendix B of Technical Paper 5).
  - **Stage 3:** Gathering information through field surveys with RAPs, recording of identified Aboriginal objects, determining areas of potential archaeological deposit and cultural heritage values, and discussing the required mitigation strategies. The outcomes of these surveys and consultation process formed the basis of the draft Indigenous Heritage Report.
  - **Stage 4:** Following TfNSW review of the draft Indigenous Heritage Report, each RAP was provided with the draft report for its review and feedback on the content, assessment and recommendations. The comments received were incorporated into the Indigenous Heritage Report.
- An assessment of the Aboriginal Heritage context including the ethnohistory of the NWRL study area.
- A review of previous Archaeological work including a review of the NSW Aboriginal Heritage Information Management System (AHIMS) library and additional reports held by GML and Jo McDonald CHM Pty Ltd. These reviews determined that:
  - Numerous archaeological surveys have been undertaken surrounding and within the study area, resulting in the recording of many Aboriginal sites.

- A number of archaeological excavations have been undertaken, all of which have recovered subsurface material from buried deposits. Many of these Aboriginal sites have contained high artefact densities and a wide range of lithic artefacts and materials.

❖ Two searches of the AHIMS database of the area along the rail corridor with a 1km and 450m buffer surrounding the study area. The 1km buffer search revealed 220 sites and the 450m buffer search identified 132 sites. These identified sites were predominantly isolated artefacts or open artefact sites. The complete results of the AHIMS search are provided in Appendix C of Technical Paper 5.

❖ An assessment of previously recorded Aboriginal objects and/or places, which identified that the proposed construction sites contain 27 Aboriginal sites within them or very near to their impact zone.

❖ In addition to a review of the results from the previous surveys undertaken by Jo McDonald CHM Pty Ltd in 2006, additional field surveys of the proposed NWRL alignment were undertaken, which aimed to achieve the following:

- Survey coverage of the Tallawong Stabling Area (excluding areas that have been recently extensively surveyed, such as Area 20; where the focus was on the re-location of previously recorded Aboriginal sites), focusing on areas where excavation and ground disturbance is proposed.
- Identification and assessment of Aboriginal sites previously identified by Jo McDonald CHM Pty Ltd along the NWRL alignment.
- Inspection of proposed rail stations with the RAPs.
- Survey of construction sites along the proposed alignment.

The survey recording methods involved:

❖ Recording and plotting all located items of Aboriginal cultural heritage using a Garmin handheld GPS.

❖ Compiling photographic records, GML site recording forms, sketch plans and diary descriptions.

Refer to the Indigenous Heritage Report for figures depicting the areas subject to archaeological surveys (Figures 4.1 to 4.20 of Technical Paper 5).

12.4 Existing Environment

For the purposes of this assessment, existing environmental conditions are assumed to be those that exist upon completion of the major civil construction works (assessed in EIS 1).

The 27 known Aboriginal sites identified as being located within or in close proximity to the NWRL rail line are detailed in **Table 12.2**. Newly recorded Aboriginal sites from the field survey are not included in this count and would be registered on the AHIMS database.

Table 12.2 Previously recorded Aboriginal sites located within or very near to the NWRL construction sites.

Aboriginal site name / number	Aboriginal site type
Cherrybrook Station	
45-5-2861	Stone artefact concentration + Potential Archaeological Deposit (PAD)
Balmoral Road and Memorial Avenue	
45-5-3158	Isolated find
Corner of Taggert Way and Balmoral Road	Isolated find
Memorial Avenue	
45-5-0981/45-5-0989 very close to construction site	Stone artefact concentration
45-5-3354	Stone artefact concentration
Kellyville Station	
45-5-2027 very close to construction site	Stone artefact concentration + PAD
45-5-2365	Stone artefact concentration
45-5-3064 very close to construction site	Isolated find/open artefact scatter
Samantha Riley Drive	
45-5-0933	Stone artefact concentration + PAD
Old Windsor Road	
45-5-0961 very close to construction site	Stone artefact concentration
45-5-2649 very close to construction site	Isolated find
45-5-3188	Stone artefact concentration + PAD
Old Windsor Road and Rouse Hill Station	
45-5-0960 very close to construction site	Stone artefact concentration
45-5-2904	PAD
45-5-2905	PAD
45-5-3077	Stone artefact concentration
Rouse Hill Station and Windsor Road Viaduct	
45-5-0959 very close to	Stone artefact concentration
Windsor Road Viaduct to Cudgegong Road	
45-5-3930	Isolated find
45-5-3931 very close to construction site	Isolated find
45-5-3932 very close to construction site	Stone artefact concentration
45-5-2805 (RH/SP15)	PAD
Cudgegong Road Station and Tallawong Stabling Facility	
45-5-2756 very close to construction site	Stone artefact concentration
45-5-3355	Isolated find
45-5-3392	Stone artefact concentration
45-5-3517	Stone artefact concentration
45-5-3933 (RH/A20P 18)	PAD
RH/A20P PAD 5	PAD

The Indigenous Heritage Report assessed the landscape context of the study area in order to provide contextual information for use in developing a predictive model relating to the remains for evidence of Aboriginal occupation and use in the area. The landscape context considered included geology and geomorphic activity, landforms and landscape features, soils, hydrology, flora and fauna, land use history and erosion. The Indigenous Heritage Report also considered the evidence at a regional level for Aboriginal landscape use of the broader study area with the aim to highlight the main issues and regional character of Aboriginal land use and the material traces it has produced.

The landscape context, land use history, and regional and local archaeological patterns were assessed in order to provide a predictive statement for the likely occurrence of Aboriginal sites within the study area. It was determined that the most likely Aboriginal site types to be found within the study area would be open camp sites or artefact scatters and isolated finds. Other Aboriginal site types that may be located in the study area include shelter sites, shell middens, grinding grooves, art sites and scarred trees. Details regarding these types of Aboriginal sites and/or places and their potential location within the study area's landscape are provided in Table 3.3 of Technical Paper 5.

12.4.1 Physical Description of the Construction Sites

The Indigenous Heritage Report assessed each site in terms of its physical setting, level of impact, existing Aboriginal sites and archaeological potential.

Epping to Cherrybrook

Epping Services Facility is described as disturbed with a high level of ground surface impact arising from the processes of urban development and provision of transport infrastructure.

Indigenous Heritage Report found there is no potential for Aboriginal heritage in the NWRL impact zones at Epping.

Cheltenham Services Facility was assessed as having a low to moderate potential for Aboriginal objects, as the area has low levels of previous disturbance and its landscape context. NWRL PAD 1 was assigned within this site.

The Cherrybrook Station site contained a mixture of disturbed (from residential development) and undisturbed (containing dense vegetation) land. A registered Aboriginal site (45-6-2861, Stone Artefact Concentration [SAC]) has previously been recorded in the centre of this site, therefore this area was assessed as possessing a low to moderate potential for subsurface Aboriginal objects and PAD (NWRL PAD 2).

Castle Hill Station

The Castle Hill Station site is highly disturbed by landscaping, including gardens, lawns and exotic trees and the construction of the adjacent roads and bulk excavation around the buildings at the eastern end of Arthur Whitling Park. No Aboriginal objects and/or sites were observed within this construction site. It was determined that there was a very low potential for intact Aboriginal sites to be present at this site.

Showground Station

The eastern portion of the Showground Station site has been heavily impacted by building and construction, parkland development, terracing, landscaping, construction of gardens and the showground ring, therefore it is considered to have no archaeological potential.

The western portion of this site has a moderate level of archaeological potential for Aboriginal objects to be located within a subsurface context. Development of this site would impact the area of NWRL PAD 3.

Norwest Station

The Norwest Station site is highly disturbed by modern buildings, cut and imported fills, roads and landscaping and was assessed as having a very low to no potential for intact Aboriginal sites.

Bella Vista Station

The Bella Vista Station site has already been highly impacted by development and the course of the creek bank along the northern end of Celebration Drive has been modified in the past. As such, this site was assessed as having very low to no potential for Aboriginal heritage sites.

Balmoral Road (Bella Vista Station to Balmoral Road)

This site has previously been impacted by housing development and service installations, however despite this, Aboriginal objects have previously been recorded within this site, and a new site (14 Cumbelege Lane (NWRL PAD 6) was observed. This site was assessed as having moderate archaeological potential associated with 12 Cumbelege Lane and 2 Cumbelege Lane, which are described through the allocation of NWRL PADs 4 and 5.

Memorial Avenue (Balmoral Road to Memorial Avenue)

This site has been subject to a low level of disturbance (primarily historical vegetation stripping). Site preparation for surrounding residential development and the Burns Road T-way station have resulted in significantly modified soil horizons. A number of Aboriginal sites, including two isolated finds with low to moderate archaeological potential and a stone artefact concentration with moderate to high potential, have previously been recorded within and adjacent to this site (located within the site there are three separate stone artefacts sites). The current survey identified that the ridge top, hill slope and flat landforms (overlooking Elizabeth Macarthur Creek) have the potential for relatively undisturbed archaeological deposits. These landforms have been characterised through designation of NWRL PAD 7 and are considered to have low to moderate archaeological potential.

Kellyville Station (Memorial Avenue to Samantha Riley Drive)

The T-way car park, some residential development and historical vegetation stripping have impacted on the archaeological potential of this site. Three Aboriginal sites have previously been identified directly adjacent to this construction site and one (a stone artefact site with PAD – 45-5-2365 and PAD 8) within its boundary. The assessment determined that this site has low to moderate archaeological potential for relatively undisturbed archaeological deposits.

Samantha Riley Drive to Windsor Road

Some disturbances were identified at this site, including earthworks adjacent to Elizabeth Macarthur Creek, stockpiling or gravels, fills and concrete dumping, and native vegetation stripping. The area of PAD (PAD 9) associated with this site covers the whole site, due to the proximity of the creek and landforms suitable for Aboriginal occupation.

Old Windsor Road to White Hart Drive

The northern portions for this site were found to contain several previously recorded Aboriginal sites, some of which have been subject to prior Section 90 consent. Aboriginal sites were not detected due to limited ground surface visibility. Creek flat landforms 100 m either side of the two creek lines (towards the south of the construction site) were found to have low to moderate archaeological potential for relatively undisturbed archaeological deposits and have been designated as NWRL PAD 10.

Rouse Hill Station

The majority of this site has been cleared and subject to extensive urban development. Section 90 permits have been previously granted for all lands in the Rouse Hill Town Centre and it was determined that there is no archaeological potential for intact Aboriginal sites to remain within the previously developed lands. The Caddies Creek Precinct was subject to archaeological salvage excavation in 2007, with the conservation outcome being the retention of all identified Aboriginal grinding grooves.

The south west portion of this site has not been developed. As such, it was determined that the lower slope landforms closer to Caddies Creek, retain a potential for further relatively undisturbed archaeological deposits – these areas have been designated as NWRL PAD 11.

Windsor Road Viaduct

This site has had a low level of previous impact, including vegetation stripping and grazing. The ridge top and ridge spurs landforms in this site have low potential to contain intact Aboriginal sites – designated as NWRL PAD 11. These locations would have provided good views to adjacent landforms and are located close to Caddies Creek and Second Ponds Creek, both locations with significant archaeological deposits.

Windsor Road Viaduct to Cudgegong Road, Cudgegong Road Station and Tallawong Stabling Facility

Prior survey work identified a number of Aboriginal sites, including two isolated finds, four stone artefact concentrations and three areas of PAD within these sites. Previous site disturbance is associated with residential development, farming, ploughing, cropping, grazing, dam construction, construction of farm tracks and vegetation stripping. The survey work identified a number of previously unrecorded Aboriginal sites (including two isolated finds, two stone artefact concentrations and two areas of PAD) confirmed the presence of previously recorded Aboriginal sites and confirmed zones with PAD (refer **Table 12.3**).

12.4.2 Aboriginal sites and areas with Potential Archaeological Deposits

The 2011 field survey of the proposed NWRL alignment identified the following 35 Aboriginal Sites and areas with PADs:

- 3 previously recorded sites that were re-located during the field survey in 2011.
- 17 previously recorded sites that were not re-located during the field survey in 2011.
- 7 new Aboriginal sites recorded in 2011. Completed AHIMS site cards for these sites are included in Appendix D of the *Indigenous Heritage Report*, refer Technical Paper 5.
- 8 areas with PAD recorded in 2011.

Table 12.3 provides a summary of recorded Aboriginal sites and / or area with PADs associated with the NWRL's alignment (both recorded in this survey and previously). It is noted that these Aboriginal sites and PADs require heritage assessment and management before and during the construction of the NWRL. Two of these sites (45-5-3188 and 45-5-0961) have been subject to prior Section 90 consent and thus do not require future heritage management as they have been previously impacted by other developments and are deemed to be 'destroyed'. For additional details regarding these Aboriginal sites and PADs refer Technical Paper 5.

Table 12.3 Aboriginal sites and PAD requiring heritage assessment and management

Site / PAD	Site Type	Level of archaeological potential
Cheltenham Services Facility		
NWRL PAD 1	PAD	Low to moderate
Cherrybrook Station		
NWRL PAD 2 and 45-5-2861	SAC with PAD	Low to moderate
Showground Station		
NWRL PAD 3	PAD	Moderate
Balmoral Road		
14 Cumbelege Lane (1) and PAD 6	SAC and PAD	Moderate to high potential
NWRL PAD 4	PAD	Moderate
NWRL PAD 5	PAD	Moderate
Memorial Avenue		
Corner of Taggert Way and Balmoral road	Isolated Find (IF)	None
NWRL PAD 7	PAD	Low to moderate
45-5-3354	SAC with PAD	Moderate to high potential
45-5-3158	IF	None
Kellyville Station		
45-5-2365 and PAD 8	SAC with PAD	Low to moderate
NWRL PAD 9	PAD	Low to moderate
Samantha Riley Drive to Windsor Road		
45-5-0933 (RH/CD9)	SAC with PAD	Moderate
Old Windsor Road to White Hart Drive		
45-5-3188	SAC with PAD	Unknown. This site has previously been destroyed
Old Windsor Road and Rouse Hill Station		
NWRL PAD 10	PAD	Low to moderate
Rouse Hill Station and Windsor Road Viaduct		
NWRL PAD 11	PAD	Low
Windsor Road Viaduct to Cudgegong Road		
45-5-2805 (RH/SP15)	SAC with PAD	High
45-5-3930	IF	Low
45-5-3931	IF	Low
69 Schofields Road (45-5-4112)	SAC with PAD	Moderate to high
Windsor Road Viaduct to Cudgegong Road Station and Tallawong Stabling Facility		
59 Schofields Road	SAC with PAD	Moderate
65 Schofields Road 45-5-4112	IF	Low
Cudgegong Road Station and Tallawong Stabling Facility		
45-5-3392	SAC with PAD	Moderate to high
45-5-3933 (RH/A20P 18)	SAC	None to Low
45-5-3355	SAC	None
RH/A20P PAD 5	PAD	Moderate
28 Tallawong Road	IF	Low

12.4.3 Significance Assessment

A significance assessment was undertaken to assess the Aboriginal heritage values of the study area in line with the four principal criteria (social, historical, scientific and aesthetic) of the Australian ICOMOS Burra Charter 1999 (the Burra Charter) and NSW Heritage Office Assessing Heritage Significance 2001, refer to the Indigenous Heritage Report for additional details (Technical Paper 5).

Following consultation with the RAPs, investigation of the archaeological context of the study area and local region, and the field survey, the heritage values in **Table 12.4** were determined.

Table 12.4 Summary of Aboriginal cultural heritage values

Value	Demonstrated characteristics	Grade of Significance
Social	The landscape through which the NWRL route traverses.	Moderate
	The physical Aboriginal sites and objects present within that landscape.	Moderate
	Rare and/or extensively destroyed site types – grinding grooves, scarred trees and stone objects.	High
Historic	Aboriginal heritage sites identified within the NWRL study area do not meet this criterion.	None
Scientific	The range of physical sites (and potentially areas with PADs).	Moderate
	Grinding groove sites (should they be present) and stratified occupation sites which demonstrate time and depth of occupation.	High
Aesthetic	Aboriginal heritage sites identified within the NWRL study area do not meet this criterion.	None

Table 12.5 presents a summary of the scientific value for each known Aboriginal site located within the proposed NWRL alignment.

Table 12.5 Summary of scientific value for each known Aboriginal site located within one of the NWRL's construction sites.

Site/PAD	Site type	Level of archaeological potential	Grade of scientific value
Cheltenham Services Facility			
NWRL PAD1	PAD	Low to moderate	Unknown, until excavated
Cherrybrook Station			
45-5-2861 and NWRL PAD 2	SAC with PAD	Low to moderate	Low, until tested
Showground Station			
NWRL PAD 3	PAD	Moderate	Unknown, until excavated
Balmoral Road			
14 Cumbelege Lane (1) and NWRL PAD 6	SAC and PAD	Moderate to high	Moderate, but potentially high if the site possesses good condition and integrity with a dense archaeological deposit
NWRL PAD 4	PAD	Moderate	Unknown, until excavated
NWRL PAD 5	PAD	Moderate	Unknown, until excavated
Memorial Avenue			
Corner of Taggert Way and Balmoral Road	IF	None	Low
NWRL PAD 7	PAD	Low to moderate	Unknown, until excavated
45-5-3354	SAC with PAD	Moderate to high	Moderate, but potentially high if the site possesses good condition and integrity with a dense archaeological deposit
45-5-3158	IF	None	Low
Kellyville Station			
45-5-2365 and NWRL PAD 8	SAC with PAD	Low to moderate	Low
NWRL PAD 9	PAD	Low to moderate	Unknown, until excavated
Samantha Riley Drive to Windsor Road			
45-5-0933	SAC with PAD	Moderate	Moderate, but potentially high, should the site contain grinding grooves
Old Windsor Road to White Hart Drive			
45-5-3188	SAC with PAD	Unknown. This site has been previously destroyed	Unknown, until further investigated
Old Windsor Road and Rouse Hill Station			
NWRL PAD 10	PAD	Low to moderate	Unknown, until excavated. High, should the site contain grinding grooves
Rouse Hill Station and Windsor Road Viaduct			
NWRL PAD 11	PAD	Low	Unknown, until excavated
Windsor Road Viaduct to Cudgegong Road			
45-5-2805 RH/SP15	SAC with PAD	High	Moderate, but potentially high if the site possesses good condition and integrity with a dense archaeological deposit

Site/PAD	Site type	Level of archaeological potential	Grade of scientific value
45-5-3930	IF	Low	Low
45-5-3931	IF	Low	Low
69 Schofields Road 45-5-4112	SAC with PAD	Moderate to high	Moderate, but potentially high if the site possesses good condition and integrity with a dense archaeological deposit
Windsor Road Viaduct to Cudgegong Road Station and Tallawong Stabling Facility			
59 Schofields Road	SAC with PAD	Moderate	Moderate
65 Schofields Road	IF	Low	Low
Cudgegong Road Station and Tallawong Stabling Facility			
45-5-3392	SAC with PAD	Moderate to high	To be determined through excavation.
45-5-3933 (RH/A20P 18)	SAC	None to low	Low
45-5-3355	SAC	None	Low
RH/AP20P PAD 5	PAD	Moderate	Unknown until excavated
28 Tallawong Road	IF	Low	Low

12.5 Potential Impacts

12.5.1 Operations

The potential impacts on Indigenous Heritage arising from rail operations are not considered to be significant.

12.5.2 Construction

The EIS1 Major Civil Works construction activities would have resulted in the complete removal of all top soil horizons and in most cases, deep excavation through the underlying bedrock of all the proposed construction sites. As such there is no potential for the retention of original intact soil horizons within any of the proposed construction sites at the commencement of the proposed EIS2 Stations, Rail Infrastructure and Systems works.

As noted in EIS1 Major Civil Works, the footprints of a number of Aboriginal heritage sites extend outside the boundaries of the construction sites. No significant construction works would be undertaken for EIS 2 Stations, Rail Infrastructure and Systems outside of the areas assessed in EIS1 Major Civil Construction Works.

The avoidance and conservation of these areas would be continued throughout the proposed construction works and operations Therefore, no additional Aboriginal heritage sites would be affected.

12.5.3 Summary of Sites and Impacts

Impacts and their consequences for all of the known Aboriginal sites, places, landscape, values and areas of archaeological potential are detailed in **Table 12.6**. It should be noted that this table only details the impacts post major civil construction works and any sites totally removed as part of the Major Civil Construction Works described in EIS 1 works are not listed.

Table 12.6 Summary of Aboriginal sites, impacts of the NWRL and consequences

Site/PAD	Site type	Post EIS 1 condition	Potential impacts of proposed construction works and operations
Cheltenham Services Facility			
NWRL PAD1	PAD	Partial loss of value	No additional loss of value provided management measures followed
Cherrybrook Station			
45-5-2861 and NWRL PAD 2	SAC with PAD	Partial loss of value	No additional loss of value provided management measures followed
Showground Station			
NWRL PAD 3	PAD	Partial loss of value	No additional loss of value provided management measures followed
Memorial Avenue			
NWRL PAD 7	PAD	Near total loss of value	No additional loss of value
Kellyville Station			
45-5-2365 and NWRL PAD 8	SAC with PAD	Partial loss of value	No additional loss of value provided management measures followed
Samantha Riley Drive to Windsor Road			
45-5-0933	SAC with PAD	Near total loss of value	No additional loss of value
Old Windsor Road to Rouse Hill Station			
NWRL PAD 10	PAD	Partial loss of value	No additional loss of value provided management measures followed
Rouse Hill Station to Windsor Road Viaduct			
NWRL PAD 11	PAD	Partial loss of value	No additional loss of value provided management measures followed
Windsor Road Viaduct to Cudgegong Road			
45-5-2805 RH/SP15	SAC with PAD	Partial loss of value	No additional loss of value provided management measures followed

12.6 Management and Mitigation Measures

12.6.1 Operation

An OEMP would be developed in the future detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures have been developed to avoid, reduce and manage identified potential operational impacts on Indigenous heritage, including avoiding and minimising harm, development of an Aboriginal Heritage Management Plan (AHMP), educating site workers, undertaking archaeological test and salvage excavation and public interpretation. These mitigation measures are presented in in **Table 12.7**.

12.6.2 Construction

The Construction Environmental Management Framework, provided in Appendix B, details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

Mitigation measures have been developed to avoid, reduce and manage identified potential construction impacts. These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 12.8**.

Ground surface impacts within the construction sites are generally unavoidable, as assessed in EIS1. However impacts outside the boundaries of the construction sites could be avoided by implementation of a strategy of Aboriginal site avoidance specific to seven of the recorded Aboriginal sites. While all impacts could not be prevented, portions of these seven sites could be avoided and thus conserved intact for future generations.

Prior to site works the boundary of the works at each Aboriginal site would be delineated with a physical barrier and a sign erected to prevent accidental access. All areas with Aboriginal sites which are to be conserved would have zero vehicle access across their extent and no earthworks or stockpiling of materials would occur within their boundaries. A site induction protocol would be implemented to ensure that all work personnel are aware of their responsibilities in this regard.

Table 12.7 Indigenous Heritage Operational Mitigation Measures

No.	Mitigation Measures	Applicable Areas*
OpIH1	Maintenance of any permanent public interpretation within new railway stations.	All

Table 12.8 Indigenous Heritage Construction Mitigation Measures

No.	Mitigation Measures	Applicable Sites*
IH3	The boundary of the construction sites would be fenced to prevent construction personnel entering a PAD or known sites outside the construction footprint.	3, 4, 6, 11-16
IH4	The Indigenous Heritage component of the site induction would include information on: Aboriginal heritage conservation areas and/or no-go zones for each construction site. The legislation and penalties for impacting Aboriginal heritage objects would be conveyed to all construction managers and personnel.	1-17
IH5	TfNSW would consider permanent public interpretation within at least one of the new railway stations following development if an extensive and high value archaeological deposit were to be uncovered during the excavation of a site.	3, 4, 6, 9-17
IH6	Results and recommendations of the Phase 1 and 2 archaeological excavations undertaken as per the EIS1 mitigation measures (IH1 and IH2) would be followed.	3, 4, 6, 9 - 17

Site 1 - Epping Services Facility, Site 2 – NOT USED, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 - Showground Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility

CHAPTER 13
LOCAL BUSINESS IMPACTS

13 LOCAL BUSINESS IMPACTS

13.1 Introduction

A local business impact assessment was undertaken to identify and provide a qualitative assessment of the potential impacts on local businesses within the immediate vicinity of the Project during the construction and operation of Stations, Rail infrastructure and Systems as described in EIS 2.

Overall, the NWRL would become a major employer and user of goods and services during the construction phase. It is estimated that the project would support more than 16,200 jobs and inject $25 billion (directly and indirectly) during construction into the NSW economy. Professions and trades would include, among others, engineers, draftsmen, environmental scientists, designers, electricians, plumbers, carpenters, bricklayers, drivers, storepersons, crane operators, dogmen, riggers, security guards and labourers. At the same time, upon operation, the increased number of patrons passing through each of the project's localities is expected to provide substantial opportunities to existing and new local businesses as part of the wider project.

It is noted that at the time of preparing the local business impact assessment, ongoing consultations were occurring with DP&I (Strategies & Land Release and Plan Making & Urban Renewal) as part of the detailed station planning. This work is considered essential to ensure that detailed access, land use integration and coordination issues are resolved.

13.2 Methodology

13.2.1 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Table 13.1 sets out the Directors General's Requirements, the Conditions of Approval and Statement of Commitments as they relate to local businesses, and where in the project these have been addressed.

The assessment of local business impacts during the construction and operational phases of the Project included:

- An overview of LGAs affected by the Project with a focus on profiling key business characteristics including the number of businesses by employment and turnover.
- A business survey along the NWRL corridor from Epping Station to Tallawong Stabling Facility to identify and document existing businesses at each station and construction site.
- An assessment and discussion of the construction and operational impacts (positive and negative) on businesses located in the immediate vicinity of the station and construction sites.
- Identification and discussion of mitigation measures (general and specific) that would assist in alleviating potential negative impacts associated with construction of stations, rail infrastructure and systems and during the project's operation.

Table 13.1 Director-General's Requirements, Conditions of Approval, Statement of Commitments

Directors General's Requirements Reference	**Description**	**Addressed**
N/A		
Conditions of Approval Reference	**Description**	**Addressed**
N/A		
Statement of Commitments	**Description**	**Addressed**
Potential business impacts identified and considered as part of design development.	45. An assessment of the potential impacts and benefits of construction and operation on adjacent businesses would be undertaken in consultation with business owners during the design phase.	Potential operational impacts in Section 13.5.1. Potential construction impacts in Section 13.5.3. Consultation in Chapter 5.

13.3 Existing Environment

13.3.1 Introduction

The NWRL Project spans three LGAs: Hornsby Shire, The Hills Shire and Blacktown City. A summary of the construction sites and the corresponding LGAs is provided in **Table 13.2**.

Table 13.2 Sites Assessed

Local Government Area	Work Site*
Hornsby Shire	1. Epping Services Facility**
	3. Cheltenham Services Facility**
	4. Cherrybrook Station**
The Hills Shire	5. Castle Hill Station**
	6. Showground Station**
	7. Norwest Station**
	8. Bella Vista Station**
	9. Balmoral Road
	10. Memorial Ave
	11. Kellyville Station**
	12. Windsor Road/Old Windsor Road
	13. Old Windsor Road/Whitehart Drive
	14. Rouse Hill Station**
Blacktown City	15. Windsor Road Viaduct#
	16.Windsor Road Viaduct to Cudgegong Road
	17. Cudgegong Road Station and Tallawong Stabling Facility**

* Work Site 2 – Epping Decline is no longer required
** Operational Sites
# Site 15 is also located within The Hills Shire LGA (boundary of the two LGAs is Windsor Road)

The key business characteristics at each LGA affected by the Project are provided in the following sections. Businesses are classified by employment and turnover size based on a count of businesses using ABS data (2011):

- Employment size
  - Small: businesses which employ 1-19 employees.
  - Medium: businesses with 20-199 employees.
  - Large: businesses that employee at least 200 employees.
- Turnover size
  - Small: businesses with an annual turnover of less than $100,000.
  - Medium: businesses which have turnover of more than $100,000 and less than $500,000.
  - Large: businesses which have turnover of greater than $500,000.

The combined data of these LGAs provide an appreciation of the wider operating environment of business in the region.

Table 13.3 Number of businesses by employment and turnover size – Hornsby Shire

Size	Local Businesses by Employment Size		Local Businesses by Turnover Size	
	%	Top Industry	%	Top Industry
Small	91%	Professional, Scientific and Technical	48%	Professional, Scientific and Technical
Medium	8%	Retail Trade	33%	Professional, Scientific and Technical
Large	<1%	Wholesale Trade, Accommodation and Food	19%	Retail Trade

13.3.2 Hornsby Shire

The Hornsby Shire covers a total area of 510 km^2 and is the second largest LGA in Sydney. ABS (2011) data recorded a population of 164,034 in 2010, representing approximately 4% of total population in Sydney. From 2005 to 2010, it is estimated that population grew by approximately 1% in this LGA.

The following is noted about the business environment of Hornsby Shire:

- The majority of businesses are categorised as being small employers (91%), followed by medium employers (8%) and large employers (less than 1%). The top industry in each employment size category is shown in **Table 13.3**.
- Almost half of businesses in the Hornsby Shire are categorised as having a small turnover (48%). The top industry in each turnover size category is shown in **Table 13.3**.

13.3.3 The Hills Shire

The Hills Shire LGA is predominantly residential and semi-rural with minor commercial and industrial land use. The Shire covers an area of 380 km^2. Based on ABS (2011) data, approximately 179,716 residents reside in the LGA, which represented approximately 4% of Sydney's total population. The LGA has experienced steady population growth from 2005 to 2010, growing by 2% over this period.

The Hills Shire contains a number of commercial, high tech employment and high end retail activity including:

- The Norwest Business Park which houses the headquarters of some of Australia's leading brands, including Woolworths and ResMed.
- Castle Towers, a major regional shopping centre.
- A major automotive / commercial / bulky goods / light industrial area centred around Victoria Avenue, Castle Hill and the Castle Hill Trading Zone.

The business environment of The Hills Shire has the following business characteristics:

- The dominant number of businesses by employment size are categorised as small businesses (94%). Based on the ABS data no large employers were registered within The Hills Shire although it is noted businesses that display this characteristic are present (for example Woolworths Headquarters and ResMed). The top industry in each employment size category is shown in **Table 13.4**.
- Small turnover businesses comprise the largest share (47%) of businesses in The Hills Shire, followed by businesses with a medium turnover (39%). The top industry in each turnover size category is shown in **Table 13.4**.

Table 13.4 Number of businesses by employment and turnover size – The Hills Shire

Size	Local Businesses by Employment Size		Local Businesses by Turnover Size	
	%	Top Industry	%	Top Industry
Small	94%	Construction	47%	Construction
Medium	7%	Retail Trade, Professional, Scientific and Technical Services, Administrative and Support	39%	Construction
Large	0 %*	NA	14%	Construction

*As noted, there are businesses within the LGA that would be categorised as large employers; however this is not reflected in the ABS data.

13.3.4 Blacktown City

Blacktown City LGA covers an area of 247 km^2 and is predominantly residential, commercial and semi-rural in character. ABS (2011) recorded the population of Blacktown City to be 307,816 in 2010 which is approximately 7% of the total population in Sydney. It is currently the most populous and fastest growing LGA in NSW (ABS, 2011).

The following is noted about the business environment of Blacktown City LGA:

- Small businesses (95%) are by far the highest category in terms of employment size. Based on the updated ABS data no large employers were registered within Blacktown City although it is noted that businesses of this typology are present (for example Arnotts, Cadbury Schweppes, Bosch and One Steel). The top industry in each employment size category is shown in **Table 13.5**.
- Blacktown City like both Hornsby Shire and The Hills Shire had businesses which primarily produce turnover in the small category (60%), with just over a third in the medium category (34%) and a low6% producing a large turnover. The top industry in each turnover size category is shown in **Table 13.5**.

Table 13.5 Number of businesses by employment and turnover size– Blacktown City

Size	Local Businesses by Employment Size		Local Businesses by Turnover Size	
	%	Top Industry	%	Top Industry
Small	95%	Construction	60%	Transport, Postal and Warehousing
Medium	5%	Utilities, Accommodation and Food , Rental, Hiring and Real Estate , Health Care and Social Assistance	34%	Construction
Large	0 %*	NA	6%	Construction

* As noted, there are businesses within the LGA that would be categorised as large employers; however this is not reflected in the ABS data.

13.3.5 Implications

A summary of the top three industries by employment and turnover in the Project area is provided in **Table 13.6**.

Table 13.6 Top three businesses with highest proportion of employment and turnover

LGA	Top three businesses by employment	Top three businesses by turnover
Hornsby Shire	▪ Professional, Scientific and Technical ▪ Rental, Hiring and Real Estate ▪ Wholesale Trade	▪ Professional, Scientific and Technical ▪ Rental, Hiring and Real Estate ▪ Construction
The Hills Shire	▪ Construction ▪ Professional, Scientific and Technical ▪ Retail Trade	▪ Construction ▪ Professional, Scientific and Technical ▪ Financial and Insurance
Blacktown City	▪ Other services ▪ Professional, Scientific and Technical ▪ Transport, Postal and Warehousing	▪ Construction ▪ Transport, Postal and Warehousing ▪ Professional, Scientific and Technical
Total	▪ Professional, Scientific and Technical ▪ Rental, Hiring and Real Estate ▪ Construction	▪ Professional, Scientific and Technical ▪ Construction ▪ Rental, Hiring and Real Estate

On this basis, the following observations can be made:

- Professional, Scientific and Technical trade comprised the largest number of businesses within the three LGAs. Once the NWRL project is operational, employees in this industry would experience enhanced accessibility to and from their location of work.
- Construction businesses also comprise a large proportion of businesses in the region. This provides a strong foundation for these businesses to support the construction of the Project as demand for these services and employment in the region increases. At the same time, it is envisaged that Construction businesses will benefit from works associated with renewals and maintenance works during the operational phase of the project.
- Other industries that make up a large proportion of businesses in the region, such as Rental, Hiring and Real Estate Services, and Accommodation and Food Services, are also likely to benefit from increased economic activity during construction and operational phases of the project.
- Although some industries in the region may potentially be negatively affected by construction works, the impacts are likely to be negligible because of their scale and nature. Examples of these types of industries may include businesses operating in the Financial and Insurance Services industries. This is because these businesses tend to be less reliant on passing trade and/or quality of the operating environment (e.g. customers seeking to use accountancy services are likely to continue using these services regardless of construction related works). Conversely these industries may stand to benefit once the project is in operation due to increased accessibility and connectivity afforded at these localities.
- Other businesses predominant in the region, such as Retail Trade in Hornsby Shire, tend to be located further north of the LGA and are unlikely to be affected by the construction works. However, once operational these businesses may experience greater demand for their goods as accessibility is improved.

- Retail traders within The Hills Shire that service the daily needs of construction related workforce (e.g. Coles, Bi Lo, Woolworths and food outlets) are expected to experience increased demand for their goods and services. Similarly, retail traders would also experience an increase in demand during operations, resulting from patronage movement to and from station facilities.
- Businesses located within the Wholesale Trade and Transport, Postal and Warehousing industry are also expected to have minimal disruptions, as they are not dependent on attracting a high proportion of passing traffic and hence trade. However, disruptions associated with accessibility to and from these businesses may affect the transport efficiency of suppliers and deliveries to retailers.

13.4 Local Business Impact Drivers

13.4.1 Operation

The potential impacts to local businesses during the Project's operation would vary depending on the locality of the businesses and their typology and include:

- **Increased competition** – It is expected the project will enhance the vitality and liveability of communities in the region as transportation and accessibility improves. The improvement is expected to attract an increasing number of people within the region, and in turn, support investment by urban developers, as well as businesses as they seek to take advantage of the increase in demand for goods and services within the region. As a result of this increase, existing businesses may experience greater competition as new businesses are established to meet this growth.
- **Increased rent** – Rent for existing business owners may potentially increase due to growth in competition for business spaces within station localities. In particular, existing businesses in close proximity to the stations may experience increased rents as demand for property increases due to enhanced competition from retailers and the like. As an example, the rents associated with local food eateries may increase due to the lack of floor space and outlets available.
- **Increased business opportunities** – The establishment of new stations is expected to provide greater opportunities for businesses within and around the station precinct due to increased population growth and/or through traffic afforded by the project. Businesses catering for station patrons such as newsagents and convenience stores are likely to experience the greatest benefit, and hence attract inward investment to the region. Future expansion of commercial businesses around the station precinct is also expected, given improved accessibility to and from these localities.
- **Increased accessibility and connectivity** – A key enabler of productivity growth is the provision of transport infrastructure that increases accessibility and connectivity of people and commerce. The project is likely to provide greater accessibility for consumers, visitors and employees to suburbs previously only serviced by buses and by private car. It would also provide enhanced connectivity to strategic employment centres, particularly Macquarie Park, Chatswood, North Sydney and CBD. Population and employment growth – Population growth is an important driver of economic growth. The forecast increased population growth is expected to lead to increased employment opportunities for local businesses, as demands for their services expand to accommodate the needs of the population. Retail outlets (i.e. supermarkets, chemists, service stations) and other service businesses within the locality are expected to benefit most.
- **Agglomeration** – Agglomeration economies relate to the geographical concentration or clustering of businesses and employees (DIT 2011). Transport projects such as the NWRL are linked with productivity, growth and economic prosperity and can expand the productive capacity of a region, by increasing resources and improving the efficiency of existing resources in the region. Increased accessibility across the region, for example, would not only allow for cheaper transportation of passengers in the North West Growth Centre, but also reduce the cost of mobility via system improvements in journey times. In this regard, a key benefit of the project's operation relates to the benefits of 'agglomeration' economies associated with the project's operation.

The locality of stations along the NWRL corridor provides an impetus for close interaction between businesses. This would result in an enlarged pool of specialist skills, which would support industries within the regional centre. In summary, the positive impacts of agglomeration arising from the project's operation can be summarised as follows:

- Improved network opportunities through larger availability of customers, visitors and employees
- Economies of scale associated with clustering of industries, leading to
  - cost savings for consumers
  - larger availability of customer and supplier markets for businesses
  - ability to utilise other industries to complement business activities
  - increased employment densities and expansion of employment lands.

Overall, the abovementioned impacts are expected to impact positively on the well-being of local businesses within the three LGAs, and more broadly, enhance the productive capacity of the NSW economy.

13.4.2 Construction

The potential impacts on local businesses during construction works for the stations, rail infrastructure and systems would vary depending on the location and type of business. In this regard, a set of common sources of impact were applied at each of the station and construction site localities to assess the nature and magnitude of impacts that would affect the operation of local businesses during the construction works:

- **Reduced accessibility** – Accessibility to business enterprises relates to the ease that customers and/or suppliers can gain access to the business within the proposed construction area. Reduced accessibility as a result of the construction works could be caused by street closures and increased traffic congestion due to heavy vehicle movements. Loss of car parking availability due to construction access and all day parking by construction workers may occur unless effectively managed.
- **Poorer visibility** – Visibility to passing traffic is important to some businesses, particularly those that are reliant on passing trade such as service stations and take-away food outlets. Poor visibility of businesses could result from a number of construction related activities including visual disruption associated with construction machinery, frequent construction vehicle movements along the local road system, construction fencing, material stockpiling and construction sites in the area.
- **Reduced quality in operating amenity** – The operating amenity of the locations may be affected by construction activity resulting in noise, air and vibration disturbances to local businesses. For example, noise and vibration has the potential to negatively affect employee productivity, interaction with customers and workplace ambience. Reduced operating amenity would have greater implications for those businesses that rely on low noise environments such as outdoor dining.
- **Economic stimulus** – The economic stimulus associated with government expenditure on construction benefits local businesses principally through expenditure by construction businesses and associated workers during the construction works for the Project. In particular, businesses that may directly benefit from the construction works may include local construction contractors and those businesses who service the construction industry such as food and beverage retailers, accommodation providers, and other retail outlets that would cater to the day-to-day needs of the construction workforce. The impacts are expected to be reflected by:
  - **Increased trade** – reflecting an increase in the demand for goods and services due to construction activity.
  - **Increased income** – reflecting increased value of wages paid to workers as a result of increased demand for labour resources for the construction works.

- **Increased employment** – reflecting the increase in the number of workers engaged during the construction works.

❖ These positive sources of impacts on trade, income and employment may be '**direct**', '**indirect**', '**induced**' or '**dynamic**'. That is:

- **Direct impacts** would relate to those businesses directly affected by the construction works (e.g. local food outlets and retailers benefiting from increased patronage during the operation of the NWRL);
- **Indirect impacts** would relate to those businesses supplying direct businesses (e.g. increased demand for the goods and services businesses supplying food outlets and retailers);
- **Induced impacts** would relate to those businesses affected by the spending of incomes by direct and indirect workers (e.g. spending by food outlet and retail employees on other businesses); and
- **Dynamic impacts** would relate to how the NWRL would shift population, workforce, labour costs and prices (e.g. the role of the NWRL in improving the productivity of businesses and in attracting economic activities such as inward investment and population).

13.5 Assessment of Impacts – Operation

The following section assesses the potential impacts on local businesses during the operation of station facilities. It includes:

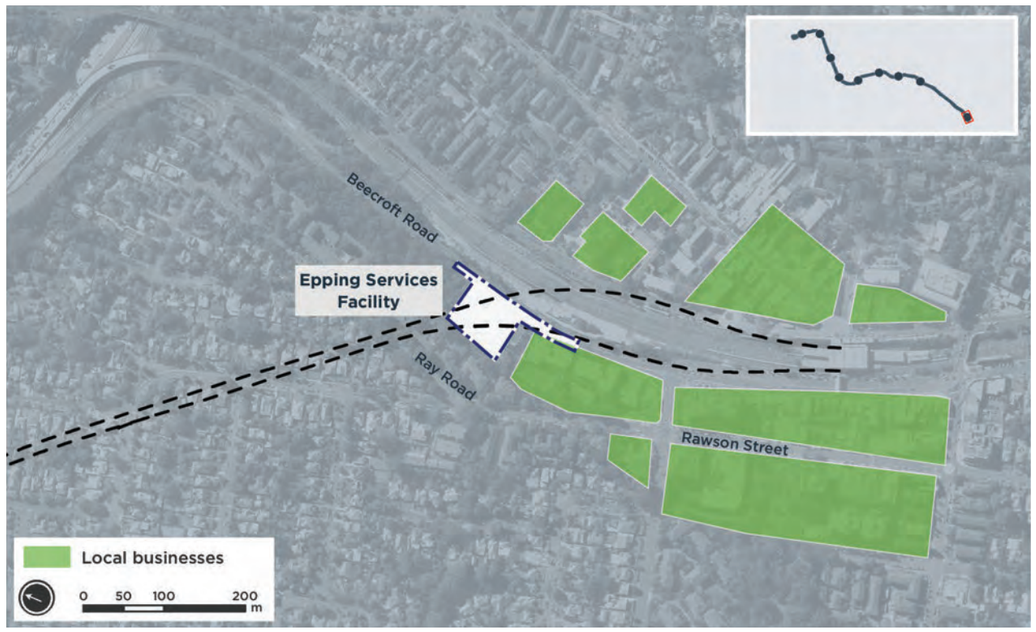
❖ Identification of the potential impacts (positive and negative) on local businesses during the operation of the Project.

❖ Identification and classification of existing businesses in the immediate vicinity Project's operation based on targeted site surveys at each station and service facility site. Businesses were classified in accordance with ABS (2011).

❖ Assessment of the type, direction and magnitude of potential impacts by qualitatively discussing the impacts at each of the sites.

13.5.1 Epping Services Facility to Bella Vista Station

Figure 13.1 Epping Services Facility – Local Businesses



Epping Services Facility

The location of local businesses relative to the Epping Services Facility and existing Epping Station is shown in **Figure 13.1**. As an established precinct, the locality provides a mix of smaller scale retail, cafés, restaurants, health services and community services.

Business Survey

A count of local businesses in the vicinity of Beecroft Road, Ray Road and Rawson Street at Epping was undertaken in May 2012. The survey identified that the following businesses may experience impacts once the project is in operation:

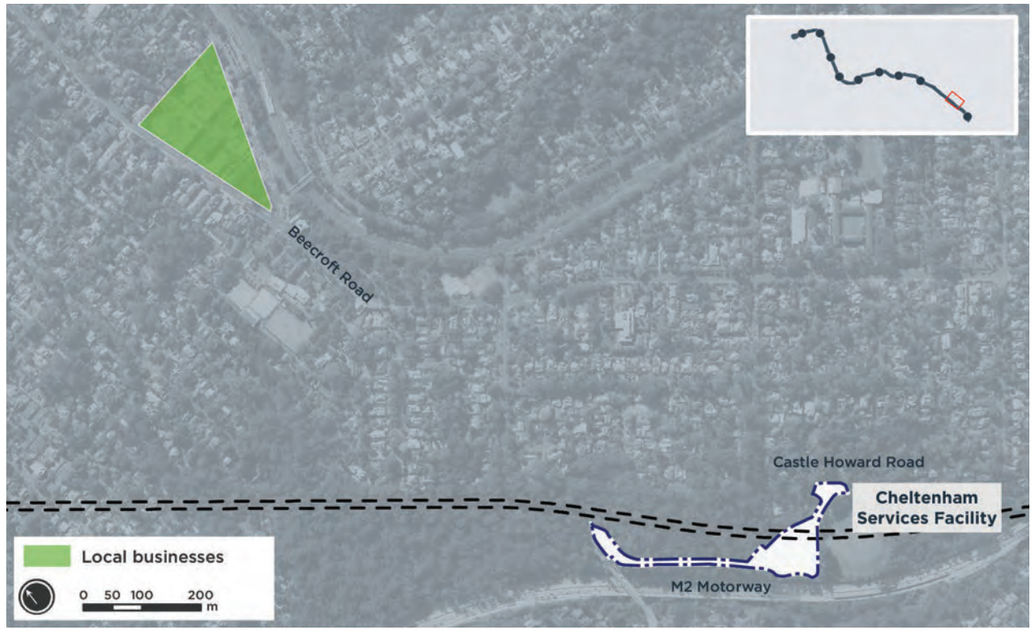
❖ Agriculture, forestry and fishing (1)
❖ Mining (1)
❖ Retail trade (21)
❖ Accommodation, cafes and restaurants (43)
❖ Communication services (2)
❖ Finance and insurance (9)
❖ Property and business services (33)
❖ Education (1)
❖ Health and community services (25)
❖ Cultural and recreational services (4)
❖ Personal and other services (22)
❖ Transport and storage (2)

Potential impacts during operation

- Businesses such as Accommodation, Cafes and Restaurants in the surrounding station precinct may potentially experience increased competition as new businesses are established to meet the growth in demand. Retail traders (i.e. newsagencies, convenience stores and mini supermarkets) providing everyday necessities to the patrons of the station may also experience increased competition from new business owners capitalising on patronage increases at the locality.
- Increased patronage and demand from existing and passing trade may result in upward pressure on rental cost to businesses due to increased demand for shop spaces (e.g. local food eateries, take away outlets, cafes or convenience stores).
- The project's implementation at Epping would provide enhanced accessibility for skilled professionals residing in the north western suburbs. This is expected to support existing and new business activity as an increasing number of patrons use the existing Epping Station (i.e. Property and Business Services and Finance and Insurance Businesses in Epping).
- Inward investment by businesses such as cafes, eateries, newsagencies and convenience stores are expected to capitalise on the increase in patronage expected at this locality. The development activities of these businesses are likely to generate flow-on affects to Property and Business Services and Finance and Insurance Industries, as new entrants utilise their services to enter this locality (e.g. a business operator would seek the services of property professionals to locate a suitable shop-front).
- Additional flow-on effects may be experienced by businesses such as Accommodation, Cafes, Restaurants and Retail businesses to service increased demand within the locality (eg. patrons may visit eateries/convenience stores after utilising services from a Physiotherapist).

13.5.2 Cheltenham Services Facility

Figure 13.2 Cheltenham Services Facility – Local Businesses



The Cheltenham Services Facility is located adjacent to Cheltenham Oval between Castle Howard Road and the M2 Motorway (see **Figure 13.2**).

As part of the maintenance works required for the project, the facility would be utilised by maintenance personnel.

Business Survey

No local businesses were identified during the survey conducted in the immediate vicinity of the construction site along Castle Howard Road.

13.5.3 Cherrybrook Station

Figure 13.3 Cherrybrook Station – Local Businesses

Cherrybrook as a suburb is expected to experience moderate employment and residential growth in the 40 years after station opening. The station will create opportunities for retail facilities situated within the station precinct to serve the station's patrons and passing traffic.

Business Survey

The business survey conducted along Franklin and Castle Hill Roads identified the following businesses:

- Health and community services (3)
- Education (1)

There are other businesses located within the vicinity of the proposed station, including a shopping village located to the north, IBM commercial building southwest of the station, and a small cluster of small retail and food stores within the IBM commercial precinct. A number of schools and community villages are also within the vicinity of the proposed station.

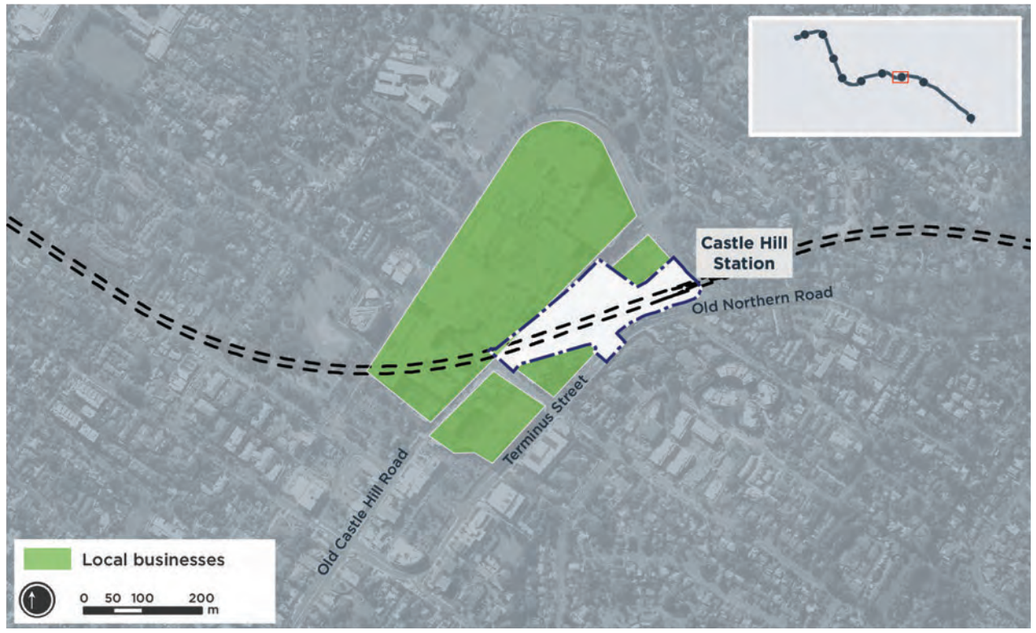
The location of local businesses expected to be impacted by the NRWL relative to Cherrybrook Station is shown in **Figure 13.3**.

Potential impacts during operation

- The limited retail space available within the station vicinity may impose higher rents due to increased competition for retail spaces. It is envisaged businesses such as cafes, eateries, convenience stores and newsagencies would occupy any retail spaces within the station precinct.
- Currently the IBM site located southwest of the proposed station is a major employer within the locality. Cherrybrook Station would allow employees that currently travel by bus or private car to utilise the rail link. This may potentially attract additional skilled professionals to the area.
- Similarly those residents from Cherrybrook would experience greater connectivity and accessibility to other employment regions. This would, in effect, provide businesses in the region with an enlarged pool of available resources.
- Opportunities exist for new businesses to establish to service the expected growth in employment, patronage and residents. Businesses such as Retail outlets (i.e. convenience stores, chemists) and those providing everyday necessities are likely to benefit from this growth.
- The increased connectivity may attract new consumers and visitors to the area. Businesses such as cafes, food outlets and convenience stores located in the station precinct and, to a lesser extent, those retail businesses located within close proximity to the IBM commercial building, may experience increased demand for their goods and services.

13.5.4 Castle Hill Station

Figure 13.4 Castle Hill Station – Local Businesses



During station operation, patrons would be serviced by the existing businesses surrounding the proposed station, including those in Castle Towers shopping centre, Castle Mall and businesses along Old Northern Road. The proposed café and retail facilities adjacent to the station building would also service the station patrons (see **Figure 13.4**).

The location of local businesses relative to Castle Hill Station is shown in **Figure 13.4**.

Business Survey

The survey of local businesses along Old Northern Road and within the Castle Hill Piazza precinct identified the following businesses:

- Retail (25)
- Accommodation, cafes and restaurants (26)
- Transport and storage (3)
- Finance and Insurance (6)
- Property and Businesses Services (2)
- Education (1)
- Health and Community Services (8)
- Personal and other services (12)

An overview of the businesses located within the Castle Towers Shopping centre found that out of the 339 retail stores within the centre, approximately 10% consisted of food outlets.

Potential impacts during operation

- Increased competition for businesses may potentially arise once the station is in operation. Combined with an expected strong growth in residential and employment activity, it is expected that demand for goods and services would result in new businesses being established, including Accommodation, Cafes and Restaurants.
- Increased accessibility and connectivity provides potential for new businesses within the Property and Business Services, and Finance and Insurance industries to be developed to service the growth. Existing businesses in these industries are likely to be affected by increased competition.
- Existing businesses may experience increased rents as competition for businesses spaces grows. In particular, businesses within the Professional Services Industry (i.e. Property and Business Services, and Finance and Insurance) may experience greater competition due to the relatively small number of businesses in this category, and demand for new businesses to be established.
- The expected growth in resident numbers at Castle Hill is expected to provide opportunities for new businesses to be established to support this growth. Businesses in retail and food outlets could be expected to benefit from the increase in patron activity associated with the NWRL.
- Increased connectivity and accessibility would enable residents and consumers to better access Castle Hill. Businesses within the Castle Towers shopping centre are likely to attract an increasing number of patrons.
- Similarly those businesses located within the existing Castle Hill Piazza and those on Old Northern Road may be expected to experience the flow on benefits of increased visitation, providing goods and services to consumers and visitors to Castle Hill.
- The provision of greater accessibility for existing residents across Sydney provides an added impetus for sharing of labour resources which may potentially lead to enhanced business productivity and provide for further availability of skilled labour for those professional businesses within Castle Hill.
- Steady employment and residential growth at this locality is likely to lead to increased expenditure and greater use of local business services. Businesses within the accommodation, cafes and restaurants and retail industries would most likely receive the greatest benefit from the expected growth.

13.5.5 Showground Station

Figure 13.5 Showground Station – Local Businesses

The location of local businesses relative to the Showground Station is shown in **Figure 13.5**.

Business Survey

The site verification addresses the area surrounding the proposed station and the Castle Hill Trading Zone.

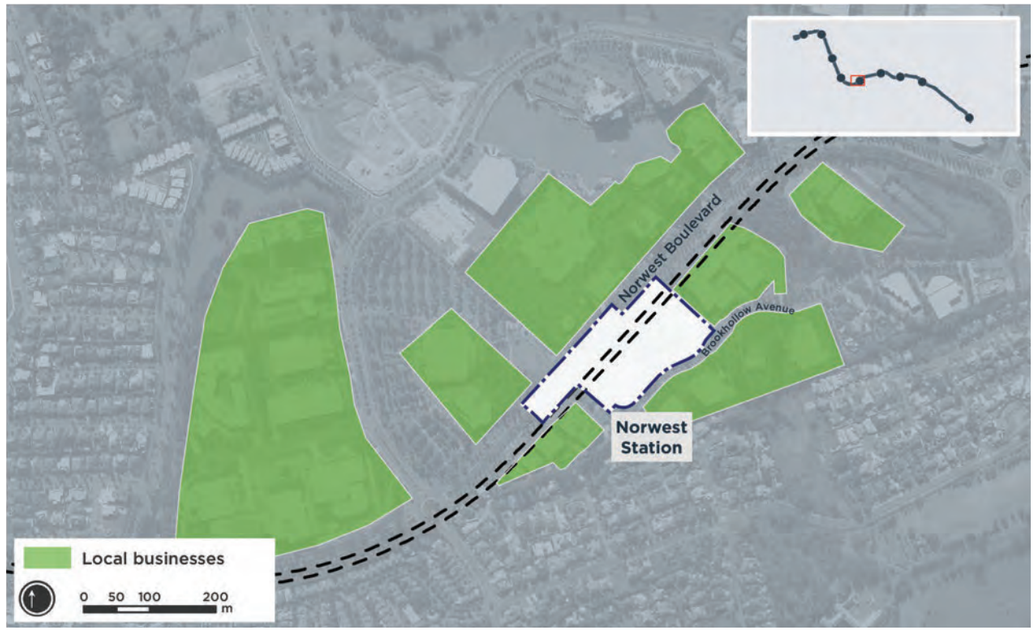
The area largely consists of retail outlets and other social community infrastructure. Businesses include education (Hills College TAFE, Carrington Pre-School Long Day Care), health and community services (Castle Hill Baptist Church) and retail (e.g. Car sales yards – Holden, Ford, Mitsubishi, Toyota). The Castle Hill Tavern is located east of the proposed station location.

Potential impacts during operation

- The anticipated growth in patronage, population and employment may result in increased competition for retail spaces within close proximity to the station, potentially leading to increased rental for these spaces.
- The increase in rents may in turn lead to business operators re-establishing their businesses further away from Showground Station where rents may be lower, providing the incumbents with increased competition. This may be particularly evident for small food outlets or cafes which may relocate to other premises due to increased cost pressures.
- The Carrington PreSchool and low rise commercial businesses surrounding the station are expected to undergo minor changes in accessibility due to an increase in through traffic in the locality.
- The Castle Hill Showground which provides for a range of activities during the weekday and on weekends as well as annual events, would benefit from the increased accessibility to the area, including reduced journey times for patrons.
- The precinct north of Showground Road which provides for exhibitions and events on weekends, and other recreational facilities in the locality (e.g. Castle Hill Indoors Sports Centre, Castle Hill Caterson Tennis Centre, and Hills Basketball Centre) would benefit from the increased accessibility to the area, including reduced journey times for patrons.
- The incoming patrons to the recreational facilities would provide flow-on effects to associated businesses (i.e. food stalls, canteens), including the Castle Hill Tavern.
- Commercial businesses providing trade services and bulky goods within the Castle Hill Trading zone could be expected to benefit from an enlarged pool of workers travelling to and from the North West.

13.5.6 Norwest Station

Figure 13.6 Norwest Station – Local Businesses



Norwest Station would be located within the major employment and specialty centre of Norwest Business Park. The area has experienced recent strong growth and the proposed station location is intended to promote further growth and employment and residentialdevelopment opportunities. Furthermore
it is noted the Hills Council Chambers would be relocated to within the Norwest Business Park.

Patrons from the Norwest station will be served through the existing Norwest Market Town which contains an abundance of retail and foodoutlets.

The location of the proposed station is within close proximity to low rise commercial businesses situated to the west and north east of the station. This is likely to allow convenient access for employees.

Norwest is expected to experience steady growth in residential and employment.

The location of local businesses relative to Norwest Station is shown in **Figure 13.6**.

Business Survey

The site survey identified businesses impacted directly north and north west of the proposed works. These businesses include:

- Retail (10)
- Accommodation, cafes and restaurants (16)
- Transport and storage (1)
- Finance and Insurance (3)
- Property and Business Services (2)
- Health and Community Services (5)
- Cultural and Recreational Services (1)
- Personal and other services (7)

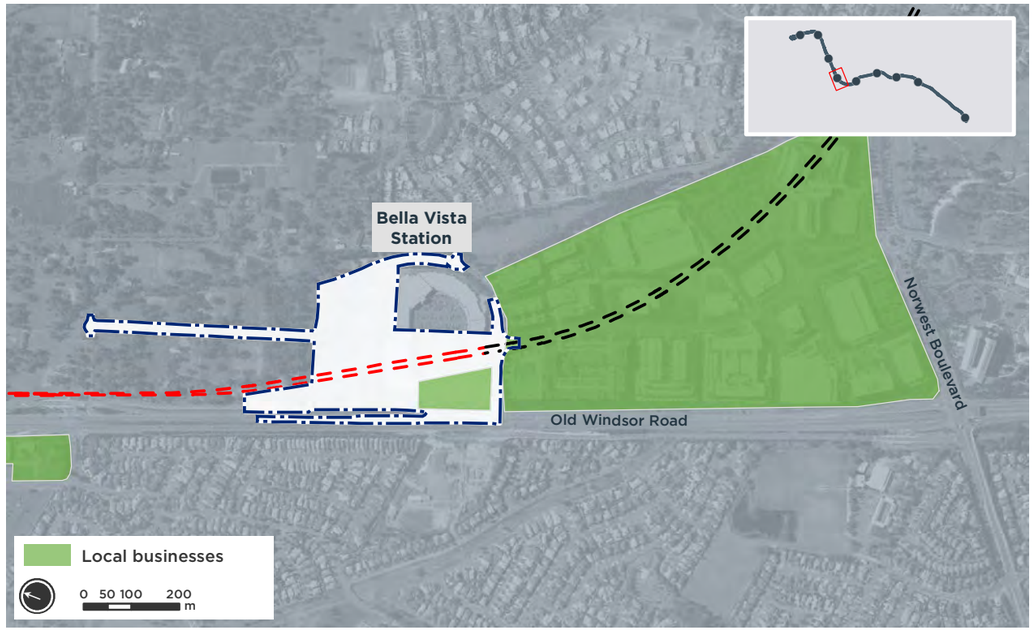
The low rise commercial businesses adjacent to the site were not included in the business survey as their impacts were envisaged to minimal.

Potential impacts during operation

- As a result of population and employment growth it is expected that existing businesses (i.e. Cafes, Food outlets, Retail) surrounding Norwest Station would experience increased competition from new businesses seeking to establish themselves to meet the increase in demand.
- Existing businesses, particularly those located within the Norwest Market Town may experience upward pressure in rents as demand for retail space (e.g. Retail, Accommodation, Cafes and Restaurants) increases.
- Accessibility for businesses in the precinct is unlikely to be reduced as Norwest Boulevard would continue to support traffic movements. As a specialised employment centre, the Norwest Business Park encompasses many retail, highly skilled employment and commercial businesses. The Station provides improved accessibility and availability of businesses, customers, visitors and employees to the region.
- It is expected that increased connectivity to the Norwest Business Park would provide for concentration and clustering of businesses and employees. This may potentially create opportunities for further employment growth and diversification of businesses.

13.5.7 Bella Vista Station to Rouse Hill Station

Figure 13.7 Bella Vista Station – Local Businesses



Bella Vista Station

The location of local businesses relative to Bella Vista Station is shown in **Figure 13.7**.

Business Survey

Two local businesses exist along Old Windsor Road and both businesses are likely to experience impacts during the station's operation. These businesses are:

- McDonalds
- BP service station

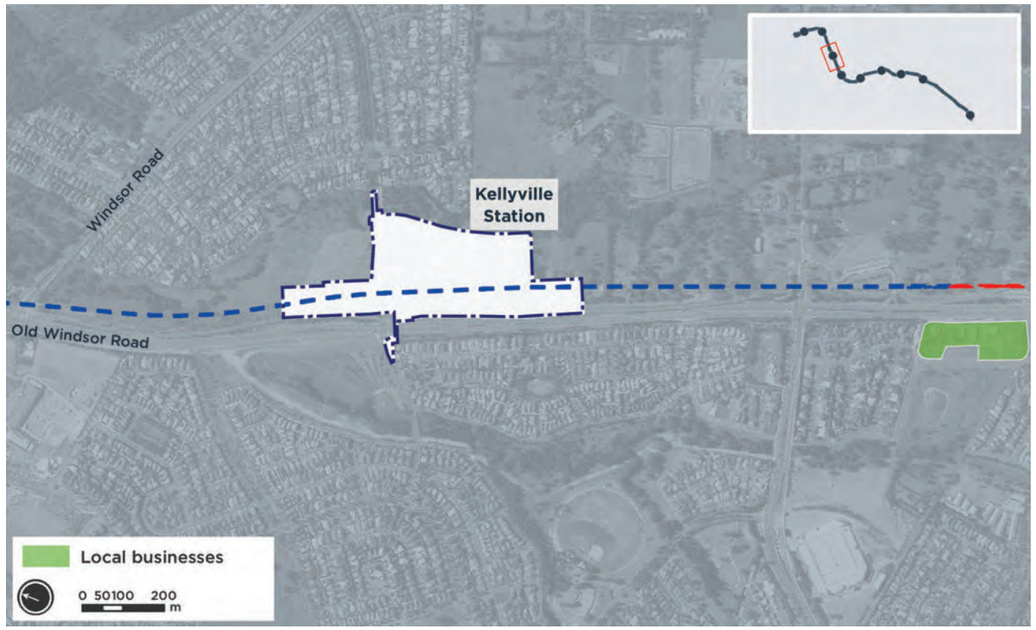
There are also low rise commercial businesses along Celebration Drive.

Potential Impacts During Operation

- The close proximity of Bella Vista Station to the low rise commercial estates and improvements in transportation afforded by the project is likely to attract new business operators to the area. New commercial businesses may establish themselves in surrounding areas due to the increased connectivity and accessibility. This may result in enhanced competition for incumbents if similar businesses were established.
- The potential for the Norwest Business Park to extend further north provides added incentive for new businesses to relocate to Bella Vista to complement the surrounding services. In this regard the demand for property spaces may increase for new and incumbent commercial businesses operators at Bella Vista.
- It is envisaged that the McDonalds located adjacent to the station anny experience increases in demand for their product. Additionally the BP service station may also experience increased passing traffic and hence increased demand for goods and services.
- At the same time, the operation of the station would complement the development of the Norwest Business Park. As a specialised employment centre, improved network connectivity will enable enhanced movement of people, greater geographical concentration and clustering of businesses and employees.

13.5.8 Kellyville Station

Figure 13.8 Kellyville Station – Local Businesses



The location of local businesses relative to Kellyville Station is shown in **Figure 13.8**.

Business Survey

A survey was undertaken adjacent to the proposed station along Old Windsor Road. Businesses in the area are located on Old Windsor Road in the vicinity of Miami Street. These businesses include:

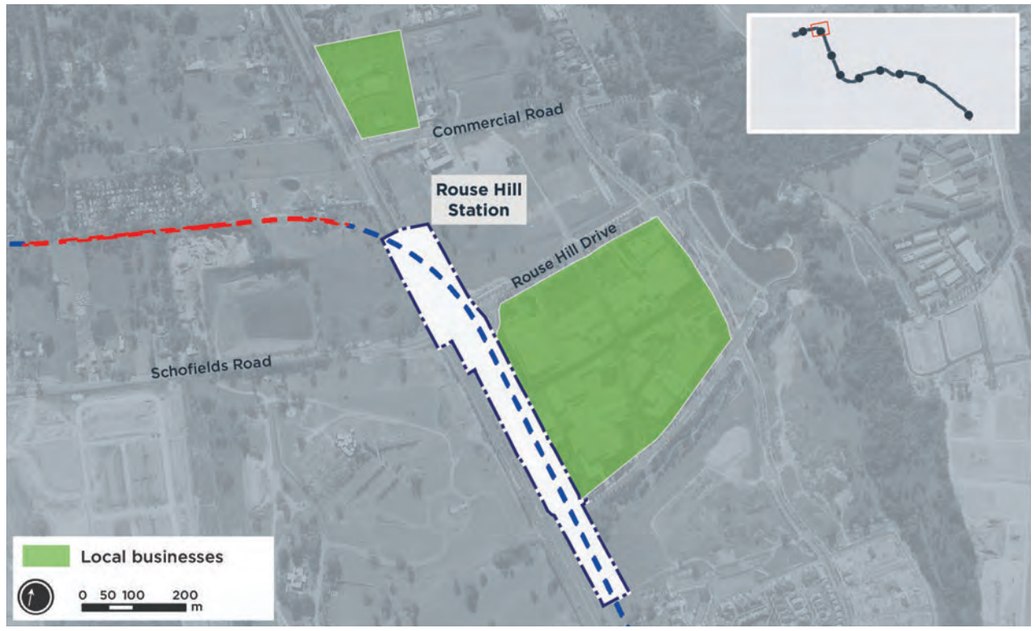
- Accommodation, cafes and restaurants (3)
- Personal and other services – car wash (1)
- Retail – Caltex service station (1)

Potential Impacts During Operation

- It is envisaged that retail space (e.g. cafes, minimarkets, dry cleaners) within the station and its surrounds would develop over time. The notable increase in patronage growth may put upward pressure on rents despite the provision of additional businesses, as demand increases for the limited number of retail spaces.
- With employment growth in Kellyville expected to be significant, new businesses may be established, leading to greater competition for existing businesses along Old Windsor Road (i.e. Accommodation, Cafes and Restaurants).
- As the station is located at some distance from the surveyed businesses, it is expected that minimal accessibility and visibility impacts would be experienced.
- The proposed station would provide improved services for current and future residents of Kellyville as a result of the station's operation. A larger availability of workers for businesses within the north-west sub-region is also expected, given the increased accessibility provided by the station.

13.5.9 Rouse Hill Station to Tallawong Stabling Facility

Figure 13.9 Rouse Hill Station – Local Businesses



Rouse Hill Station

The location of local businesses relative to Rouse Hill Station is shown in **Figure 13.9**.

Business Survey

A site verification of the businesses within the Rouse Hill Town Centre identified the predominant businesses in the Rouse Hill Town Centre to be:

- Retail Trade (132)
- Accommodation, cafes and restaurants (47)
- Health and community services (14)
- Finance (8)
- Professional Services (4)
- Other (17)

A small cluster of businesses is also located south of the Rouse Hill Town Centre along Windsor Road in the vicinity of Merriville Road. These businesses include:

- Accommodation, cafes and restaurants (2) – McDonalds and Ettamogah Pub
- Retail Trade (2) – Dan Murphy's and Caltex service station.

Potential Impacts during Operation

- Rouse Hill Station provides enhanced accessibility to over 225 businesses at Rouse Hill Town Centre for visitors and consumers from across Sydney.

Those businesses within the Accommodation, Cafes and Restaurant industry in the locality are expected to be best placed to benefit from the increase in passing trade.

13.5.10 Cudgegong Road Station and Tallawong Stabling Facility

Cudgegong Road Station and the Tallawong Stabling Facility are located within the Area 20 precinct of the North West Growth Centre.

Business Survey

A survey conducted along Schofields Road identified no businesses in the immediate vicinity of the proposed station and stabling facility. However, it is noted that a planned neighbourhood centre is located adjacent to the proposed station.

Potential Impacts during Operation

- With no businesses identified along the station and stabling yard locality, impacts were not considered at this location.
- The increased connectivity and accessibility provided by the project is likely to provide residents of Area 20 and its surrounds greater ease of access to employment centres.
- With the planned development of the local village, opportunities for new businesses are likely to emerge to service demand.

13.6 Assessment of Impacts – Construction

The following section assesses the potential impacts on local businesses during the construction of station facilities. It includes:

- Identification of the potential impacts (positive and negative) on local businesses during construction.
- Identification and classification of existing businesses in the immediate vicinity of the Stage 2 construction works based on targeted site surveys at each construction site. Businesses were classified in accordance with ABS (2011).
- Assessment of the type, direction and magnitude of potential impacts by qualitatively discussing the impacts at each of the sites.

13.6.1 Epping Services Facility to Bella Vista Station

Epping Services Facility

The construction workforce would comprise approximately 30 full-time equivalents (FTEs) at the Epping Services Facility. Further jobs such as suppliers of materials for the construction workforce would also be indirectly created by the project.

Potential Impacts During Construction Works

- Accommodation, Cafes and Restaurants and Retail Trade on Rawson Street and Beecroft Road may experience reduced operating amenity due to noise and vibration impacts, however these would be temporary and intermittent over the construction period.
- Businesses along both Rawson Street and Beecroft Road are likely to experience increased trade from construction workers. It is envisaged that the retail businesses (i.e. Coles, newsagencies, convenience stores and mini supermarkets) would service the construction workforce with everyday necessities.
- The 7/11 service station situated at the corner of Beecroft and Carlingford Road would also likely experience increased demand for their convenience goods due to its close proximity to the construction site.
- The Cafes and Restaurants in the area would also likely experience an increase in demand for goods and services during the construction works. In this regard, the incomes for these businesses and their employees may also increase to reflect the increased trade.

13.6.2 Cheltenham Service Facility

During the construction works of the Cheltenham Services Facility it is envisaged the workforce would be approximately 15 FTEs. Further jobs such as those associated with servicing the construction workforce (e.g. material suppliers, mechanics for construction vehicles) would also be indirectly created by the project.

Potential Impacts During Construction

- No negative impacts on local businesses are anticipated from the construction works at Cheltenham.
- The cluster of small businesses and food outletslocated at Beecroft Station may experience additional demand and positive flow-on effects from the construction works at the Cheltenham site.

13.6.3 Cherrybrook Station

Works would primarily consist of construction of the station fit out and rail infrastructure and systems.

Construction works at Cherrybrook Station would approximately utilise 60 FTEs , further jobs such as those associated with servicing the construction workforce (e.g. material suppliers) may also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction noise and vibration impacts on businesses such as the two health and community centres, the education centre on the eastern side of the immediate construction vicinity on Franklin Road and child care centre on the western side of the construction site on the corner of Glenhope Road/ Castle Hill Road are discussed in Chapter 10. Two clusters of local businesses are located within approximately two kilometres of the construction site. One at Shepherds Drive to the northeast and the other at Coonara Avenue to the southwest of the works. Businesses such as the cafes, food outlets and convenience stores providing everyday necessities may experience increased patronage from workers during construction works.

13.6.4 Castle Hill Station

Construction works at Castle Hill Station would primarily consist of construction of the station building and fit outs in addition to the rail infrastructure and systems.

During the construction works, the workforce would be approximately 30 FTEs at the Castle Hill Station. Further jobs such as those associated with servicing the construction workforce (e.g. material suppliers, equipment manufacturers) may also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction traffic and transport impacts on businesses are discussed in Chapter 9.
- Potential construction noise and vibration impacts on businesses are discussed in Chapter 10.
- Retailers and cafes, restaurants and food outlets along Old Castle Hill Road may experience poor visibility during construction from placement of hoarding and fencing along the construction site boundary and/or the movement of construction vehicles.
- During construction work, a small to moderate increase in the demand for goods and services may be expected. The businesses which are most likely to experience this demand are the food outlets and local retailers along Old Northern Road and within Castle Towers Shopping Centre due to the flow-on effects of construction workers.
- Overall, there is potential that construction related works would induce a rise in incomes for local businesses (by the spending of direct and indirect workers.

13.6.5 Showground Station

The construction works at Showground Station would require a workforce of approximately 60 FTEs during the peak construction period. Further jobs such as those associated with servicing the construction workforce (e.g. material suppliers, servicing agents) would also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction traffic and transport impacts on businesses are discussed in Chapter 9.
- Potential construction noise and vibration impacts on businesses such as Hills College TAFE, Carrington Pre-School Long Day Care and Castle Hill Baptist Church are discussed in Chapter 10.
- Certain businesses within the Castle Hill industrial area may experience increased trade. Food outlets may have increased flow-on effects from the construction workforce.

13.6.6 Norwest Station

A workforce of approximately 20 FTEs is envisaged during the peak construction period. Further jobs such as those associated with servicing the construction workforce (e.g. material suppliers, equipment manufacturers) would also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction traffic and transport impacts on businesses including those on Brookhollow Avenue are discussed in Chapter 9.
- Potential construction noise and vibration impacts on businesses are discussed in Chapter 10.
- Industries which would most likely benefit from construction are the cafes, restaurants, food outlets and retail outlets catering for the day-to-day needs of the construction workforce (e.g. large retail supermarkets, fruit/vegetable markets).
- During construction works, a small to moderate increase in sales and demand may be expected in these industries as a result of the flow-on effects from construction workers in the area. Businesses located within the Norwest Market Town would primarily benefit from the demands of the construction workforce.

13.6.7 Bella Vista Station to Rouse Hill Station

Bella Vista Station

The construction works at the Bella Vista Station are likely to require a workforce of approximately 20 FTEs. Further jobs such as suppliers of materials for the construction workforce would also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction traffic and transport impacts on businesses are discussed in Chapter 9.
- Potential construction noise and vibration impacts on businesses are discussed in Chapter 10.
- Accessibility to the McDonalds and BP service station would be altered as a result of construction works. The entrance to these businesses, would be relocated.
- The close proximity of construction works to McDonalds and the BP service station may result in an increase in business related sales from the construction workforce.

13.6.8 Kellyville Station

Construction work at the Kellyville Station is likely to employ a workforce of approximately 20 FTEs during the peak construction period. Further jobs such as those associated with servicing the construction workforce (e.g. material suppliers, servicing agents) would also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction traffic and transport impacts on businesses are discussed in Chapter 9.
- Potential construction noise and vibration impacts on businesses are discussed in Chapter 10.
- The cafes, restaurants and service station at this location, in particular the Hungry Jacks and Caltex service station would most likely experience an increase in business from construction workers.

13.6.9 Rouse Hill Station to Tallawong Stabling Yard

Rouse Hill Station

The construction works at the Rouse Hill Station would potentially consist of a workforce of approximately 20 FTEs during the peak construction period. Further jobs such as suppliers of materials for the construction workforce would also be indirectly created by the project.

Potential Impacts during Construction

- Potential construction traffic and transport impacts on businesses are discussed in Chapter 9.
- Potential construction noise and vibration impacts on businesses are discussed in Chapter 10.
- The erection of construction fencing, height of material stockpiles and frequent movement of large heavy machinery may result in businesses such as cafes and restaurants, located adjacent to the station construction site being less visible from Windsor Road.
- The cafes, restaurants and eateries within the immediate vicinity of the construction works are expected to experience an increase in demand for goods and services from construction workers.
- Health and community services and retailers catering for everyday needs (e.g. chemist, supermarkets) may also experience increased demand for goods from construction workers.

13.6.10 Cudgegong Road Station and Tallawong Stabling Facility

During the construction works of Cudgegong Road Station and Tallawong Stabling Facility a combined approximate workforce of 140 FTEs would be employed. Further jobs such as those associated with servicing the construction workforce (e.g. material suppliers, mechanics for construction vehicles) would also be indirectly created by the project.

Potential Impacts during Construction

- There are no businesses currently in the station and stabling facility locality; therefore, no negative impacts on local businesses are anticipated during the construction works along Schofields Road.
- During the construction period, workers may travel to Rouse Hill Town Centre which is located 1.5 km east of the works. Certain types of businesses (e.g. food and beverage retailers and supermarkets) in the Centre may therefore experience positive flow on effects as a result of worker related expenditure in the vicinity.

13.7 Mitigation Measures

Based on the investigations described above no operation mitigation measures are required.

Mitigation measures developed to address construction impacts would form part of the Construction Environmental Management Framework, provided in Appendix B which details the environmental, stakeholder and community management systems and processes for the construction of the NWRL.

These mitigation measures and their application to the construction sites for the NWRL are presented in **Table 13.7**.

In addition to the mitigation measures identified in **Table 13.7**, measures outlined in other EIS chapters would assist in alleviating the potential negative sources of construction impacts that may affect the day-to-day operation of businesses including:

- **Accessibility** – Appropriate way-finding signage would be provided to ensure drivers' understanding of access to local businesses adjacent to construction works including signage related to parking for stopping motorists (as detailed in Chapter 9 Traffic).
- **Construction worker parking** – Construction worker parking areas would be planned to minimise impact of parking availability for customers and staff of local businesses (as detailed in the Chapter 9 Traffic).
- **Operating amenity** – Chapter 10 (Noise and Vibration) and Chapter 19.1 (Air Quality) identifies effective mitigation measures for controlling temporary amenity impacts during construction.

Table 13.7 Mitigation Measures Construction

No.	Mitigation Measures	Applicable Sites
LB1	A business consultation group would be formed to monitor, consider and provide business specific advice to manage the impacts during construction. Members of the consultation group may include representatives from local councils, and the NSW chamber of commerce and industry.	1, 3-17
LB2	The project has employed specialist Place Managers to act as a single, identifiable and direct point of contact for local residents, business people and community groups with the project during construction. Place Managers would work closely with all affected local businesses to help ensure timely responses to queries.	1, 3-17
LB3	A business impact risk register would be developed to identify, rate and manage the specific impacts associated with construction related works for individual businesses.	1, 3-17
LB4	A toll free number and website would be in place for the duration of the construction works to enable business owners and/or operators to receive prompt responses to their concerns, access information and view assistance measures in place during construction related works.	1, 3-17

Site 1 - Epping Services Facility, Site 2 – Not Used, Site 3 - Cheltenham Services Facility, Site 4 - Cherrybrook Station, Site 5 - Castle Hill Station, Site 6 – Showground Station, Station, Site 7 - Norwest Station, Site 8 - Bella Vista Station, Site 9 - Balmoral Road, Site 10 - Memorial Avenue, Site 11 - Kellyville Station, Site 12 - Samantha Riley Drive to Windsor Road, Site 13 - Old Windsor Road to White Hart Drive, Site 14 - Rouse Hill Station, Site 15 - Windsor Road Viaduct, Site 16 - Windsor Road Viaduct to Cudgegong Road, Site 17 - Cudgegong Road Station and Tallawong Stabling Facility