CHAPTER 14

LANDUSE AND COMMUNITY FACILITIES

14 LAND USE AND COMMUNITY FACILITIES

14.1 Introduction

This chapter assesses the potential impact of the operation and construction of the NWRL on existing land uses, known future land uses and community facilities. The framework for integrated land use and transport planning is described through the consideration of the existing character, planning controls, potential impacts on surrounding land uses, as well as mitigation and management measures to reduce any potential adverse impacts.

The relationship between the NWRL and land uses is primarily being addressed through a parallel precinct planning and land use integration process centred around each station location. This process is being led by the DP&Infrastructure in consultation with Councils and TfNSW. As part of this process, broader land use planning and development issues which influence each area are being assessed for the existing and potential future environments. The outputs of the process are expected to guide the future planning for integrated and transport oriented development around each station precinct. Ongoing consultations are 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.

Existing strategic plans developed by State and Local Government for areas around the NWRL have been reviewed as part of this EIS. The outcomes of this process are discussed in Section 14.5 of this chapter which discusses opportunities for the integration of the station precincts within the surrounding area.

The NWRL would provide important transport infrastructure that would support opportunities for future residential, business and commercial development around each station, thereby assisting in the achievement of State targets for additional dwellings and employment and increasing the mode share by public transport for this area. The development of the NWRL would increase transport choice within the region and between regions, providing increased accessibility for those without private vehicles.

The land use and community facilities assessment aims to achieve a number of objectives to ensure minimal adverse impacts on existing and future land uses occur as a result of the operation of the NWRL. These objectives include:

- Land use and transport integration that promotes accessibility and good urban design that activates areas and provides spaces of high functionality.
- Facilitating appropriate and responsible future development around the stations.
- Providing connectivity, amenity, safety and security for pedestrians, cyclists, vehicles and public transport through the design of station buildings, entries, intersections and street upgrades.
- Facilitating high quality built form that is sensitive to the local context and high quality design of station and railway buildings.
- Supporting the planned growth of the north west region and the key centres along the route.

14.2 Director General's Requirements, Statement of Commitments, Conditions of Approval

Table 14.1 sets out the Director-General's Requirements, the Conditions of Approval and Statement of Commitments as they relate to land use planning and community facilities, and indicates where each item is addressed.

Table 14.1 Director-General's Requirements, Conditions of Approval and Statement of Commitments

Director-General's Requirements Reference	Description	Addressed
Director-General's Requirements 31 August 2012	Integration with current and future land use plans and studies, and precinct/structure planning, in consultation with the Department (Strategies and Land Release and Plan Making and Urban Renewal) and relevant Councils, including:	Section 14.5.
	▪ Impacts on land use as a result of the change in design to a viaduct, the proposed Cudgegong Station and Tallawong Stabling Facility	Sections 14.6 and 14.7
	▪ Potential land severance and connectivity to and across the rail corridor	Sections 14.4 and 14.6
	▪ Impacts associated with ancillary and servicing facilities	Sections 14.6 and 14.7
	▪ Consideration of the Land Use and Rail Integration Study for Area 20 (CFA, 2011).	Section 14.5.8
CoA Reference	**Description**	**Addressed**
Project Design	2.1 The Proponent shall in consultation with relevant Government agencies, relevant Councils and relevant stakeholders, ensure that underground components of the project are designed with regard to existing and/ or planned future underground utilities and infrastructure including the planned extension of the M2 Motorway.	Chapter 5. Section 14.5
	2.2 The Proponent shall in consultation with relevant Councils and relevant Government agencies including (but not necessarily limited to) the SLR, the Department, Landcom, ensure that surface components of the project are integrated with surrounding land use (existing and planned future, as relevant) as far as feasible and reasonable, consistent with the objectives of Integrated Land Use and Transport (DUAP 2001 or as updated), to minimise the potential for land use conflicts. In particular: ▪ design of Castle Hill station shall consider the Castle Hill Draft Master Plan (or as updated); and ▪ Kellyville and Rouse Hill Stations and stabling facilities are to be integrated with the precinct planning for the Burns Road Release Area, Rouse Hill Regional Centre and the Area 20 precinct of the North West Growth Centre, as relevant.	Chapter 5. Section 14.5

Director-General's Requirements Reference	Description	Addressed
	2.4 The Proponent shall ensure that station precincts across the project provide a high degree of accessibility to all modes-of-access, consistent with the objectives of *Integrated Land Use and Transport* (DUAP 2001 or as updated).	Chapter 9 and Chapter 6
Project applications and specific requirements	3.1c An updated assessment of statutory matters, where the project affects land that has not already been identified in the documents referred to in conditions 1.1 (a) to (d).	Chapter 3
Property and Land use	3.2 The Proponent shall confirm the footprint of the project with respect to alignment, station precincts and ancillary infrastructure as far as feasible and reasonable, and describe the land use impacts on existing and planned future use associated with any additional land take.	Chapter 7. Section 14.4 and Section 14.5.
Statement of Commitments	**Description**	**Addressed**
Land use, property and infrastructure planning	6. Consultation with Councils, the Growth Centres Commission, RailCorp and other relevant stakeholders would be undertaken to ensure environmental planning instruments reflect planning, construction and operation of the project and include integrated planning provisions for appropriate development controls within the vicinity of the rail line and stabling facility.	Chapter 5.
	7. Land use and property impacts of the project, including construction sites and all ancillary facilities, would be further assessed in consultation with Councils and surrounding landowners.	Sections 14.6 and 14.7 Chapter 9 and Chapter 5.

Director-General's Requirements Reference	Description	Addressed
	8. A Land Asset Management Strategy to address 'land surplus to use', post construction would be developed jointly with the Department of Planning (Land Management Branch) in consultation with Councils, Growth Centres Commission and RailCorp. This strategy would investigate opportunities for land amalgamation of parcels severed by the project and identify opportunities for development that is consistent with surrounding land use planning.	To be developed in consultation with key stakeholders as part of the precinct planning work. This would be undertaken during the NWRL construction phase and would be completed prior to commencement of NWRL operations.
	9. Consultation with relevant Councils, government agencies, utility providers, land owners and communities involved in the planning of precincts in the vicinity of each station would be undertaken with the aim of encouraging transit-orientated development around each station. The role of each station within the context of provision of public transport services would be established, including the need and capacity of park and ride facilities, establishing connections with other transport modes (including the potential for integrated ticketing), and integrating pedestrian and cyclist facilities.	Chapter 5
	10. Further investigations would be undertaken with respect to the planned expansion of the Castle Hill Shopping Centre and integration of the project with the Castle Hill Draft Master Plan.	Section 14.5.3 Chapter 5 Chapter 20

14.3 Methodology

14.3.1 Operation

The process of understanding and assessing the surrounds of each station and above ground components was undertaken using the following approach:

- Definition of the existing catchment for assessment. The parallel precinct planning study being undertaken by DP&I, local Councils and TfNSW identifies that the NWRL would be a catalyst for new development and in particular, development at higher densities in areas that are in walking or cycling catchments of a 400 metre-800 metre radius around a station. Assessment of existing and future land use has, however, been conducted for this study over a larger 1,600 metre radius area, to fully capture potential impacts within the surrounding area and to remain consistent with the DP&I precinct planning study.
- Description of the existing environment with reference to natural and built form characteristics, planning controls, key attractors and community facilities. Information to describe the area has been predominantly sourced from desktop surveys, zoning maps and site visits. It should be noted that the existing environment for the operation phase is taken to be post construction.
- Review of strategic planning policies and master plans relevant to the study corridor to identify planned future development by the State, councils and private authorities.
- Identification of constraints including barriers to movement and connectivity and interchange opportunities.
- Assessment of the potential implications for existing and likely future land uses, from the construction and operation of the NWRL. Assessment considered land use requirements of the project and potential changes to existing or likely future land use, community facilities and development.
- Identification of opportunities for future transit oriented development including key attractors and integration with existing land uses, facilities and transport services.
- Identification of mitigation measures to avoid or manage potential impacts on land use.

14.3.2 Construction

The objective of the land use and community facility assessment in relation to the construction of the NWRL as outlined in EIS 2 Stations, Rail Infrastructure and Systems is to ensure that potential impacts to surrounding land uses are identified and managed appropriately.

Assessment of impacts from construction works on land use and community facilities has been carried out by undertaking the following key tasks:

- Providing an overview of the existing character and land use in the immediate vicinity of the construction sites. The existing environment for the construction phase is described as the area post EIS 1 Major Civil Works construction activities. Construction of elements described in EIS 1 Major Civil Works would have occurred resulting in an existing environment for EIS 2 Stations, Rail Infrastructure and Systems of a disturbed construction site.
- Identifying key community facilities that would be either directly or indirectly impacted by the construction works.
- Identifying the planned future development within the project area that may be impacted by the construction works.
- Identifying potential land use and community impacts associated with the construction works focussing on the direct impacts of the construction footprint.
- Compilation of mitigation measures (general and specific) that would assist in reducing the land use and community impacts.

14.4 Existing Environment

This section describes the existing environment. A general overview of the wider area surrounding the route is provided, followed by more detailed station precinct descriptions encompassing a 1,600 metre radius area from each station. The 1,600 metre distance provides a practical zone of influence that ensures areas between stations are assessed appropriately and all impacts likely to result from the NWRL are identified. Information presented here is based predominantly on a desktop survey, supported by existing and proposed future land use zoning.

14.4.1 Overview

The NWRL traverses a large distance from Epping to Cudgegong Road, Rouse Hill via the major centres of Castle Hill and Rouse Hill and the specialised centre of Norwest. Land uses within close proximity to the NWRL include business, commercial, industrial, special uses, residential, open space and conservation and rural. Station locations have been determined with a view to service as many existing key land use areas as possible as well as future key land use and areas of growth.

The NWRL would facilitate essential connectivity and form a direct link to the global economic corridor, extending from Sydney CBD to Parramatta via North Sydney and Macquarie Park. This provides the opportunity to strengthen the corridor, extending it into the highly skilled areas of the north west and connecting the major business and employment centres of Norwest Business Park, Macquarie Park, Chatswood and onto the Sydney CBD.

The north west has experienced significant levels of growth over the past 10 years with continued rapid growth into the future expected, driven by new land releases, the proximity to the North West Growth Centre and the high demand for land within the area. Nearly 350,000 people currently live in north west Sydney.

Employment in the area has also increased significantly in the north west over the last 15 years. The number of additional jobs is planned to increase in the period between 2006 and 2036 as follows:

- **Castle Hill** – Increase of 5,000 jobs from 8,000 in 2006 to 13,000 in 2036
- **Norwest** – Increase of 17,000 jobs from 13,000 in 2006 to 30,000 in 2036
- **Rouse Hill** – Increase of 12,000 jobs from 0 in 2006 to 12,000 in 2036

(Metropolitan Plan for Sydney 2036, DP&I 2010).

Zoning

Land use planning within and adjacent to the NWRL alignment is governed by relevant provisions of:

- *Hornsby Shire Local Environmental Plan 1994* (Hornsby LEP 1994).
- *The Hills* Local Environmental Plan *2012* (Hills LEP 2012).
- *Blacktown Local Environmental Plan 1988* (Blacktown LEP 1988).

The NWRL alignment traverses a range of zoning within these three LGAs as discussed below.

Hornsby Shire Council has also drafted new comprehensive LEPs for the LGA namely:

- *Draft Hornsby Local Environmental Plan 2012* (Draft Hornsby LEP 2011).

Land within the North West Growth Centre is governed by the SEPP *(Sydney Region Growth Centres) 2006*.

Current land use zonings are discussed in the following sections and future land use zonings in Section 14.5.

14.4.2 Epping Services Facility

Existing Character and Land Use

The proposed Epping Services Facility would be located within the established town centre of Epping, on the western side of Beecroft Road and about 350 metres north of Epping Station. **Figure 14.1** shows the Services Facility site which is located on land currently used for commercial purposes.

The Epping town centre has a commercial area centred around the existing railway station and provides a mix of smaller scale retail, cafes, restaurants, heath services and community facilities. The surrounding residential suburbs of Epping, North Epping and Cheltenham consist of a variety of housing styles, primarily of lower density, however there are some pockets of medium and high density residential development surrounding the town centre and station. Built form within Epping varies in age with recent, modern development intermingling with some older, inter-war style dwellings. Infill development is evident in some areas, particularly around the town centre, which have allowed higher housing densities to be achieved to cater for some demand.

Areas of vegetated corridors exist to the north of Epping Services Facility.

Upon commencement of works described in EIS 2 Stations, Rail Infrastructure and Systems, the existing environment in the surrounding areas would not have been noticeably altered from current conditions. The actual Services Facility site would be the only localised change in the existing environment with the commercial use having changed to that of a construction site.

Zoning

The zoning of an area reflects the current built form nature of the wider area as well as the desired development for particular locations. Under the Hornsby LEP 1994, the Epping Services Facility site is zoned as Business B (Special). This zoning extends south a short way from the site location. To the north is a small area zoned Open Space A (Public Recreation – Local). Bordering the site to the west is a strip of land zoned Residential C (Medium High Density) separating the Residential A (Low Density) from the site. To the east is the existing railway corridor separating the adjoining Special Business and Medium High Density Residential zones from the site location.

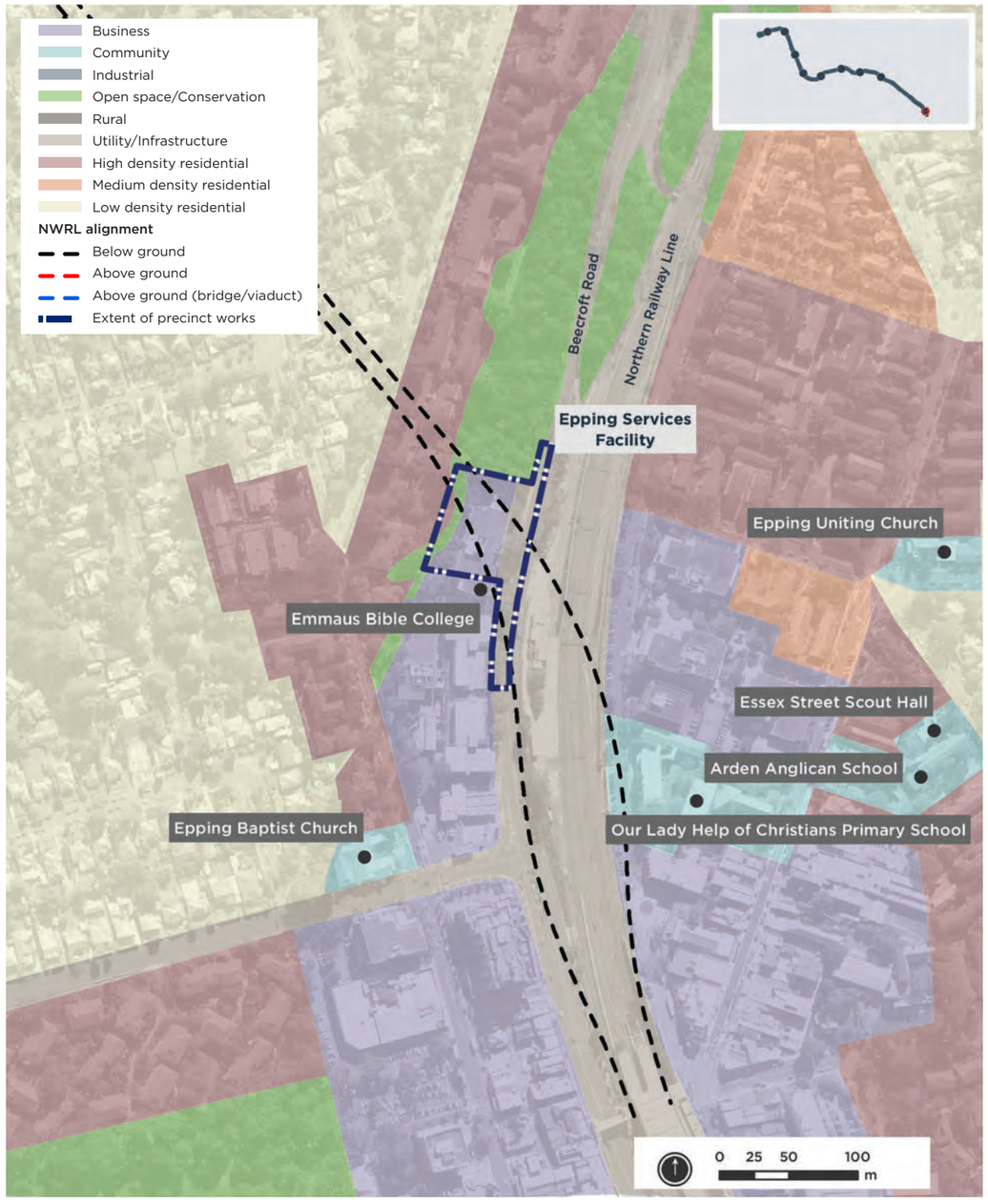
Under the Draft Hornsby LEP 2011, the Epping Services Facility site is proposed to be zoned as B2 (Local Centre). This zoning is consistent with the existing zoning and would not result directly in a significantly altered character. The Medium High density Residential zoning in the surrounding area has been changed to R4 High Density Residential.

Community Facilities

A number of community facilities, listed in **Figure 14.1**, are in close proximity to the proposed site including the Essex Street Scout Hall, places of worship (Epping Uniting Church and Epping Baptist Church) and educational establishments (Arden Anglican School and Our Lady Help of Christians Primary School). The installation of the Epping Services Facility would not cause any operational or physical changes to these facilities nor alter their community value.

The Emmaus Bible College is currently operating at the location of the proposed Epping Services facility and would be acquired.

Figure 14.1 Land use and community facilities – Epping services facility and Epping decline sites



14.4.3 Cheltenham Services Facility

Existing Character and Land Use

The proposed Cheltenham Services Facility would be located between Castle Howard Road and the M2 Motorway, adjacent to the Cheltenham Oval. The facility would be located within the construction site created by EIS 1 Major Civil Construction Works. This area was previously open space predominantly incorporating the netball training courts at Cheltenham Oval. Existing land use in the immediate vicinity of the proposed Services Facility is shown in **Figure 14.2**.

The locality is characterised by low density residential with a recreational area comprising a range of sporting facilities including netball training and tennis courts, cricket nets, a playground and a large sports oval. The location is set amongst natural vegetation with Beecroft Reserve located directly to the north west. Vegetation also extends to the south east providing a buffer between the M2 and residential areas. This vegetation forms part of a larger green corridor network extending north and south across the M2 as well as to the north east into a large area of natural open space. To the north of the site, the area is characterised by established low density residential dwellings with large established gardens and street trees.

Zoning

Under the Hornsby LEP 1994, the Cheltenham Services Facility site is zoned as Open Space A (Public Recreation – Local). In the surrounding area this zoning extends north west/south east, bordering the Special Uses B (Transport Corridor) which supports the M2 to the south. Extending out from these zones is predominantly Residential A (Low Density). Small areas of Open Space A (Public Recreation – Local) and Special Uses A (Community Purposes) are scattered within the surrounding area.

Under the Draft Hornsby LEP 2011, the Cheltenham Services Facility site is zoned RE1 (Public Recreation) and the surrounding areas remain consistent with current zones.

Community

A number of community facilities are located within the immediate vicinity of the proposed Services Facility including Beecroft Nursing Home, Chesalon Care Beecroft-an aged care facility, Beecroft Reserve and Cheltenham Oval as shown in **Figure 14.2**.

Recreation

Cheltenham Oval

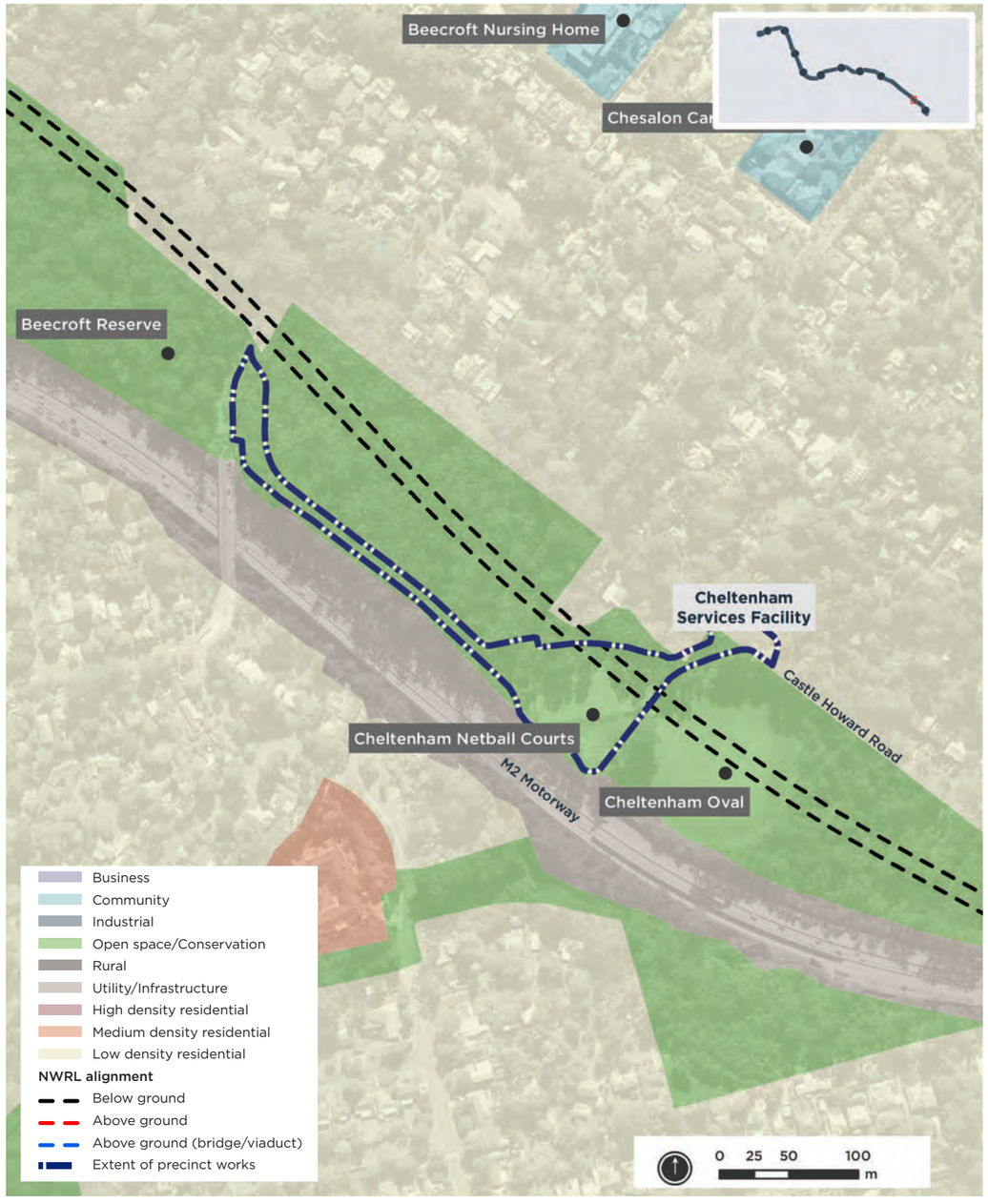
Cheltenham Oval, constructed in the 1930s and located on Castle Howard Road, provides a venue for active recreation offering an oval, netball training courts, a playground and cricket nets. The oval is primarily used as a soccer field during the winter months and for cricket matches during summer. The four netball training courts are used throughout the year. Sporting facilities are utilised by a number of different clubs and sporting associations.

Beecroft Reserve

Beecroft Reserve, situated directly to the north west of Cheltenham Oval and bounded by the M2 to the south, is an important bushland reserve for surrounding residents. Hornsby Shire Council declared the reserve a Wildlife Protection Area in 2006.

The bushland reserve is highly valued by the community and provides opportunity for active and passive recreation including walking, mountain biking, picnicking and bird watching. Local groups are also active maintaining the local bushland within the reserve.

Figure 14.2 Land use and community facilities – Cheltenham services facility site



14.4.4 Cherrybrook Station

Existing Character and Land Use

Cherrybrook Station would be located adjacent to the northern side of Castle Hill Road, between Robert and Franklin Roads, approximately two kilometres south of the existing Cherrybrook village centre. Cherrybrook Station would be constructed within a construction site created by EIS 1 Major Civil Construction Works (**Figure 14.3**) . Previous land uses at this site includes several large residential blocks with established homes incorporating wide grassed areas and gardens of exotic and native vegetation. A high voltage (132kV) transmission line crosses the site to the east, set back from Franklin Road by one row of houses. One of the transmission towers is located within the construction footprint, about half way along the south east boundary.

The area around Cherrybrook Station is well established with subdivision having occurred in 1959. At this time the original bushland was cleared and exhibition homes were built on cut and fill sites to form the first project home village in Sydney. This initial development was followed by further accelerated development in the 1980s during which the semi-rural area became a residential boom suburb and the characteristics of today's environment were formed. Prior to residential development, this area had been used as a farm first producing peaches, pears, plums and citrus fruit, and later dairy. Upon commencement of works described in EIS 2 Stations, Rail Infrastructure and Systems, the existing environment in the surrounding areas would not have been noticeably altered from current conditions. The actual station site would be the only localised change in the existing environment with the residential use having changed to that of a construction site.

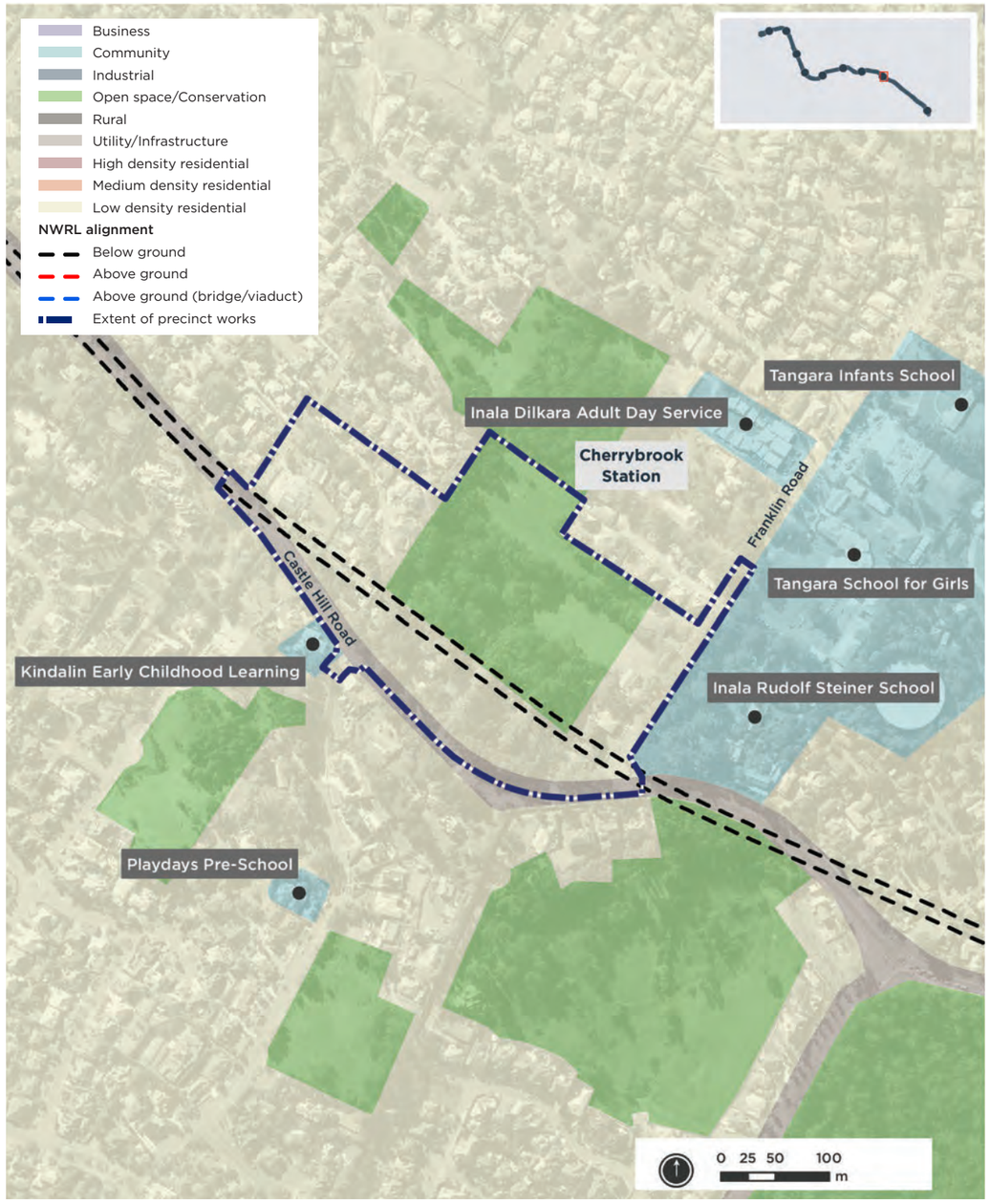
Today, the Cherrybrook locality is characterised by generally large, low density dwellings predominantly built within the last 30 years, surrounded by established vegetation, green open spaces and natural corridors across the undulating topography. Houses are generally set back from the street front with landscaping. Limited medium density housing in the form of townhouses is available where new pockets of recent infill development have occurred.

At the station location, the population is currently low with only 1-25 people per hectare. Surrounding this immediate location, however, higher population densities extend out from the station, north of Castle Hill Road with a patchwork of areas housing 26-31, 32-41 and more than 41 people per hectare. The area south of Castle Hill Road has lower population densities with a fairly even split between areas with 1-25 people per hectare and those with 26 to 31 people per hectare.

Zoning

Cherrybrook Station is located within the Hornsby LGA adjacent to the border with The Hills Shire LGA. Under the Hornsby LEP 1994, the Cherrybrook Station site is zoned as Residential A (Low Density). Likewise, the area within the Hornsby LGA surrounding the station site is also largely zoned as Residential A (Low Density). To the south of the station in The Hills LGA, bounded by Castle Hill Road, land is zoned E4 (Environmental Living) which aims to preserve the low-impact large lot residential development already established in the area and reflects geotechnical constraints to development.

Figure 14.3 Existing land use in the immediate vicinity of Cherrybrook Station



Key Attractors

A range of community facilities and key attractors exist in the area surrounding Cherrybrook Station as discussed below (**Figure 14.3**).

Educational Establishments

A number of educational establishments are located within a 1,600 metre radius from the station including Tangara Infants School, Tangara School for Girls, Inala Rudolf Steiner School, Cherrybrook Public School and Oakhill College.

Cherrybrook Technology High School falls just over 1,600 metre north of the station and within close proximity to the existing village centre. Cherrybrook Technology High School is one of the largest government secondary schools in NSW with over 1,900 students. This school, together with the village centre, may form a major attractor in the area, with Cherrybrook Station serving as a crucial link for accessibility. This station would provide rail services to this area at roughly half the distance to the nearest existing station of Pennant Hills.

Commercial

IBM Australia

IBM Australia is located on a large area of land on Coonara Avenue just off Castle Hill Road and about 800 metres to the south of the station. IBM Australia represents a major employer, and therefore key attractor within the area and is currently largely accessible by car. The NWRL would provide an alternative sustainable transport option for the commute to work.

Open Space

A number of reserves and open space areas serve as recreational facilities for residents for both passive and active activities. Noteworthy reserves within close proximity to the Cherrybrook Station include Castlewood Community Reserve and George Thornton Reserve.

Cumberland State Forest

Cumberland State Forest to the south east is a State forest providing 40 hectares of native forest and supporting recreational facilities such as walking tracks, picnic areas and education opportunities to the public. Currently, access to the forest for the majority of the community is by private vehicle. The NWRL would offer an alternative mode of transport for people to access the facility.

The Koala Park Sanctuary

The Koala Park Sanctuary is located along Castle Hill Road, south of the station and forms a major tourist attraction in the area. Officially opened in October 1930, the Koala Park has been providing a natural and safe habitat for Koalas and other Australian native animals for many decades. Currently a tourist destination that is heavily reliant on road accessibility, the NWRL may open up this venue to travellers who do not have access to a car or bus services.

Other Community Facilities and Key Attractors

The Anglican Retirement Village to the north west of the proposed station houses a large number of retirees and employs many people, generating a high volume of traffic movements. Located between Cherrybrook Station and Castle Hill Station, the NWRL may provide an alternative means of transport for employees to travel to work as well as increasing accessibility to relatives and residents.

Other community facilities include childcare centres and an adult day care service.

14.4.5 Castle Hill Station

Existing Character and Land Use

The proposed Castle Hill Station would be situated beneath Arthur Whitling Park, between Old Castle Hill Road and Old Northern Road. The location is at the core of the Castle Hill Major Centre within the retail precinct centred around Castle Towers. The station would be located within the existing environment comprising a construction site created by EIS 1 works. This area was previously utilised as open space, part of Old Northern Road reserve and one commercial property on Old Castle Hill Road. (**Figure 14.4**)

Generally, higher population density occurs to the south of the proposed station location with the majority of the area ranging in population densities of between 26-31 and 32-41 people per hectare. There are some areas of more than 42 people per hectare to the south of the station. To the north of the station population densities are generally lower with the majority of the area containing between 1-25 and 26-31 people per hectare.

Castle Hill is a well-established urban area with development having occurred upon the opening of the original tram line in 1910 and the subsequent land subdivision. From the 1950s, urban development rapidly spread into the Castle Hill area, further establishing an urban centre and causing a decline in the former agricultural uses. Construction within the urban centre is ongoing with recent and future expansions of Castle Towers, alterations to the road layout and the upgrade of Old Northern Road to provide a more pedestrian friendly connection between Castle Towers and Castle Mall. The section of Old Northern Road between Crane Road and Terminus Street has recently been closed to public vehicles and reserved as a 'bus only' road, to support the public transport services and interchange at this location.

The area immediately surrounding the station is dominated by the shopping precinct including Castle Towers, Castle Mall and numerous speciality retail and commercial uses extending south along Old Northern Road. There are a number of independent businesses and offices located within close proximity to the construction site. A part of the main bus interchange is located on Old Castle Hill Road outside the David Jones entrance to Castle Towers providing numerous bus services throughout the LGA and neighbouring regions and a layover facility.

The Castle Hill locality is highly urbanised with large scale shopping centres, pedestrian focussed malls and retail streets. The retail precinct is surrounded by residential uses with higher densities clustered around the commercial core and medium and low density further afield. The predominant housing stock within Castle Hill consists of single detached dwellings on larger blocks. Higher density housing stock is becoming more prevalent in the area through infill development of apartments and some townhouses. The mix of retail, civic, education, employment and residential creates a variety of urban forms in the area surrounding the station. The built form consists of a variety of style and ages, predominantly built within the last 30 years. Within the retail centre, buildings are often built to the edge of the lot creating a strong urban edge along streets and footpaths. Limited open space is available within the centre.

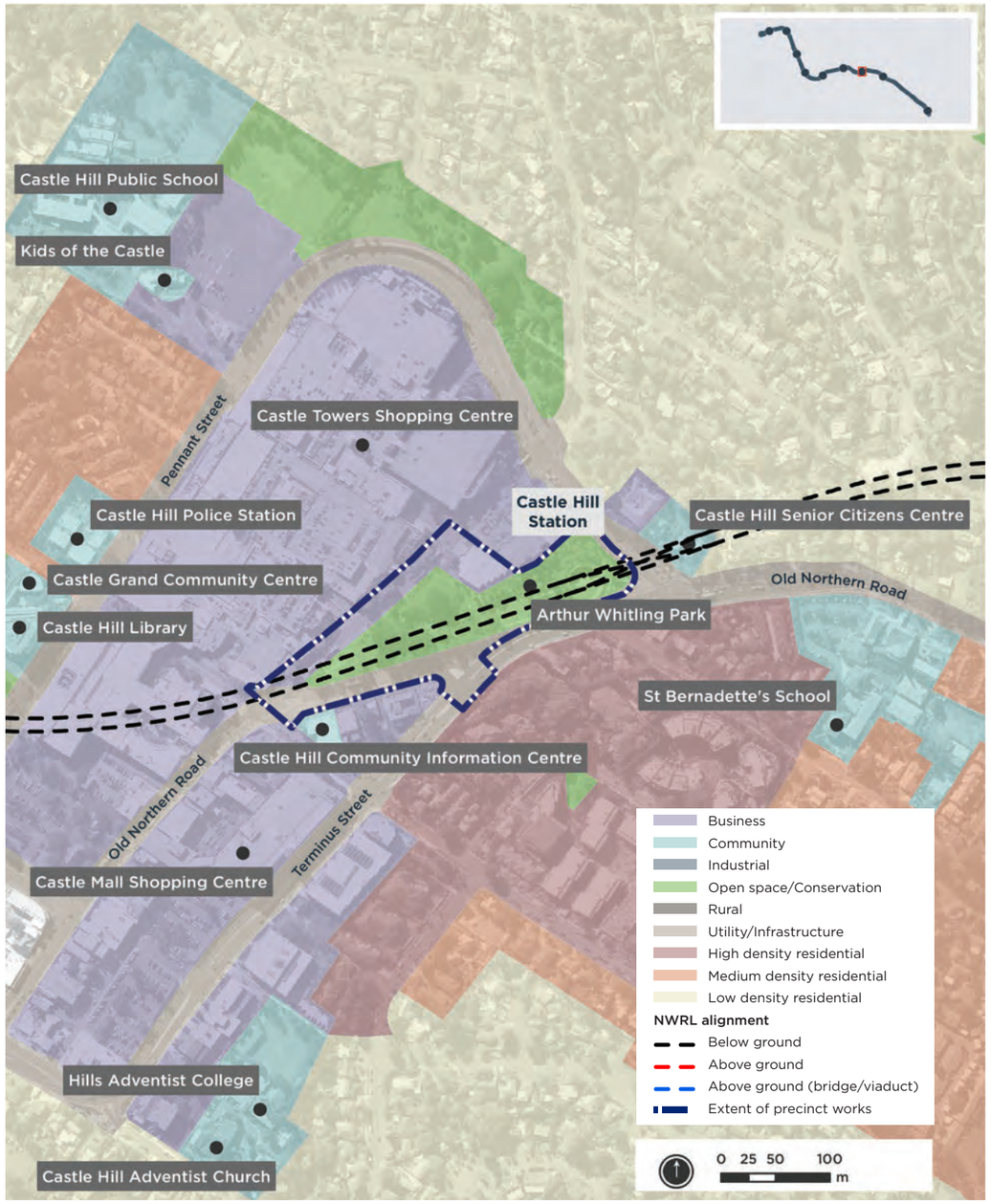
The majority of employment uses within Castle Hill centre are retail related and some professional employment is provided in small commercial offices.

The Castle Hill Station would provide access to the major retail core of Castle Towers and surrounding key attractors from a wide catchment area. As Castle Hill is a Major Centre as defined in the Sydney Metropolitan Strategy, the true catchment is likely to be very large, with people commuting from further away to access the facilities available. This station would be a key destination from a regional perspective.

Zoning

Under The Hills LEP 2012, Castle Hill Station would be located in Arthur Whitling Park, zoned RE1 Public Recreation. During construction, the site would include land containing the zones of R1 General Residential to the north and R4 High Density Residential to the south. Once operational, access to the station would be contained within the RE1 Public Recreation zone. Castle Towers, adjoining the site to the north west, and Castle Mall, to the south west of the site, are zoned B4 Mixed Use. Bordering the Mall, to the south east of Terminus Street is a small business area zoned R1 General Residential. Residential is the dominant land zoning in the surrounding area. Immediately adjoining the area zoned for Castle Towers are fairly large areas of land zoned R4 High Density Residential, permitting higher densities close to the centre core. Surrounding the centre core and high density zones is a large area of R3 Medium Density Residential, and extending further out from the centre, the predominant zone is R2 Low Density Residential. Areas of RE1 Public Recreation and small areas of SP2 Infrastructure are scattered in the surrounding area to serve various community purposes. It is clear from the zoning that the area surrounding the station has a level of regional significance as a major centre through the provision of various essential land uses and that the centre would be well supported through the introduction of mass transit transport.

Figure 14.4 Existing land use in the immediate vicinity of Castle Hill Station



Key Attractors

Community Facilities

Many community facilities are located in close proximity to the station site including Castle Hill Library and Community Centre, Castle Hill Police Station, Castle Hill Senior Citizens Centre, Castle Hill RSL and fitness club, Castle Hill Bowling Club, the Anglican Retirement Village and numerous childcare centres (**Figure 14.4**). These facilities are discussed below.

The Anglican Retirement Village forms a major attractor and community facility to the north west of the station. The Village houses a large number of retirees and employs many people, therefore generating a high volume of traffic movements. Located between Castle Hill Station and Cherrybrook Station, the NWRL may provide an alternative means of transport for travel as well as increasing accessibility.

After extensive renovations in 2003 that saw Castle Hill RSL virtually rebuilt and C2K Fitness and Aquatic Centre developed adjoining the main club, Castle Hill RSL has become a major attractor within the area, regularly filling the extensive car park. As well as being a key attractor, Castle Hill RSL is integral to the community due to its commitment to sponsoring sport clubs within the Hills District. Additionally a range of community clubs meet at the RSL for activities including chess, billiards, backgammon, badminton, canasta, jazz, fishing, golf, photography, pipe band and youth club to name a few.

Educational Establishments

A number of educational establishments are located within a 1,600 metre radius from the station including St Bernadette's Catholic School, Castle Hill Primary School, Castle Hill High School, Oakhill College, St Gabriel's School for Hearing Impaired Children, Gilroy Catholic College and the Hills Adventist College.

Open Space

Castle Hill Heritage Park to the north, Pioneer Place Reserve and Castlewood Community Reserve as well as smaller neighbourhood parks are located within 1,600 metres of the proposed station.

Arthur Whitling Park

The construction footprint for the Castle Hill Station site would temporarily restrict access to Arthur Whitling Park and would permanently alter the landscape. The park is historically significant, housing some monuments and memorials. The northern end of the park contains a war memorial incorporating a Cenotaph and Remembrance Pool around which annual ANZAC Day services are held. Other monuments within the park include a railway heritage structure, a "Lone Pine" tree and memorials to prominent local community figures.

Arthur Whitling Park would be a major construction site for the duration of construction works, rendering it inaccessible for public use.

Retail

Castle Towers Shopping Centre

Castle Towers is a major attractor within the north west region and forms the centrepiece of the Castle Hill Centre. With over 300 stores it is the major traffic generator in the area. An extension of Castle Towers Shopping Centre to the west of Pennant Street (approved by Council February 2011) is planned for the area.

14.4.6 Showground Station

Existing Character and Land Use

The proposed Showground Station site would be located on land bounded by Carrington and Showground Roads on land associated with the Castle Hill showground complex and the Hills Shire Council depot. The existing environment of the station location would be a construction site developed from EIS 1 Major Civil Construction Works.

The majority of the area to the east of the proposed location, and surrounding the industrial area, consists of residential dwellings of a low density character. This residential area typically consists of one and two storey brick veneer houses with generous street setbacks, established trees and a relaxed landscaped character (**Figure 14.5**).

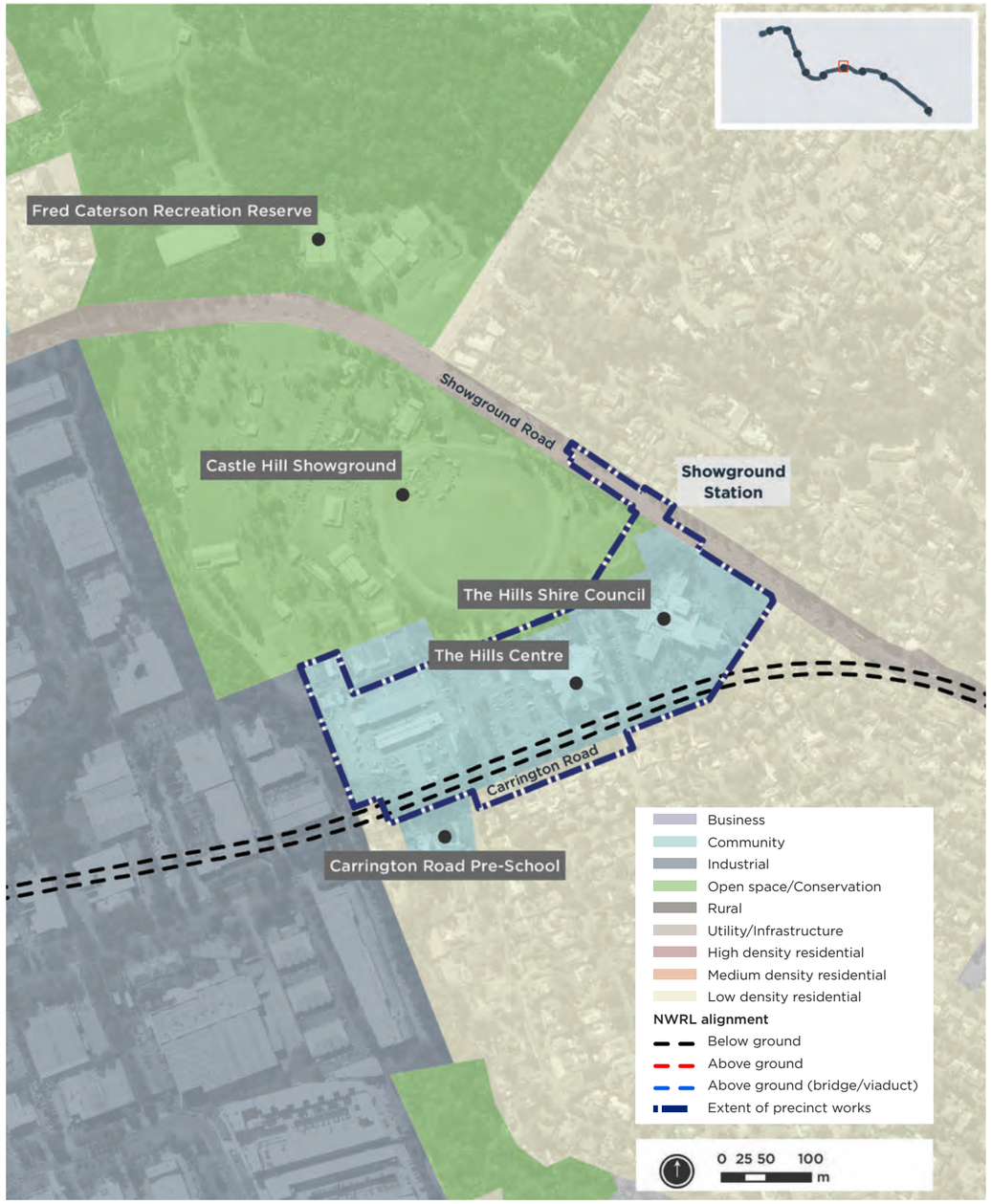
The site boundary has been defined to ensure minimal impact on the area during construction and operation of the NWRL. The showground extends to the east of the construction site to Showground Road. Extending north from the showground and the Station location, across Showground Road, is Fred Caterson Reserve, a large recreational and open space area accessed from the station precinct via a bike track along Cattai Creek, the majority of which is naturally vegetated.

Castle Hill Industrial Area to the west includes a diverse range of commercial land uses including light industrial, warehousing and large-scale bulky goods retail.

Zoning

Under The Hills LEP 2012, the Showground Station site is zoned as B2 (Local Centre), B6 (Enterprise Corridor), RE1 (Public Recreation), B6 Enterprise Corridor and R1 (General Residential). There is a mix of land use zones present in the surrounding area. To the north the Castle Hill Showground and Fred Caterson Reserve are zoned as RE1 Public Recreation. The Castle Hill Industrial Area to the west is zoned IN2 Light Industrial with a corridor along its main spine of Victoria Avenue zoned B5 Business Development. The majority of the remaining area surrounding the station zoned for residential purposes as R2 Low Density Residential. RE1 Public Recreation and RE2 Private Recreation are scattered throughout the area and SP2 Infrastructure is zoned for some places.

Figure 14.5 Existing land use in the immediate vicinity of Showground Station



Key Attractors

The Hills Home Hub, located on the corner of Showground and Victoria Roads is a key attractor in the area with a large number of locals patronising the centre. This centre is located within the industrial area which is characterised by low rise buildings, commonly two to three storeys high, set back and separated from the road by landscaping. A range of services and facilities are located within this 135 hectare precinct including factory units, motor vehicle sales lots, vehicle repairs, commercial, small scale manufacturing, bulky goods retailing, warehousing and some recreational facilities.

Educational Establishments

Educational establishments, Castle Hill High School, Excelsior Public School and Castle Hill TAFE, are located within a 1,600 metre radius from the station.

Recreation Facilities

Castle Hill Showground

Castle Hill Showground is bounded by Showground Road to the north and north east, the Council Chambers to the south and the Castle Hill Industrial Area to the west. The Council Chambers are proposed by The Hills Shire Council to be relocated by early 2014. Located two kilometres from the town centre at Castle Towers and 2.5 kilometres from the Norwest Business Park, the showground forms a historic and important part of life in The Hills Shire area. The showground provides The Hills area with a venue for events throughout the year with facilities including a large trotting track, a variety of grassed areas, grandstands, spectator seating, stables, food service facilities and car parking.

The Castle Hill Agricultural Show is the major, annual event held at the showground and held its 126th Show in 2012. Located at the showground since 1891, it is described as "a country show catering for the city and surrounding districts" (Castle Hill & Hills District Agricultural Society 2011) and provides a platform for many local residents to go on to compete in the Sydney Royal Easter Show. The Showground also hosts a range of special events including concerts, circuses, markets and animal shows.

Fred Caterson Reserve

Fred Caterson Reserve is located directly adjacent to the Castle Hill Showground on the corner of Showground Road and Gilbert Road. Fred Caterson Reserve is a large multi-facility complex covering 58 hectares and offering residents a wide range of active and passive recreational facilities set in a landscaped setting.

The Reserve offers a large area of natural bushland that supports a wide diversity of flora and fauna species.

The Caterson Tennis Centre, run by the Hills District Tennis Association, forms a major part of the Reserve and creates a transition between the built form of Showground Road and the natural areas of bushland.

A wide range of sporting clubs use the reserve facilities including soccer, basketball and cricket clubs to name a few. Personal training groups and recreational sports groups such as orienteering and informal sports groups also use the reserve, with access mainly by car.

14.4.7 Norwest Station

Existing Character and Land Use

The proposed Norwest Station would be located in the specialised centre of Norwest, underground and adjacent to Norwest Boulevard. The station would be built within a construction site created by EIS 1 Major Civil Construction Works. This construction site is within close proximity to Norwest Marketown Shopping Centre, the Hillsong Church, numerous businesses and some Bella Vista residences (**Figure 14.6**).

To the south of the station location the Norwest Business Park houses more than 42 people per hectare. The density declines slightly further south to between 26-41 people per hectare. A low population density currently exists to the north of the business precinct with 1-25 people per hectare. Currently, this area is predominantly vacant land known as the Balmoral Road Release Area and is planned to cater for future employment and housing growth. The area is already in the initial stages of residential development and will house a significant number of people in the future as detailed in Section 14.5.

Development of the 377 hectare Norwest Business Park commenced in 1998, establishing the formation of the major employment area characterised by large format campus style commercial buildings of between three and five storeys located within a modern landscaped setting. Wide roads, large setbacks and established native trees and vegetation separate buildings and create a relaxed and park-like atmosphere that complements the man-made recreational lakes and walking tracks within the area. Footpaths are provided along each road within the business park, promoting walkability within the area. Norwest has succeeded in attracting high profile corporations with many establishing headquarters and major offices within the business park including Woolworths, ResMed Inc, B.Braun, IBM, Schneider and Capital Finance. Norwest continues to grow and attract significant businesses. Amenities that complement the business nature of the area and provide essential services to workers are offered within Norwest Business Park including childcare, hotels, restaurants and gyms. Parklands within close proximity include the Bella Vista Farm Park, reservoir and Village Green as well as some residential and retail land uses including Norwest Marketown.

Norwest is strategically positioned within the road network with a high level of accessibility by private vehicle. Direct access is provided to the M7 and M2 Motorways and the major regional roads of Windsor Road and Old Windsor Road perpendicular to the main spine of Norwest Boulevard.

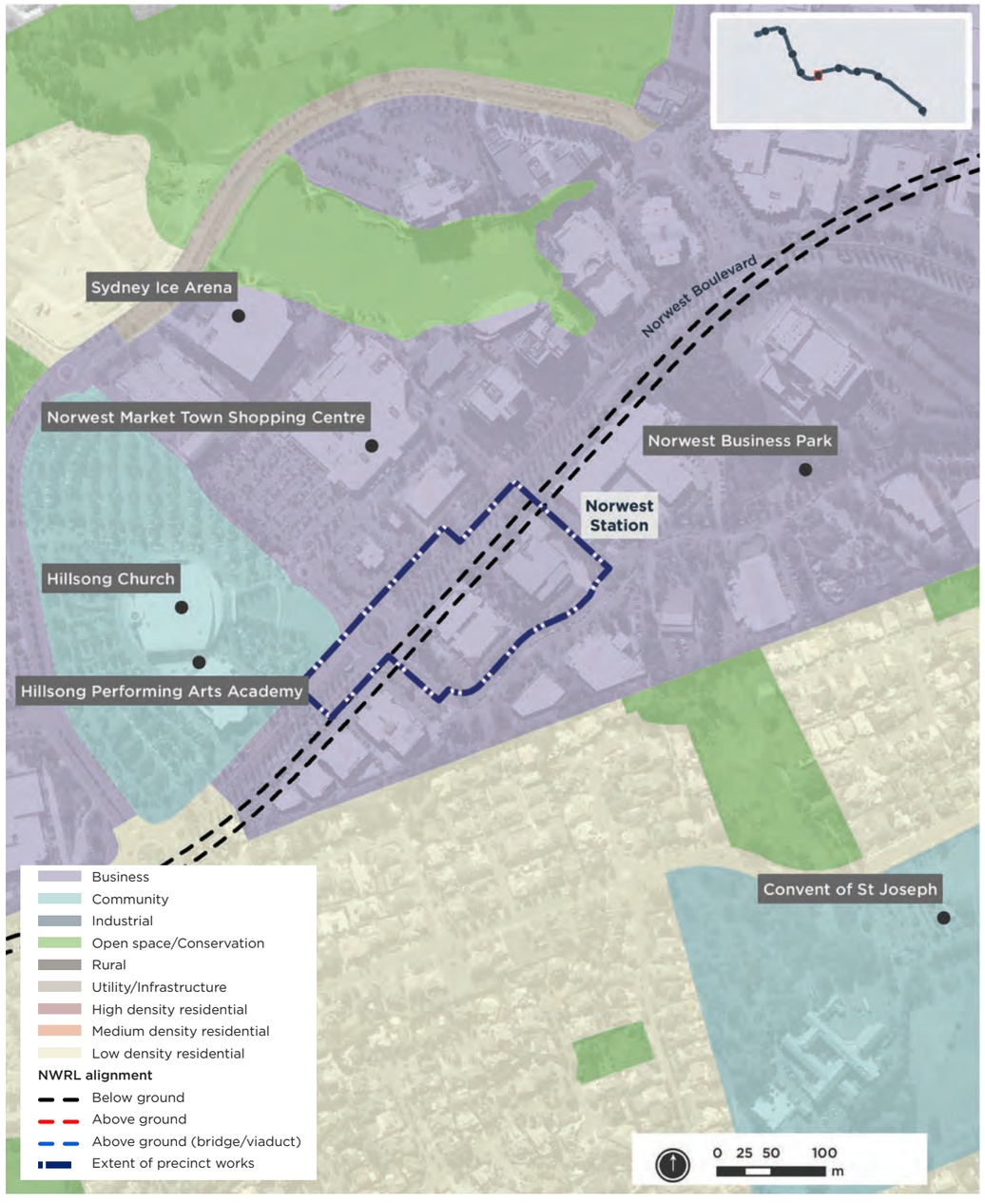
The residential precinct of Bella Vista predominantly lines the southern side of the commercial precinct and contains over 2,000 dwellings, a 22 hectare heritage park and more than 30 hectares of recreational space. Whilst the vast majority of housing in the Norwest area are large single detached dwellings, some medium density options are currently being developed in the form of townhouses and low rise apartments.

Zoning

The Norwest Station is located within the larger area of Norwest Business Park, zoned B7 Business Park, adjacent to the Norwest Marketown zoned B2 Local Centre. The objectives of the two zones surrounding the station are reflected in the character of the existing environment. The area zoned as 'Business Park' has grown to become one of Sydney's employment areas whilst the area zoned as local centre provides the supporting services for the surrounding area.

Higher density residential zones are located within close proximity to the Norwest Business Park with lower densities extending outwards. R4 High Density Residential is allocated to the north of the business park, bordered by R3 Medium Density Residential before being surrounding by R2 Low Density Residential. A corridor running east-west to the south of the business park is largely zoned R3 Medium Density Residential with a small portion in the middle zoned R4 High Density Residential. This is surrounded by R2 Low Density Residential to the south. Extending to the north of the Norwest Centre there is a large area of land comprising the Castle Hill Country Club and golf course zoned RE2 Private Recreation. A IN2 Light Industrial zone comprising the Castle Hill Industrial Area is located to the east.

Figure 14.6 Existing land use in the immediate vicinity of Norwest Station



Key Attractors

A number of community facilities are located in the immediate vicinity of the proposed station. These include Hillsong Church and the Hillsong Performing Arts Academy, the Norwest Marketown Shopping Centre and associated services and other facilities including child care, the Sydney Ice Arena, Bella Vista Village Centre, Bella Vista Farm Park and the Crestwood Community Centre.

Hillsong is a major key attractor within Norwest Business Park offering religious activities and hosting large events on a regular basis. In addition to the main church, Hillsong holds a number of other activities at its location within Norwest including Hillsong College for tertiary education and a music recording studio. These activities attract a large number of people to the area.

No community facilities would be acquired as part of the construction footprint for the proposed Norwest Station.

Educational Establishments

Crestwood High School is the only educational establishment that falls within 1,600 metres of the proposed Norwest Station. Crestwood Public School and St Michael's School fall just beyond 1,600 metres from the station.

Commercial

Norwest Business Park

Norwest Business Park as an entity is a key attractor, generating large volumes of traffic movements due to the number of jobs provided within the area and the additional services and facilities available. Planned future growth within the area would cause additional travel demands to and from the area. Norwest is both a destination for employment and an origin area for residents within the adjacent housing and movements to, from and within the area reflect this.

Open Space

Some open space exists around the centre including Bella Vista Farm Park and Castle Hill Country Club. Bella Vista Farm Park is located on 20 hectares of historic farm land and is open to the public. It features a historic precinct that includes the homestead and farm buildings and hosts community and private events. The Castle Hill Country Club is a private club situated on 167 acres of manicured fairways and gardens and provides golf and event facilities to members.

14.4.8 Bella Vista Station, to Memorial Avenue

Existing Character and Land Use

The proposed Bella Vista Station would be located on the east side of Old Windsor Road just north of Celebration Drive on the former site of the Totally Home Centre. The site is located to the north of the current boundary of the Norwest Specialised Centre with frontage to Old Windsor Road and the existing T-way. The existing environment at the station location would be a construction site as a result of EIS 1 Major Civil Construction Works (**Figure 14.7**).

In the largely undeveloped areas to the north and north east 1-25 people are housed per hectare. To the west of Old Windsor Road within the suburb of Glenwood, the majority of areas house people at more than 42 people per hectare.

The Bella Vista Station area is characterised by large format commercial buildings, which are generally newer and taller than the older part of Norwest to the east, and newer residential lands to the east.

Residential land to the east of the proposed station is mostly low density residential with small pockets of medium density townhouse development. Lands to the north and north east are currently rural in character and will be developed as low to medium density residential uses as part of the Balmoral Road Release Area. A few businesses and recently developed low density residential areas are located to the west of Old Windsor Road in the suburb of Glenwood within Blacktown LGA.

On the corner of Old Windsor Road and Memorial Avenue, about 1.3 kilometres north of the Bella Vista Station, is the T-way station (Burns Road Station), with existing parking capacity for approximately 160 cars. The T-way provides a key transport link through this area between Rouse Hill and Parramatta.

Between Bella Vista Station and Memorial Avenue, the current land use is largely rural or vacant with transformation into a residential area having recently begun as part of the Balmoral Road Release Area.

Zoning

The Bella Vista Station is located in The Hills Shire, adjacent to the border to Blacktown LGA, demarcated by Old Windsor Road. Under The Hills LEP 2012, the construction site is zoned as B5 Business Development and SP2 Infrastructure (Railway Corridor). The Railway Corridor zone extends north in a corridor, catering for the NWRL alignment. The Business Park zone extends to the south. To the east, land is zoned predominantly for residential purposes with areas of SP2 Infrastructure and RE1 Public recreation zones scattered throughout. Directly to the east of the station location, the area is zoned as R2 Low Density Residential. This extends some distance to the east and south. Pockets of higher density residential zones are present within the surrounding area. To the west of the site and Old Windsor Road, in Blacktown LGA, land is predominantly zoned 2(a) Residential.

Key Attractors

A limited number of key attractors are located within the surrounding area

Educational Establishments

Educational establishments within 1,600 metres from the proposed station include Glenwood High School and Anglican Technical College Western Sydney. The Holy Cross Catholic Primary School – Glenwood is located just over 1,600 metres from the proposed station.

Open Space

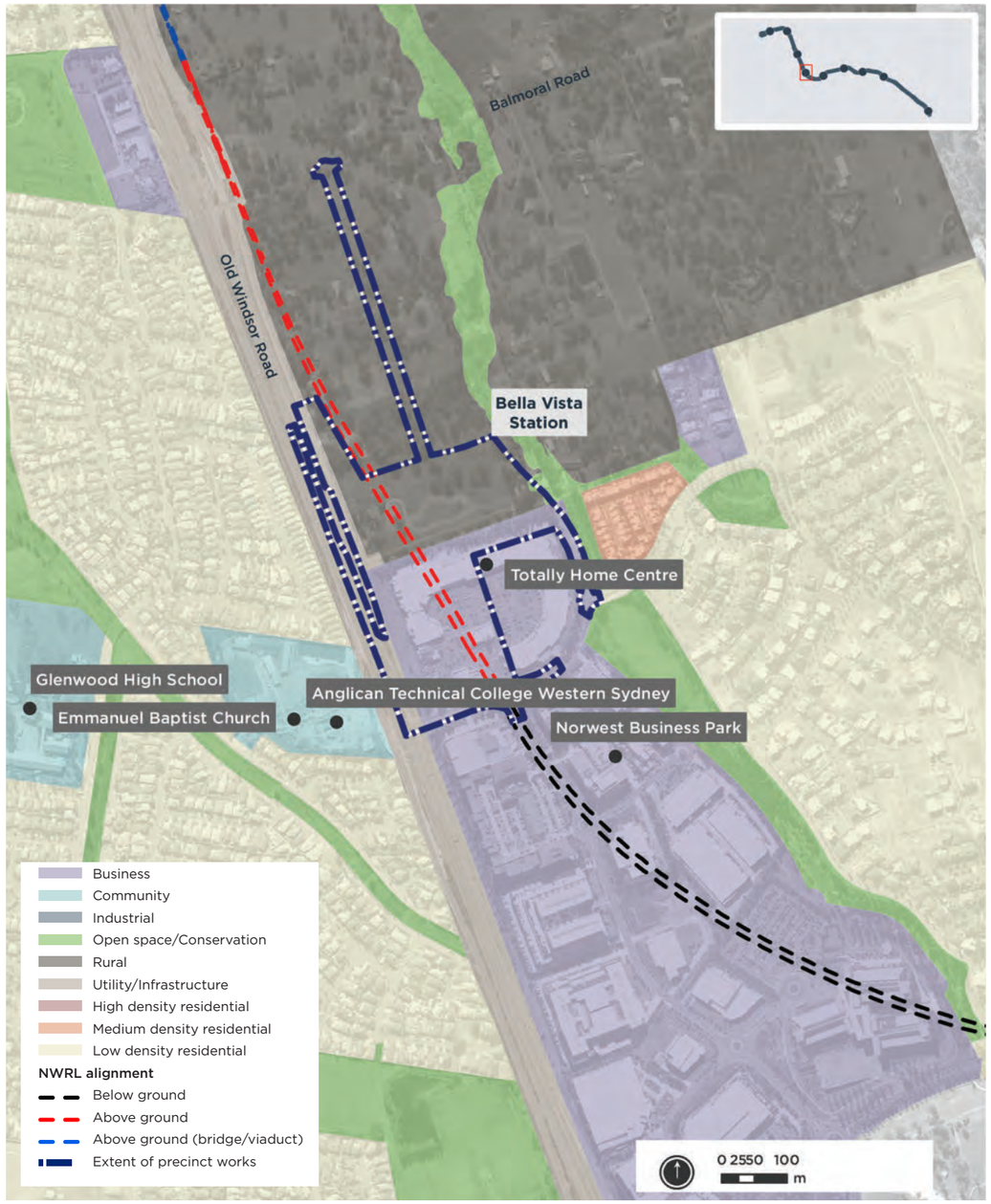
Some open space is provided within the surrounding area including Valentine Sports Park and other neighbourhood parks.

Retail

Parklea Markets

Parklea Markets, located about 1.5 kilometres to the north of the station is a key attractor within the area, drawing large numbers of shoppers over the weekends and generating significant traffic movements.

Figure 14.7 Existing land use in the immediate vicinity of Bella Vista Station



14.4.9 Kellyville Station to Windsor Road

Existing Character and Land Use

The proposed Kellyville Station is located on the southern side of Samantha Riley Drive at the intersection with Old Windsor Road. The site would be located within a construction that previously encompassed a car park and bus interchange, open space and scattered residential properties. The North West T-way car park is located to the west.

Smaller pockets of higher densities exist around the station housing 26-41 people per hectare and a few areas housing more than 42 people per hectare. Lower population densities surround these areas housing just 1-25 people per hectare.

The area to the east of Old Windsor Road is currently vacant land forming part of the Balmoral Road Release Area. The land consists of open plains with some remnant Cumberland Plain woodland coverage and is bordered by Elizabeth Macarthur Creek. Subdivision of this land has been undertaken to allow for future growth with low to medium density residential and business park uses to the east of Kellyville Station. Residential development has taken place recently to the north east of the station and in the vicinity of Sanctuary Drive and is predominantly low density single and two storey detached dwellings (**Figure 14.8**).

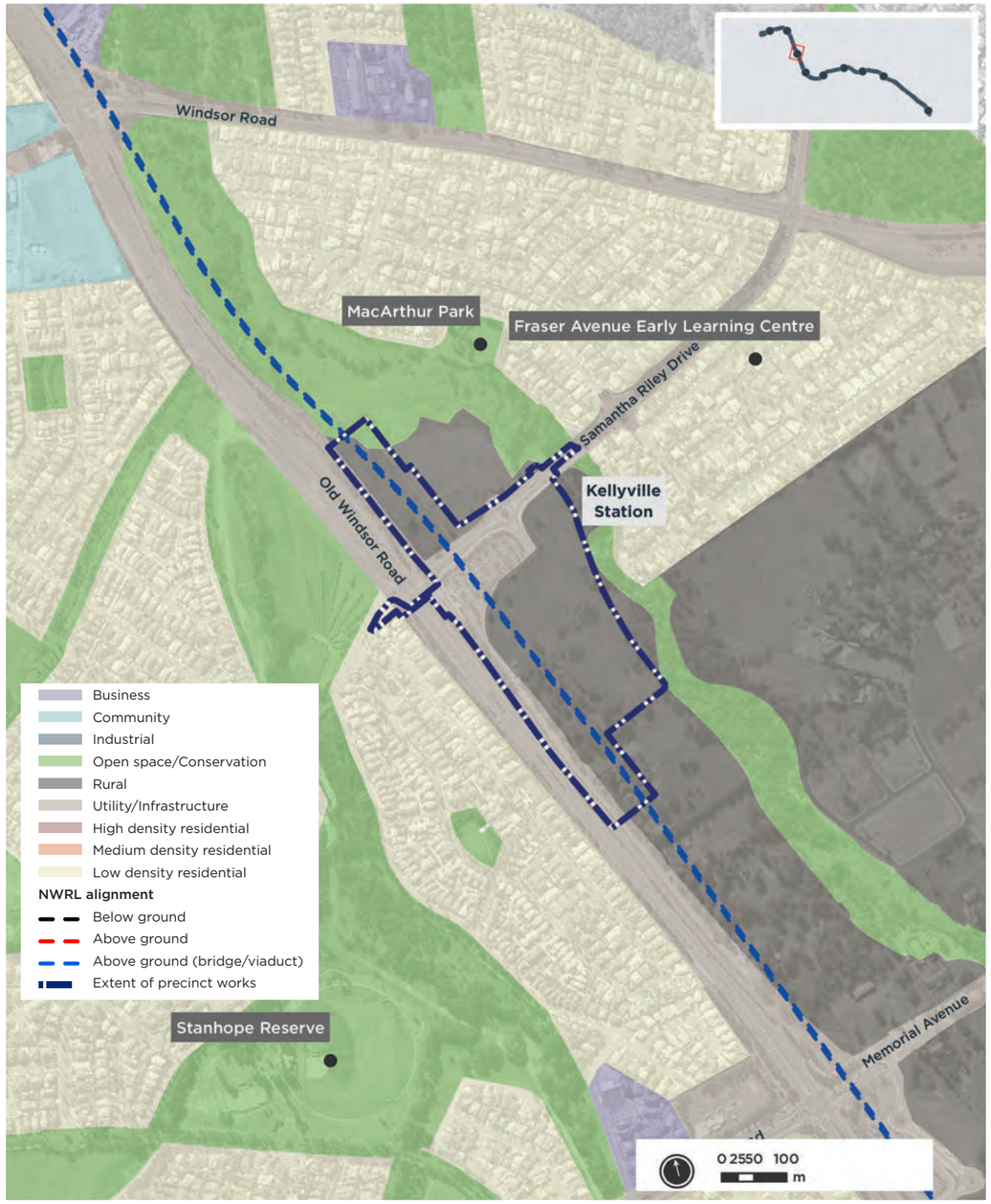
Recently developed low density residential areas are located to the west of Old Windsor Road in the suburbs of Stanhope Gardens and Kellyville Ridge. These suburbs are connected by cycle and walking paths in open space corridors and are bordered by Caddies Creek drainage line and associated floodplain. The character consists of low density dwellings with a mix of housing types including separate detached dwellings and townhouse style houses. Landscaping within the area is a dominant feature with the incorporation of water features and public art.

Kellyville Station is located on the proposed viaduct within the construction site stretching from Memorial Avenue to Windsor Road. Along this area where the viaduct is proposed to be located, the land is currently used as a stormwater management area with the current zoning allowing for the NWRL within this corridor. The area beneath the viaduct and immediately adjacent are not likely to be further developed regardless of the NWRL operation.

Zoning

Under The Hills LEP 2012 the proposed station is located within the zones of SP2 Infrastructure (Railway Corridor) and B7 Business Park. Extending to the south is a corridor of B7 Business Park bordered on either side by SP2 Infrastructure zones for the purposes of Stormwater Management and Railway Corridor. Surrounding this area to the east of the station location is a combination of residential zones including R2 Low Density Residential immediately to the east, a large area of land zoned R3 Medium Density Residential to the north east and south east and some small pockets of R4 High Density Residential. To the north of the station location the SP2 Infrastructure zone for the purpose of stormwater management extends beyond the Windsor Road intersection before widening out into a large area. Some areas of RE1 Public Recreation are present throughout the area. To the west of the proposed station, within Blacktown LGA, the land use zoning is predominantly 2(a) Residential. Special use zones are integrated throughout the area together with some smaller areas of 6(a) Public Recreation.

Figure 14.8 Existing land use in the immediate vicinity of Kellyville Station



Key Attractors

Retail

The Ettamogah Pub is located to the north and, together with other retail co-located on the site, forms a relatively large attractor within the area. Parklea Markets are located about 1,000 metres from the station location and provides a shopping destination over the weekends which attracts large numbers of visitors.

Stanhope Shopping Village

Stanhope Shopping Village is just located within 1,600 metres to the west of Kellyville Station on the corner of Stanhope Parkway and Sentry Drive in Stanhope Gardens. The Village forms a local centre comprising of anchor tenants including Coles and Kmart and numerous specialty stores and services. The centre is adjacent to Blacktown Leisure Centre.

Community Facilities

Community facilities located in the vicinity of the construction footprint include educational childcare centres including ABC Kellyville Ridge, Goodstart Early Learning, and Fraser Avenue Early Learning Centre, Mungerie House Rouse Hill Visitor Information Centre and Castlebrook Lawn Cemetery and Crematorium.

No community facilities would be acquired for this section of the alignment.

Blacktown Sports and Leisure Centre

Blacktown Sports and Leisure Centre provides invaluable services to the community including sporting facilities such as indoor fields, basketball courts, squash courts and swimming facilities. Members of the general public are able to attend a wide range of activities for all ages at this location.

Educational Establishments

Educational establishments within 1,600 metres of the proposed Kellyville Station include John XXIII Catholic Primary School and Kellyville Ridge Public School.

Open Space

Some small neighbourhood parks provide open space to the area and tennis courts and other recreational facilities are provided at Stanhope Reserve.

14.4.10 Rouse Hill Station, Windsor Road Viaduct, Cudgegong Road

Existing Character and Land Use

The proposed Rouse Hill Station is located within the Rouse Hill Town Centre on Tempus Street and adjacent to Windsor Road. Rouse Hill Town Centre is located on the eastern outskirts of the North West Growth Centre. Rouse Hill Town Centre has grown considerably since opening in 2007 to become a town centre providing convenient retail services. High density housing is around the central square (**Figure 14.9**).

The Rouse Hill Town Centre is continuing to expand with planned future development within the Northern Frame works immediately north west of the existing commercial centre (refer Section 14.5.7).

The area surrounding Rouse Hill Town Centre is currently being developed largely for residential purposes as part of the North West Growth Centre.

To the north, the residential land use is largely established, characterised by large double storey houses in a landscaped setting comprising neighbourhood parks. Some higher population densities exist within this neighbourhood with the majority of the area housing 32-41 people per hectare. Some pockets of more than 42 people per hectare are present, particularly centred around Rouse Hill Public School and Aberdoon Park and Rouse Hill Community Centre. Along Windsor Road, to the north of the Centre are some additional small shopping complexes including the Aldi complex, The Terrace and the Rouse Hill Village Centre. These standalone small shopping centres offer services on a neighbourhood scale including restaurants and fast food outlets, gyms and health services.

Development is currently occurring to the east and south east of the centre with the construction of new houses and townhouses. This development will extend to meet the established area of Beaumont Hills. The character of this area would be developed into much the same as that to the north with residential uses punctuated by natural open space and neighbourhood parks. Lots are generally smaller in this area and of a high density. Immediately east of the Rouse Hill Town Centre, the population density is currently shown as low as the area is still being developed. Further east however, the area of Beaumont Hills contains higher population density with the majority of the area housing between 32-41 people per hectare and more than 42 people per hectare.

South West of the Rouse Hill Town Centre is Kellyville Ridge, comprising a range of housing types including low rise flats, medium density housing and low density separate detached dwellings. Additionally, a number of businesses are located to the south along Windsor Road including a Woolworths Petrol Station, Dan Murphy's and the Ettamogah Pub. A wide diversity in population density exists to the south with a wide range of people located per hectare.

To the west of the centre, development is still in its initial stages. There is planned future development in the Area 20 precinct located north of Schofields Road (refer Sections 14.5.7 and 14.5.8). Currently this area consists of rural and quarry land uses as well as areas of remnant bushland and a creek corridor. The population density in this area is very low as is consistent with rural uses with 1-25 people per hectare.

The Castlebrook Lawn Cemetery and Crematorium is located to the south of Schofields Road and is surrounded by new residential development.

Major roads ensure vehicular access to the area with Windsor Road providing direct access to Old Windsor Road, the M7 and M2. A major bus interchange is located on the perimeter of the Rouse Hill Town Centre which caters for T-way services as well as a range of other bus services.

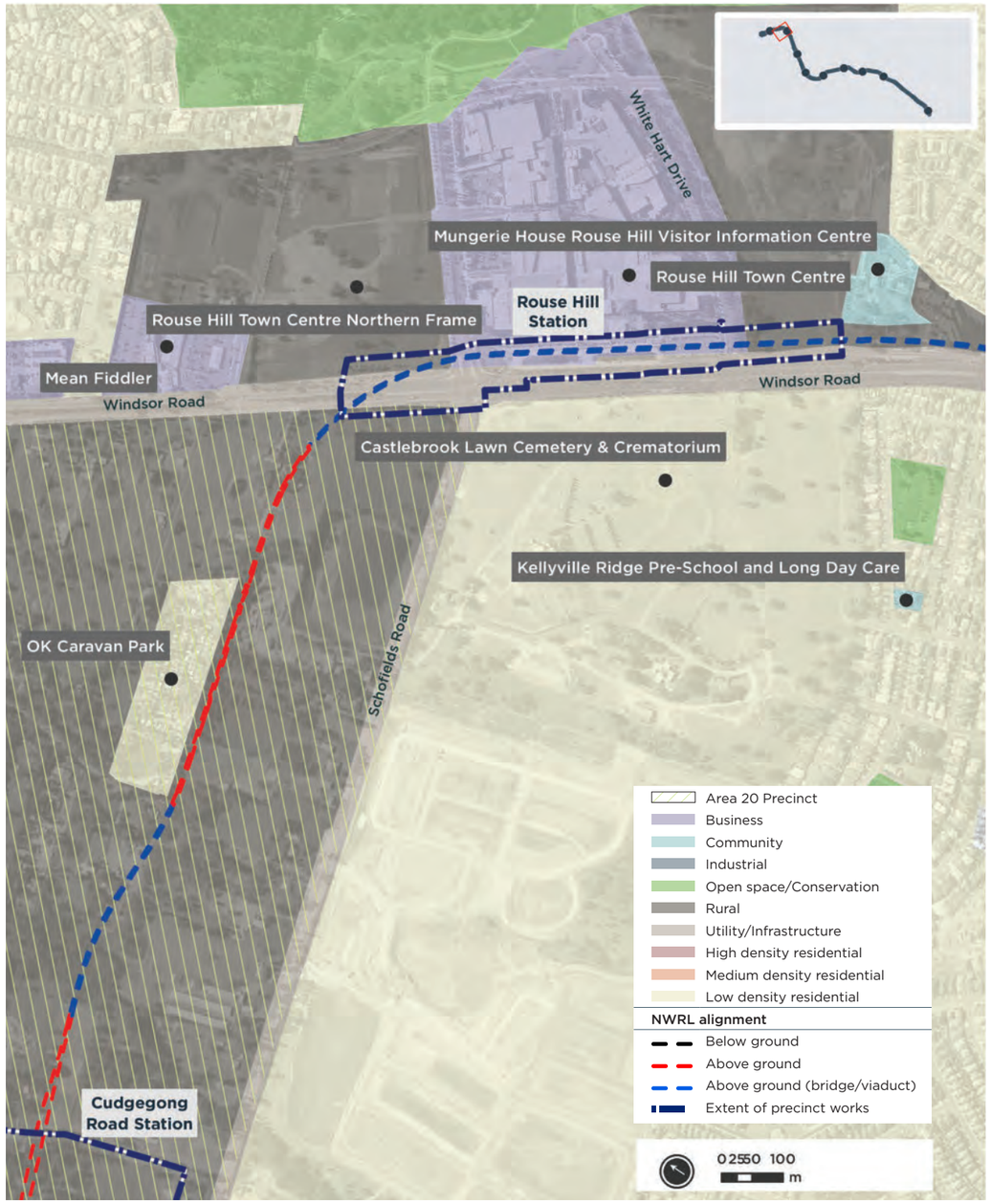
The section of proposed viaduct running parallel to Windsor Road from Old Windsor Road to Cudgegong Road is, in some places, fairly close to residential sensitive receivers, particularly to the north between Sanctuary Drive and White Hart Drive. The development of this area has accounted for the NWRL alignment and as such impacts would be limited.

Zoning

Rouse Hill Station is situated in The Hills Shire near the border with Blacktown LGA. Under The Hills LEP 2012, Rouse Hill Station is zoned as B4 Mixed Use and is located within the major retail centre of the region. East of Windsor Road, the surrounding area is largely residential with R3 Medium Density Residential surrounding the shopping centre site. Extending further out is the R2 Low Density Residential zone. Large areas of RE1 Public Recreation are present within the area, providing predominantly for sporting facilities serving the local area. A large corridor of SP2 Infrastructure (Stormwater Management) extends parallel to Windsor Road, connecting with the stormwater management system near Kellyville Station. The land directly adjoining the Rouse Hill Town Centre is zoned as B4 Mixed Use, allowing for the expansion of the centre as outlined in Section 14.5.7. Adjacent to this zone, to the north, is a small area of land zoned as B5 Business Development and B6 Enterprise Corridor. Across the road from this land use zone is a small area zoned B2 Local Centre where the Rouse Hill Village is located.

The area to the west of Rouse Hill Station falls within the Blacktown LGA. To the north of Schofields Road is the Area 20 growth centre precinct zoned under SEPP *(Sydney Region Growth Centres) 2006*. To the south of Schofields Road are the areas of The Ponds and Kellyville Ridge which are governed by Blacktown City LEP 1988. Residential uses to the west include R3 Medium Density Residential within Area 20 and low density 2(a) Residential to the south.

Figure 14.9 Existing land use in the immediate vicinity of Rouse Hill Station



Key Attractors

There are a number of community facilities and key attractors within the Rouse Hill area.

Entertainment

The Mean Fiddler and Ettamogah Pub both provide entertainment facilities for the community. These venues are highly patronised by local residents as well as visitors to the area.

Community Facilities

A number of community facilities are located within Rouse Hill including the Castlebrook Lawn Cemetery and Crematorium located opposite the proposed Rouse Hill Station, the OK Caravan Park, located off Corral Drive, Mungerie House and several childcare centres.

Educational Establishments

A large number of educational establishments are located within 1,600 metres of the proposed Rouse Hill Station. These include Rouse Hill High School, Iron Bark Ridge Public School, Our Lady of the Angels Catholic Primary School, St Gregory's Armenian School, Rouse Hill Public School, Kellyville Ridge Public School, John XXIII Catholic Primary School and the Rouse Hill Anglican College.

Retail

Rouse Hill Town Centre

The Rouse Hill Town Centre forms a key attractor within the region providing shopping and services as well as a library and community centre. The centre is planning to expand to provide additional services, shopping and facilities. The centre hosts local events including farmers and weekend markets along central roads, the provision of play areas in several locations around the centre and a community kitchen garden.

Open Space

Rouse Hill Regional Park is located just over 1,600 metres to the north west of the proposed station location offering a wide range of facilities including play areas, walking tracks, a horse riding circuit, and open space all within a natural bushland setting. The Rouse Hill House and Farm is located adjacent to the park and contains the culturally significant original farmhouse built between 1813 and 1818.

Sports Facilities

A number of sporting facilities are key attractors within close proximity to the proposed station location and generate large traffic movements when events are held.

The Commercial Road Netball Reserve provides approximately 40 netball courts and a large parking area. Weekly netball games are held at this location, creating traffic within the immediate vicinity, particularly affecting Commercial and Withers Roads. A large number of netball clubs use this venue.

The Hills Centenary Park, located on the northern corner of Commercial and Withers Roads provides numerous facilities for passive and active recreation including multi use and purpose built sports fields, soft ball and cricket nets, sports and community buildings, passive open space, children's playground and car parking.

The Bruce Purser Reserve, located on the southern corner of Commercial and Withers Roads and adjacent to the Rouse Hill High School, has been built to competition standard for AFL and cricket.

14.4.11 Cudgegong Road Station and Tallawong Stabling Facility

Existing Character and Land Use

The proposed Cudgegong Station and Tallawong Stabling Facility are located in the North West Growth Centre, on the northern side of Schofields Road. Cudgegong Road Station would be located just to the west of Cudgegong Road and at the western extent of Area 20 while Tallawong Stabling Facility would be situated further west on the other side of Tallawong Road. The site is adjacent to the Rouse Hill switching station, pylons and electrical easement for overhead wires. Currently the site is rural, however upon commencement of the Stations, Rail Systems and Infrastructure works forming part of EIS 2, the existing environment of the site would be a construction site (**Figure 14.10**).

As can be expected for rural and currently developing areas, the population density surrounding the proposed station is very low, housing only 1-25 people per hectare. To the south and south east of the station land is currently being developed.

The character of the existing area is typified by rural lands to the north of Schofields Road. The character of this area will however change in the future as part of the north west growth centre development. New low density residential housing is currently underway south of Schofields Road in The Ponds area and further west. The Ponds is being developed as a largely low density, single detached dwelling area with the incorporation of some medium density townhouses surrounding the neighbourhood park.

Cudgegong Station is within the Area 20 precinct, located within the Cudgegong Station Special Area (Clause 6.5 of Appendix 6 of SEPP *(Sydney Region Growth Centres) 2006*). The Area 20 precinct would give rise to a new village centre and provide housing for approximately 6,400 residents.

Zoning

Zoning within the Area 20 is governed by *SEPP (Sydney Region Growth Centres) 2006*. The Cudgegong Station Special Area is zoned SP2 (Infrastructure) for railway purposes. This zone is bordered by R3 (Medium Density Residential) and RE1 (Public Recreation).

The area surrounding the station contains a mix of land use zones, particularly within the Area 20 precinct. Small areas of industrial and business zones are located within close proximity to the station, surrounded by R3 (Medium Density Residential). To the east of the station, a corridor of SP2 (Special Uses) for trunk drainage runs perpendicular to the railway. West of the station, the growth centre precinct of Riverstone East has not yet been rezoned. The area of The Ponds south of Schofields Road is zoned predominantly R2 (Low Density Residential), dotted with small areas of RE1 (Open Space) and partitioned by SP2 (Special Uses) drainage and creek corridors, generally running in a north-south direction.

Key Attractors

Due to the undeveloped nature of the area there are few key attractors in the area to date.

Retail

Some shops on Windsor Road and the RHTC fall just within 1,600 metres from the proposed station location but are more likely to be accessed from the Rouse Hill station.

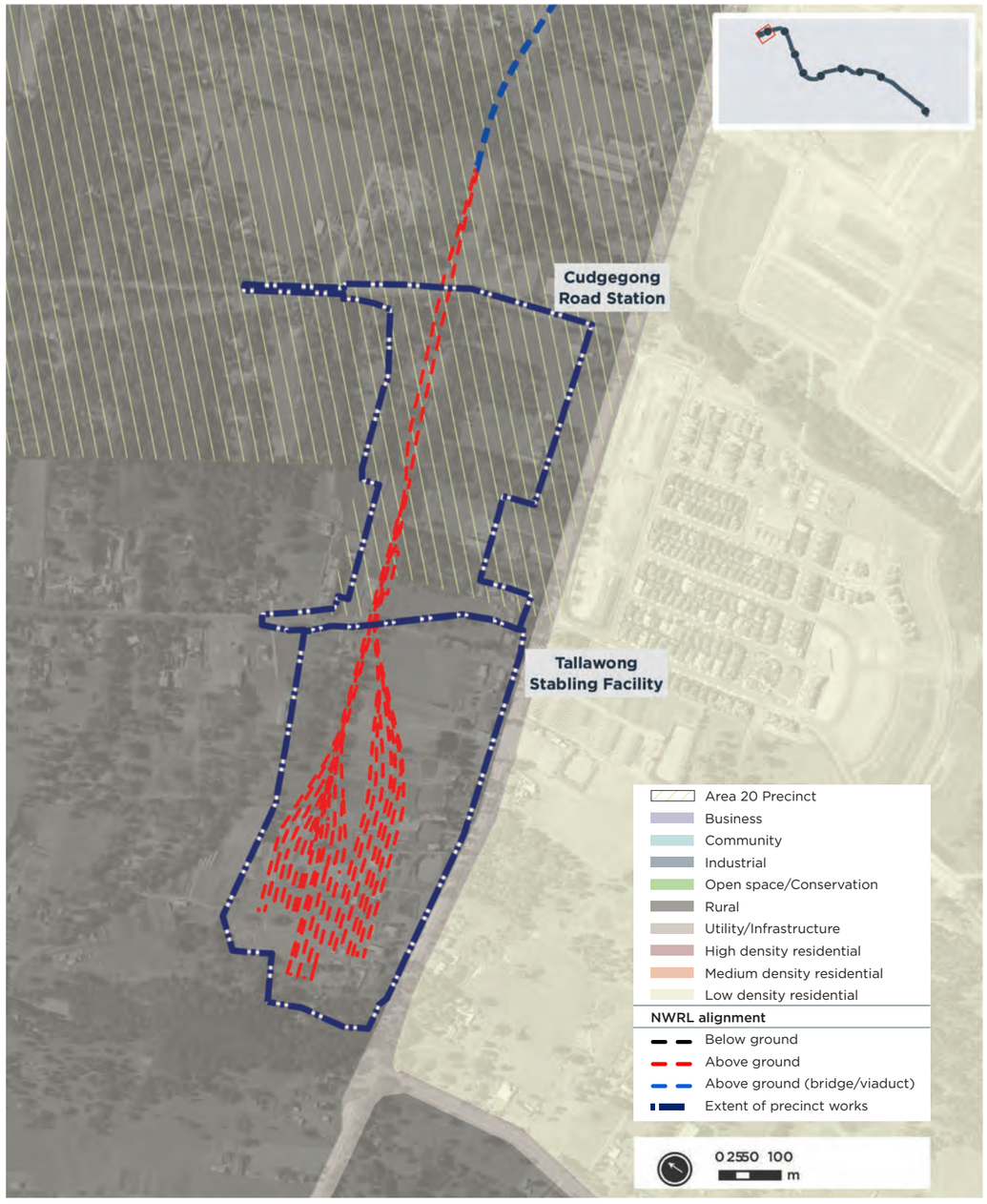
Educational Establishments

The Rouse Hill Anglican College is the only educational establishment located within 1,600 metres of the proposed station location.

Open Space

Several open space areas are present in the form of neighbourhood parks or riparian corridors. These would be further developed as the residential development is completed.

Figure 14.10 Existing land use in the immediate vicinity of the Cudgegong Road Station



14.5 Potential future development

The planning approach being adopted for the NWRL recognises that development around the stations would occur over time, but that measures must be taken now to provide a robust framework within which this development can occur. A station precinct planning process, parallel and separate to the NWRL planning approval process, is currently underway involving a collaborative approach with councils and DP&I.

Precinct planning

The DP&I and Transport for NSW have jointly established a Precinct Planning Working Group with Blacktown, The Hills and Hornsby Councils. The primary objective of the working group is for state and local government to work collaboratively to develop and implement station precinct planning frameworks to maximise the land use opportunities associated with the NWRL.

The outcomes of the precinct planning working group will be used to facilitate community and stakeholder discussion about the desired future character of station precincts. This will ultimately inform future planning controls and infrastructure requirements to support growth scenarios along the NWRL corridor. Ongoing consultations are occurring with DP&l (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.

The proposed NWRL station and precinct designs have been developed through an iterative process aimed at maximising opportunities to integrate with existing and future land use, and have taken into account early feedback from the working group and councils.

Key land use integration elements of the project design include:

- Locating stations within existing centres or locations with the potential for creating new transit oriented neighbourhoods
- Ensuring that station access infrastructure is set within a robust street pattern that is adaptable to future urban development needs
- Optimising station precinct and car park layouts to provide opportunities for active uses near stations, which helps to improve precinct safety and surveillance and allows day-to-day needs to be met locally, reducing the need for additional vehicle trips
- Ensuring that the design and location of transport infrastructure and service facilities maintains the potential for future development of residual lands.

14.5.1 Overview of Potential Future Development

The NWRL is closely associated with the centres for growth identified in Sydney Metropolitan Strategy, including Castle Hill and Rouse Hill as major centres and Norwest as a specialised centre. Other station sites along the route are planned to provide opportunities to develop new local centres with active uses, local services and provide greater residential capacity.

It is envisaged that the NWRL would provide a catalyst for development at stations along the corridor to varying degrees, helping to achieve dwelling and employment targets for the area. New development located in close proximity to a reliable public transport system supports NSW 2021 goals to grow patronage on public transport and to help communities access jobs and services closer to home.

A key aim is to locate as much new housing as possible within walking distance of centres of all sizes with good public transport. This is seen as essential to reducing car dependence and making walking, cycling and public transport more viable options for residents. These types of centres are known as transit oriented developments (TODs).

The NWRL provides opportunities for TODs focussed on new train stations, with potential new centres identified at Cudgegong Road, Kellyville, Bella Vista, Showground and Cherrybrook and growth within existing centres at Castle Hill, Norwest and Rouse Hill

Local Strategic Planning

Hornsby Shire, The Hills Shire and Blacktown City have developed strategies to guide future growth within their LGA. These have been used to provide an understanding of the potential future character of precincts surrounding the proposed stations. The impact of these strategies on the station precincts as well as specific elements of these plans are discussed on a station specific basis below.

Principles outlined within Council Strategies would be embodied in the planning for any future development sites identified within Station Precincts.

Hornsby Shire Council Epping Town Centre Study

The *Epping Town Centre Study* was prepared in July 2011 for Hornsby Shire Council, Parramatta City Council and the DP&I. The study area covers approximately 247 hectares, including the rail corridor. The area is based on the nearest road outside the 800 metre radius from Epping Railway Station, which reflects a 10 minute walking distance to the centre. Only a small portion of the NWRL falls within the study's applicable area.

The study identifies opportunities for the Epping Town Centre to accommodate increased residential and employment growth to fulfil its role as a Town Centre. It also recommends traffic and public domain improvements to facilitate the growth. The study concludes by recommending zoning changes, increased floor space ratios and heights, heritage controls and public domain improvements to accommodate the forecast desired population increase.

The proposed Epping Services Facility and underground tunnel alignment would be located within the area identified by the Epping Town Centre Study.

The study recommends the erection of multi-storey mixed use buildings in the town centre and it is anticipated that multi-storey underground car parking would be required to support these buildings. As such, there is potential for the depth of the NWRL tunnel alignment to have implications for the study and its recommendations. Additionally, the study recommends revised planning controls that would permit multi-level residential flat buildings with height limits between 28-35m on the site which includes the proposed Epping Services Facility.

Consultation with Hornsby Shire Council and Parramatta City Council has been undertaken to discuss the implications of the Project on implementing the recommendations of the study (refer Chapter 5). Consultation would be ongoing during the detailed design.

The Hills Shire Council Adopted Draft Local Strategy

The Hills Shire is expecting significant growth to occur by the year 2031 with at least an additional 100,000 people, 36,000 dwellings and 47,000 jobs provided in this time. Council has developed a suite of documents in response to this expected growth, each focusing on a particular aspect of the LGA growth into the future. These documents are encompassed in the Adopted Draft Local Strategy adopted by Council in 2008. The aim of the Local Strategy is to provide an overall strategic context for the planning and management of development and growth in the Shire to 2031.

The Draft Local Strategy is divided into eight directions covering employment lands, centres, residential, integrated transport, rural lands, environment and leisure, waterways and governance.

The vision for employment is to facilitate sustainable and economic development that promotes employment growth. Sufficient land is to be zoned to accommodate an additional 47,000 jobs by 2031. Employment growth would be focussed on the NWRL corridor from just north of Rouse Hill to Castle Hill.

A key role identified by the draft *North West Subregional Strategy* (DP&I 2007) for the Hills Shire is to strengthen the roles of centres. The Draft Local Strategy aims to achieve this through the encouragement of mixed-use and multi-functional development within a manner appropriate to the centre hierarchy.

The draft *North West Subregional Strategy* (DP&I 2007) sets a target for the Hills Shire to contribute an additional 36,000 dwellings by 2031. Of this, 14,500 dwellings would be located within the growth centres while 21,500 dwellings are to be provided within existing areas. The Local Strategy recognises that there are considerable opportunities remaining for high and medium density housing around future train stations.

Blacktown City 2025
Blacktown City Council has developed the *Blacktown City 2025* strategy which provides a broad overview of the strategic direction of growth within the LGA. New development and growth would be focused on community, environmental sustainability, vibrant commercial centres, economy, urban living and infrastructure, clean green spaces and places, mobility, and recreation.

Area 20 Precinct Plan
Area 20 was rezoned for urban development in October 2011 and is one of the first release precincts in the North West Growth Centre. The 245 hectare precinct will deliver capacity for approximately 2,500 new dwellings to accommodate around 6,400 residents. This development would be guided by the Growth Centres *Area 20 Precinct Plan* (DP&I).

14.5.2 Cherrybrook Station

Potential Future Development

Draft Hornsby LEP 2011
Under the *Draft Hornsby LEP 2011*, the Cherrybrook Station site is proposed to be zoned as R2 (Low Density Residential) thus essentially maintaining the existing character of the area. In the surrounding area, the proposed future zoning for the residential areas of Hornsby and would be mostly R2 (Low Density Residential), consistent with current zoning.

14.5.3 Castle Hill Station

Potential Future Development

Draft North West Subregional Strategy 2007 and Metropolitan Plan for Sydney 2036
Castle Hill Station would be located at the heart of Castle Hill, adjacent to the major shopping centre, Castle Towers, and the associated bus interchange. Castle Hill is recognised as a Major Centre within the *Metropolitan Plan for Sydney 2036*. Under this strategy, a Major Centre is defined as a "Major shopping and business centre serving immediate subregional residential population usually with a full scale shopping mall, council offices, taller office and residential buildings, central community facilities and a minimum of 8,000 jobs".

Castle Hill is expected to continue growing in the future with the *Metropolitan Plan for Sydney 2036* targeting employment growth to a total of 13,000 jobs in 2036. Continual infill development is occurring within Castle Hill, supported by Council strategic plans to guide growth into the future.

Castle Hill Main Street Vision (former Castle Hill Master Plan)
Upgrade Works have been completed along Old Northern Road, Castle Hill's main street, in the area that runs between Castle Towers and Castle Mall. Council has identified the following vision for this area; *"The CBD as the heart of the community, should be a vibrant and energetic place with pedestrian activity, restaurants, cafes, retail services and places for people to enjoy and meet taking full advantage of existing and proposed public transport opportunities and significant heritage items"*. The Main Street improvement aims to promote this vision through creating a safe and secure public domain, enhanced pedestrian amenity and movement through traffic calming and restrictions and overall the creation of a place where people can shop, relax and meet in a modern, convenient setting with better paving, seating, lighting and open spaces. Under Council's proposal, Arthur Whitling Park is set to become a unified public space, linking the bus interchange to parkland with extended seating areas. Council's plan takes advantage of existing and proposed public transport opportunities and protects significant heritage items while incorporating a new playground and native street tree plantings.

The Hills Shire Council Adopted Draft Local Strategy
Castle Hill is the historical, civic, administrative and cultural centre of the shire having evolved as the main centre. It has 125,000m^2 of retail floor space and 40,000m^2 of commercial floor space and provides the services and facilities needed for residents from a wide area. The Adopted Draft Local Strategy has identified goals needed for the sustainable and managed growth of the Castle Hill Major Centre. Of the overall 47,000 additional jobs required to be accommodated within the LGA by 2031, 3,000 would be provided within the Castle Hill centre and providing roughly six per cent of new jobs in the Hills Shire.

The Draft Local Strategy identifies that commercial and retail development opportunities within the proposed Castle Hill Station Precinct should be pursued and carefully planned to provide appropriate and desirable development outcomes, forming well utilised and integrated public transport and residential hubs. Redevelopment of a number of key sites in the future including Council owned land at Terminus Street would further strengthen and revitalise the centre as the major centre in the Hills Shire and assist in meeting the employment capacity targets and functions as set out in the draft *North West Subregional Strategy.*

The Terminus Street Precinct represents a key component in the development of Castle Hill as a major centre providing an opportunity for redevelopment that contributes to public space, public facilities, improved built form and sustainable growth.

The vision this strategy has for the Castle Hill centre is consistent with wider metropolitan objectives regarding intensification of development, both employment and residential, within existing centres and around public transport nodes. The Castle Hill station would be a catalyst for future development and the creation of public domains within the established area.

Potential Future Development Proposed by QIC – Expansion of Castle Towers Shopping Centre
Expansion of the existing Castle Towers Shopping Centre at Castle Hill would include two sites. The first site (A) involves upgrading and expanding the existing centre building between Old Northern Road, Showground Road and Pennant Street. The second site (B) would entail redevelopment of the former primary school on the western side of Pennant Street, adjacent to Castle Grand, for retail and retail related purposes, with pedestrian and vehicle overbridge connection to the existing centre. Approval was granted for this development on the 8 February 2011.

The proposal involves an increase in retail and commercial floor space of 60,487 m^2, together with an increase of 19,438 m^2 in other floor space. The development includes the closure of Castle Street between Pennant Street and Old Northern Road, and the closure of the southern section of Kentwell Avenue, and incorporates a number of changes to existing access and parking arrangements as well as new access points, tunnels under existing roads and adjustments to the existing road network in the vicinity of the site.

The expansion would include a new cinema complex, an eat-street area, additional car parking spaces and department stores, supermarkets, restaurants and retail stores.

The proposal incorporates a number of measures to ensure integration with the surrounding area and proposed future developments including:

- Shopfronts are provided to Old Northern Road, to reflect the intended pedestrian orientation and activation of this road through the centre associated with completion of the eastern ring road system.
- A heritage square focused on the heritage precinct, is proposed towards the southern part of the centre, designed to provide links with potential redevelopment on the eastern side of Old Northern Road, and with the former primary school site on the western side of Pennant Street
- Planning for the centre has taken into account the proposed underground railway station, and the potential for an associated bus interchange and

public space. On grade through-site links along the alignment of Castle Street are maintained, connecting the proposed transport interchange with community facilities and residential areas to the west. Alternate access is also proposed through both level 3 and level 4 of the retail centre enabling safe undercover access across the pedestrian bridges, and the integrated vertical transportation systems to Pennant Street and the Castle Grand community facilities.

- The former primary school site is proposed to be redeveloped for predominantly retail and retail related purposes. The retail component has been designed to accommodate a retailing operation that is new to Australia.
- This site is to be linked to the town centre with an overbridge to Pennant Street, providing integrated access for pedestrians and vehicles.

The proposed station and underground alignment would be located in close proximity to the expansion of the Castle Towers Shopping Centre.

14.5.4 Showground Station

Potential Future Development

Draft North West Subregional Strategy 2007
The draft *North West Subregional Strategy* (DP&I 2007) recognises that Showground Station provides the opportunity to develop a new local centre. The Strategy states that it is likely this centre would develop as a local centre providing higher density housing, and associated retail and other services, easily accessible to jobs in the nearby strategic centres.

Adopted Draft Local Strategy
The Adopted Draft Local Strategy recognises that Showground Station is positioned within a strategic location where it would provide services to the Castle Hill Industrial Area. This employment area encompasses 135.74 hectares of light industrial/bulky goods land, home to a variety of business activities including factory units, vehicle sales and services, bulky goods retailing and warehousing as well as other non-industrial uses. The strategy notes the importance of integrating the station with these surrounding uses to facilitate development of a wider range of employment uses.

14.5.5 Norwest Station

Potential Future Development

Metropolitan Plan for Sydney 2036 and Draft North West Subregional Strategy 2007
The *Metropolitan Plan for Sydney 2036* identifies Norwest as a Specialised Centre providing an important economic and employment role in the north west area. It highlights Norwest's role over the past 15 years with employment in this area growing at three times the rate of other Strategic Centres. Norwest is described as a major employment hub in the Strategy with an employment growth of 17,000 additional jobs expected between 2006 and 2036 to a target of 30,000 jobs by 2036.

The draft *North West Subregional Strategy* (DP&I 2007) attributes some of Norwest's success to the fact that it is located within easy reach of parts of the metropolitan area which house a high proportion of professionals, who largely comprise its workforce. Additionally, the strategy predicts that the centre will reach its planned employment target in the next two decades, with the NWRL providing incentive for further redevelopment and intensification beyond this.

Adopted Draft Local Strategy
The Strategy recognises that the NWRL has the potential to allow for a wider range of employment uses. The capability to extend and intensify employment land within this precinct may provide opportunities for additional employment land if needed. In line with the Metropolitan and draft Subregional Strategies, the Adopted Draft Local Strategy recognises the potential growth that should occur within this centre, providing a significant number of future jobs to the region as well as stimulation of economic prosperity in the area.

14.5.6 Bella Vista Station and Kellyville Station

Potential Future Development

Draft North West Subregional Strategy 2007
The draft *North West Subregional Strategy* (DP&I 2007) has included a requirement for The Hills Shire Council to carry out investigations to determine an appropriate centre designation for the area around the previously proposed Burns Road Kellyville and Balmoral Road stations on the NWRL. This would ensure appropriate centre type and future land uses designed to link effectively with the current and longer term land use patterns. This requirement would be similarly applied to new locations of the Bella Vista and Kellyville Stations as there is potential for new centres and land use integration opportunities at these stations.

Baulkham Hills Development Control Plan Balmoral Road Release Area
The Balmoral Road Release Area is a large area of undeveloped land within The Hills LGA bounded roughly by Old Windsor Road to the west, Samantha Riley Drive to the north, Windsor Road to the east and Norwest Business Park to the south and in the vicinity of Balmoral Road and Memorial Avenue.

The Balmoral Road Release Area DCP describes the vision and objectives for the area and prescribes a range of development controls to ensure appropriate development is undertaken. The vision is *"To create a high quality, integrated and ecologically sustainable urban environment integrated with good public transport accessibility, open space, community facilities and employment opportunities"*.

The release area is approximately 500 hectares and will accommodate 6,000 dwellings when fully developed with a mix of housing types. The area will be integrated with public transport corridors, open space, community facilities and employment opportunities.

Parts of the land release area have been identified and zoned as land for railway purposes by *Baulkham Hills LEP 2005* in line with the original concept approval for the NWRL project. However, the design and configuration of the NWRL project has been refined, as a result of further project development.

Consultation regarding the interaction of the NWRL in relation to planning in the Balmoral Road precinct with key Council and agency stakeholders has been undertaken (refer Chapter 5). Further consultation will be held with relevant stakeholders to discuss master planning and urban design issues relating to station precincts and integrated land use planning issues associated with the Balmoral Road Release area.

Adopted Draft Local Strategy
The Draft Local Strategy highlights the 16.5 hectares of employment zoned land located alongside Old Windsor Road in the Balmoral Road Release Area. It predicts that employment capacity for this area would be in the vicinity of 4,000 jobs based on a mix of commercial and light industrial uses. The operation of the NWRL would be a factor in influencing development at this location.

The Strategy has identified two neighbourhood centres in the Balmoral Road Release Area stating that the development of these centres over time will further reinforce the centre hierarchy and ensure residents have adequate and timely access to services and facilities. These centres would be located in prominent positions with the location and design of centres to be reviewed as part of the precinct planning works to ensure maximum opportunities from the NWRL.

Development Contribution Plans
Works around the Bella Vista and Kellyville Stations have been identified in The Hills Council's, Draft The Hills Shire Wide Section 94A Contributions Plan 2011. These include works on the local community building and district level multipurpose community facility at Bella Vista Farm Park, traffic signals at the intersection of Norwest Boulevard / Lexington Drive and an upgrade to the traffic signals at Samantha Riley Drive/Windsor Road intersection.

No impact would arise to or from the NWRL to the Bella Vista Farm works as they are some distance from each other and as the nature of the two works would ensure that no conflicting activities would occur. Traffic signals to be installed at the Norwest Boulevard / Lexington Drive intersection are listed as a high priority meaning that they would be installed within the next five years. The upgrade of existing traffic signals at Samantha Riley Drive/Windsor Road

intersection would assist in ensuring minimal impact of the NWRL Kellyville Station on the surrounding area through the increased efficiency of the major intersection providing access to the station. The NWRL would not directly impact on these works that are considered to be high priority.

14.5.7 Rouse Hill Station

Potential Future Development

Draft North West Subregional Strategy 2007 and Metropolitan Plan for Sydney 2036
Rouse Hill is designated in the *Metropolitan Plan for Sydney 2036* as a planned Major Centre with a targeted employment growth of 12,000 jobs by 2036 which would be supported through the integration of land uses and transport systems, including the NWRL. It is currently being developed to serve development areas in the North West Growth Centre. It is an emerging location for shopping, jobs and services within a residential area.

The draft *North West Subregional Strategy* (DP&I 2007) states that the station would provide an important impetus for development of the centre as well as good access to Norwest and Castle Hill Centres thereby supporting the region as a whole. Rouse Hill will also become a major retail destination with planned expansion of the recently completed retail facilities.

Adopted Draft Local Strategy
The Draft Local Strategy recognises both the major retail centre of Rouse Hill as well as the smaller village shops located a short distance north west. The Draft Local Strategy envisages the Rouse Hill Station as enhancing the sustainability of the centre as an employment, entertainment, community and residential precinct serving a regional area expanding as far as Windsor in the north.

The village shops to the north have been developed in a fragmented pattern with the Draft Local Strategy realising the importance of managing future development around this centre by improving connectivity and interrelation between the different developments.

Potential Future Development Proposed by Private Stakeholders

Rouse Hill Town Centre Northern Frame
Growth of the Rouse Hill Town Centre is set to continue as the development of the North West Growth Centre is realised. Mixed use development of the Northern Frame is planned which is located on the land immediately north of the existing Rouse Hill Town Centre. This would strengthen the role of the centre and support the community through the provision of essential services and facilities. Consultation with relevant stakeholders regarding the implications of NWRL on the Rouse Hill Town Centre has been undertaken and further consultation is scheduled (refer Chapter 5).

Cumulative impacts of NWRL and the Rouse Hill Town Centre Northern Frame works are considered in Chapter 20.

14.5.8 Cudgegong Road Station and Area 20

Potential Future Development

SEPP (Sydney Region Growth Centres) 2006
Cudgegong Road Station is within Area 20, governed by *SEPP (Sydney Region Growth Centres) 2006*. Area 20 is located opposite the Rouse Hill Town Centre and a section of the NWRL traverses the precinct from the intersection of Windsor Road and Schofields Road to Tallawong Stabling Facility.

Area 20, a 245 hectare precinct, was rezoned for urban development in October 2011 providing for the proposed NWRL corridor, railway station, commuter car parks and supporting facilities. The area will deliver capacity for about 2,500 dwellings to accommodate 6,400 residents. A village centre, light industrial land and open space would also be incorporated.

The current project is generally consistent with the land use planning in Area 20, however, the vertical and horizontal alignment has been refined as a result of further strategic planning and project development. Current zoning in the vicinity of Windsor and Schofields Roads assumes an underground rail tunnel with planned open space and residential development over the rail alignment.

Clause 6.5 *Development in special area – Cudgegong Station Area* of Appendix 6 (Area 20 Precinct Plan) of the *SEPP (Sydney Region Growth Centres) 2006* sets out development requirements within the vicinity of the proposed Cudgegong Road Station. The proposed corridor for NWRL, including Cudgegong Station and Tallawong Stabling Facility is generally consistent with what is provided for the Cudgegong Station Area of the precinct plan.

The NWRL Project Team has held a number of meetings with the DP&I regarding the integration of the NWRL with the 'Area 20' Precinct Plan (refer Chapter 5). Further design consultation will be held with TfNSW, DP&I and Blacktown City Council to refine the precinct planning around the Cudgegong Road Station and to revise proposed future local streets within the NWRL rail corridor between Rouse Hill and Second Ponds Creek.

The Tallawong Stabling Facility is located a short distance to the west of the Cudgegong Railway Station in an area identified for urban development and is surrounded by zoned urban areas.

Development Contributions Plans
The Draft Section 94 Contributions Plan No. 22 – Area 20 Precinct includes the NWRL alignment as originally conceived in the indicative layout plan. The alignment has been slightly altered from this original layout, however this would not affect the works outlined in the contributions plan. More information regarding the change in NWRL alignment is provided in the following section.

Immediately adjacent to the southern side of the identified rail corridor some landscaping works are proposed by Blacktown City Council including a landscaped channel between 20 and 28 metres wide and the introduction of a culvert under a future road. Due to the change in alignment, these channels may become wider than originally planned, however no other impacts would be incurred.

Works are to be carried out in the drainage and bioretention areas to the south of the NWRL including the installation of a gross pollutant trap at the inlet to bioretention and the construction of the standalone bioretention. Additionally, the same works are to be carried out to the north of the corridor just to the east of Cudgegong Road. There would be no impacts to the works to be carried out to the south of the corridor, however due to the shift in alignment to the north, the location of the biorentention and gross pollutant trap may need slightly adjustment.

Major changes to Terry Road are planned in the Contributions Plan with it being extended to connect to Schofields Road. As part of this extension, the road would pass over the NWRL alignment, and the Contributions Plan has identified the need for a northern and southern railway bridge over the rail corridor. These changes have been carried out in accordance with NWRL planning and as such there would be no adverse impacts incurred as a result of this development. In addition to this, the need for the development of a footbridge over Second Ponds Creek to the north of the railway corridor has been identified. This would have a positive impact on the NWRL through increased connectivity around the precinct and to the station for pedestrians.

Area Precinct Land Use and Rail Integration Study

The Area 20 Land Use and Rail Integration Study considers how the NWRL would interact within the surrounding area of the Area 20 precinct, including its relationships to land use, public transport, pedestrian and cycle movement networks and urban design for the proposed Cudgegong Village Centre surrounds. The purpose of the study is to identify opportunities for better integration of the rail line, station and commuter car parks with surrounding land use and development. Considerations include access, safety, surveillance and activation of areas, opportunities for realigning road crossings and ways to improve urban design outcomes. The study also considered the outcomes of separate investigations being undertaken concurrently, such as retail planning advice, traffic modelling and public domain and landscaping strategies.

The Area 20 Land Use and Rail Integration Study has identified six key investigation areas where the rail infrastructure and land uses may conflict and thus attention to integration is required. These are:

1. Cudgegong Village Centre (including Cudgegong Station)
2. Cudgegong Road
3. Terry Road
4. Second Ponds Creek
5. Portal/Entry to tunnel
6. Tallawong Road

The Study has investigated these key areas taking into account the NWRL as proposed in this EIS. Constraints to station access have been considered for vehicle, bus and pedestrian movements and possible solutions have been proposed to ensure that the NWRL and surrounding land uses integrate in the most effective and low impact manner.

The study proposes solutions to identified constraints that consider Council requirements, good urban design, natural constraints and provide detailed information as to how the various components of the area would link into each other. The Area 20 Land Use and Rail Integration Study has no negative implications for the NWRL, ensuring only that it works well within the precinct.

In particular, the Area 20 Land Use and Rail Integration Study addresses:

- Road network issues including signalised intersections, bridge design and consequent flow on effects
- Bus route planning issues including the NW Sector Bus Servicing Strategy and interchange between bus and rail services
- Routes of pedestrian and cyclist networks to follow as directly as possible the likely future desire lines within the precinct – a key issue in the design of these linkages would be the provision of safe crossing facilities where these routes cross the major road and railway line corridors.

Since this Study, conducted in August of 2011, there have been changes to the NWRL alignment. Assessment of extension options has concluded that there is merit in extending the NWRL beyond the Rouse Hill Town Centre to provide a new station with park and ride facilities of up to 1,000 spaces west of Windsor Road. This would reduce traffic demand on Windsor Road, for commuters driving to work, and those driving to Kellyville Station (which is a park and ride station location proposed for the NWRL). It would also allow for the establishment of a long term train stabling facility compared with only a temporary stabling facility approved as part of the earlier scheme.

As a result of the options evaluation, further investigations were completed to refine a corridor within the North West Growth Centre for future design development and investigation. This decision was planned for, assessed and publicly exhibited as part of the Area 20 Precinct Planning process undertaken in accordance with the Growth Centres State Environmental Planning Policy.

Originally the alignment of the NWRL was fairly straight running parallel to Schofields Road, however this has been altered slightly. The original alignment now kinks slightly to the north about 300 metres east of Cudgegong Road to Tallawong Road Stabling Facility.

The Area 20 Land Use and Rail Integration Study (which was based on the original alignment for NWRL) has been considered as part of the design development process. The proposed NWRL design responds to the objectives and opportunities identified in this study by:

- Locating the Cudgegong Road Station interchange immediately to the north of the station adjoining the proposed village centre
- Providing an opportunity for active uses adjoining the commuter car park to the south of Cudgegong Road station
- Ensuring access between the commuter car park and the village centre, via a new local road bridge between Cudgegong and Tallawong Roads
- Retaining key rail corridor road crossings at Tallawong Road, Cudgegong Road and Terry Road, and safeguarding future local road crossing between Windsor Road and Terry Road
- Providing an opportunity for pedestrian / cycle access under the railway in the vicinity of Second Ponds Creek

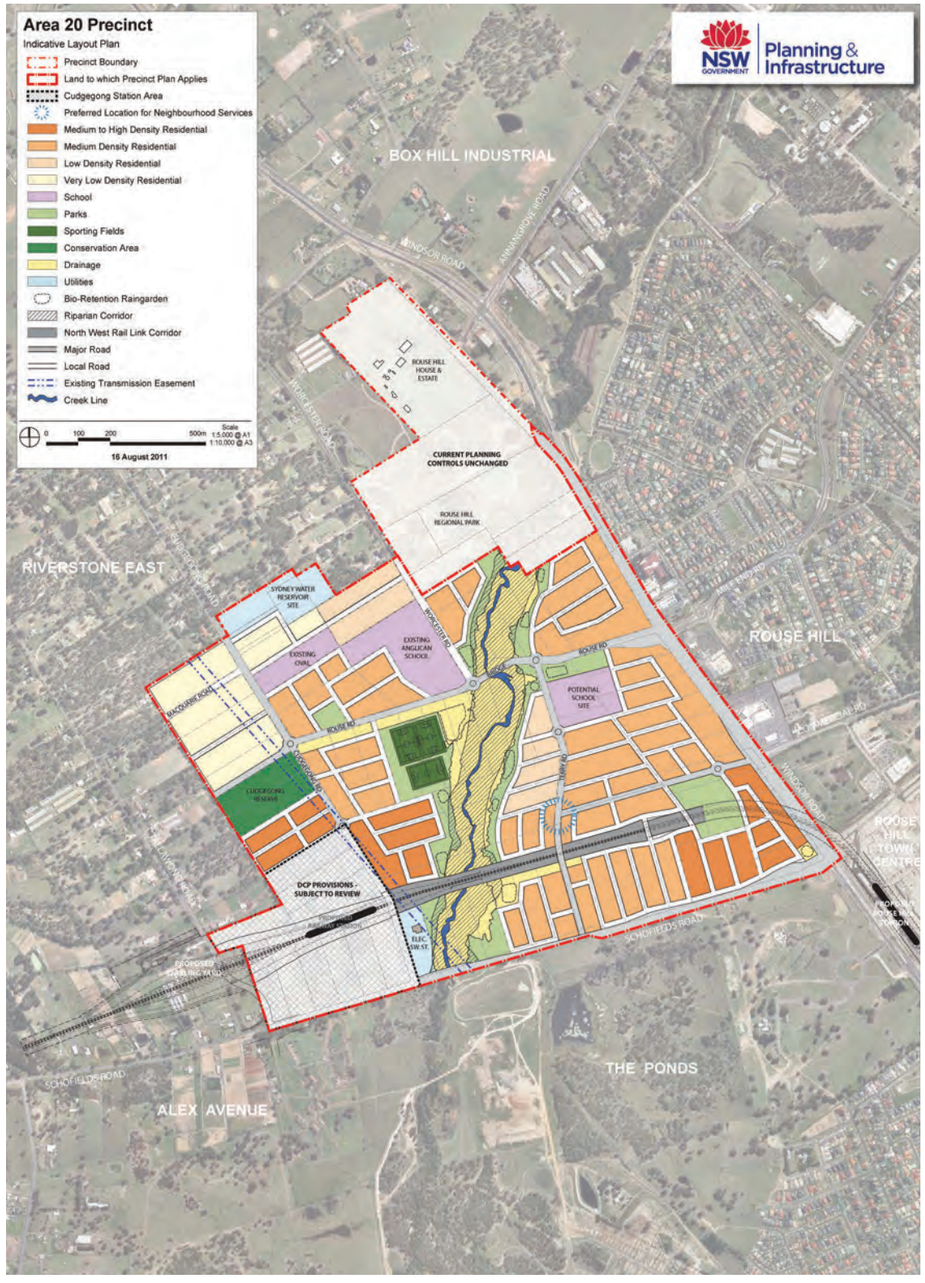
Area 20 Indicative Layout Plan

The Area 20 Indicative Layout Plan dated August 2011 caters for the NWRL (**Figure 14.11**).

The zoning for the area that has been gazetted as part of SEPP (Growth Centres) 2006 is generally consist with the layout plan in terms of locations and shapes of land uses as well as expected housing density. According to this plan, residential uses would adjoin the railway corridor along its length except for where the creek and associated drainage and riparian area cross. Both the Indicative Layout Plan and the SEPP zoning include higher density residential located within walking distance of the station and a mixed use local centre adjacent to Cudgegong Road Station. NWRL is therefore, a key enabling infrastructure for the gazetted Area 20 precinct plans.

Modifications to the horizontal and vertical alignment since the gazettal of Area 20 are considered to have minimal impact on the land use strategy contained within the Indicative Layout Plan. However some minor revisions are likely to be required to the proposed local road network and open space areas between Windsor Road and Second Ponds Creek. Future modifications to SEPP and DCP provisions will be determined in conjunction with DP&I Growth Centres and Blacktown City Council. Clause 6.5 of the Growth Centre SEPP provisions for Area 20 effectively defers finalisation of DCP provisions for the Cudgegong Road Station precinct, to allow the rail alignment and station/interchange design to be finalised and integrated with surrounding land uses.

Figure 14.11 Area 20 Indicative Layout Plan



14.6 Impact Assessment - Operation

The NWRL is located within the high growth area of North West Sydney, connecting the significant Sydney Global Economic Arc and North West Growth Centre. Knowledge-based ties would be strengthened and enhanced between major universities and the significant employment areas of Norwest Business Park, Macquarie Park, Chatswood and the Sydney CBD. The rail system would integrate with a number of high growth residential and employment areas and serve many key community facilities. The development of stations in these key areas would provide an improved public transport network and create the opportunity to decrease demand for private vehicle trips along key transport spines, particularly through integrating with existing transport infrastructure.

Impacts to land use associated with the NWRL operation would be predominantly positive with both direct and indirect impacts contributing to changes within the surrounding areas.

Integration of land use and transport infrastructure is a key consideration in designing the NWRL. At a regional level, the NWRL would provide much needed rail services to North West Sydney and would assist in managing capacity and congestion issues in the area. The NWRL operation has the potential to act as a catalyst for development in the areas surrounding the stations. The development of new stations at key growth areas such as Castle Hill, Norwest, Bella Vista, Kellyville and Rouse Hill would create an opportunity for TOD with the improved public transport network encouraging higher intensity development around stations. The location of essential services and facilities within close proximity to residential areas may reduce the demand for private transport. The NWRL would integrate seamlessly with existing transport services such as the T-ways and other bus and train routes, to create multi-modal transport interchanges at key nodes, improving accessibility region-wide. To ensure effective integration, preparation of a Land Asset Management Strategy would be undertaken during the NWRL construction phase and would be completed prior to commencement of NWRL operations. . This would be prepared in consultation with DP&I, councils and other relevant agencies.

The NWRL would enhance the regionally significant specialised employment area of Norwest Business Park and encourage further business development in the area through the connection to the Sydney Global Economic Arc extending through Macquarie Park to North Sydney and Sydney City. This Global Economic Arc is a focus of knowledge and employment activities clustered around and partnered with learning environments such as universities and attracting highly skilled workers.

Some impacts are likely to be experienced at station precincts along the length of the route. These include:

- Future intensification of development within the station catchment, giving rise to TOD centres. Intensification would be greater than what would otherwise occur in the area. This would see mixed uses that reduce the need for residents and workers to make additional trips to meet daily needs. This would occur as an indirect impact of the NWRL operation. This may result in indirect changes to land use, access and amenity due to increases in transport services.
- Station precincts have the opportunity to revitalise areas through well designed development that adds to the overall quality of existing centres while promoting a sense of place and community.
- Business centres within the NWRL corridor would be strengthened via the provision of a direct connection to the Global Economic Arc potentially causing further investment and expansion of employment land within the region.
- To facilitate the creation of TOD, the development of the NWRL would have a strong focus on pedestrian, cycle and bus access to encourage sustainable transport modes and reduce the need for private vehicle use. Mobility within the surrounding areas would increase which would have an indirect impact on land use in the area. Increased pedestrian and cycling mobility would change the way different land uses are accessed and may alter the functionality of future development.

14.6.1 Epping to Bella Vista

The section of the NWRL from Epping to Bella Vista would traverse underground with the only above ground components being two Services Facilities and five stations. Bella Vista forms the transition point where the train emerges from the tunnel before extending onto the viaduct.

Towards the east, the NWRL traverses beneath predominantly residential as well as a small section of the M2. Towards the west the NWRL traverses beneath a range of land uses, predominantly residential and employment/industrial. Land use impacts between Epping Station and Bella Vista Station during operation would occur in areas surrounding stations through the stimulation of development. These impacts would be predominantly indirect in the form of higher intensity future development surrounding station precincts. Improved accessibility would be a direct and positive impact of the NWRL.

Site specific impacts are outlined in the tables below.

Table 14.2 Operational Impacts Epping to Bella Vista

Site	Direct Impacts on existing land use and community facilities
Epping Services Facility and Decline Site (Site 1) **Cheltenham Services Facility (Site 3)**	**Implications for Existing Land Use** ▪ There would be no direct impacts on land use or amenity during operation at the Epping Services Facility site (Site 1). ▪ The Cheltenham Services Facility would see the new infrastructure facility located within an area currently used as a sports venue. The existing netball training courts would be reinstated in a similar location when NWRL is operational. **Implications for Future Land Use** ▪ Land use at the sites would be confined to the use of rail facilities associated with the NWRL. ▪ Land use immediately adjacent to the facilities would be reinstated as netball training courts at Cheltenham. ▪ It is expected that the NWRL would not have a significant impact on the future built form surrounding Epping Town Centre development.
Cherrybrook Station (Site 4)	**Implications for Existing Land Use** ▪ Acquired land would be subject to land use planning under DP&I and local Council. ▪ Castle Hill Road acts as a physical barrier between land uses on either side. This physical separation would be improved to enable access to the station through the introduction of a signalised pedestrian crossing. **Implications for Future Land Use** ▪ NWRL operation is predicted to stimulate development within the area surrounding this station particularly medium density housing. This would increase the dwelling stock and choice and would increase the population density within the area over the longer term. ▪ The station and the station precinct may become a focus for the local area with the accommodation of new activities and services to meet needs on a local level. This would create a beneficial, long term impact for residents and commuters accessing the station.
Castle Hill Station (Site 5)	**Implications for Existing Land Use** ▪ Arthur Whitling Park would be transformed into an open civic area interfacing with the retail centre of Castle Towers and continuing to provide a revitalised open space area. Increased security and accessibility would be provided across the park. ▪ The park is currently home to a number of historical artefacts and culturally significant monuments which would be permanently altered for operation of the NWRL. No damage would be incurred by the items, however they would be relocated. ▪ It has been agreed with stakeholders that once operational, the completed precinct would incorporate appropriate recognition of the current war memorial. ▪ The area surrounding the station is largely used for commercial purposes and sensitive receivers such as residents are located further away. Direct impacts to existing sensitive residential receivers would be minimal. **Implications for Future Land Use** ▪ Castle Towers' approved plan for future expansion safeguard direct connection to the underground station at Castle Hill. ▪ Castle Hill has recently experienced an intensification of residential dwellings. The station would support further medium to high density development as well as an increased intensity of commercial and business development. ▪ Castle Hill would benefit from the development of a major public transport interchange once the NWRL is operational. This would have a positive long term impact on the centre with a vibrant focal point for future regeneration ▪ Revitalisation may occur adjacent to the station along Old Northern Road where there is potential to integrate new development. ▪ The station has the potential to contribute towards a high quality public domain and create vibrant public spaces.

Site	Direct Impacts on existing land use and community facilities
Showground Station (Site 6)	**Implications for Existing Land Use** ▪ The site is located on Council owned land, including land currently used as the Council Depot. These land uses would be permanently transformed to accommodate the station precinct. ▪ The area to the south east of the station has been changing over time from predominantly residential, to small businesses that can be accommodated within dwellings such as dentists, accountants and childcare. ▪ Care has been taken to minimise disturbance to the Castle Hill Showground with the construction site designed clear of main activity areas. Major events would be able to continue with minimal long term disturbance. ▪ Fred Caterson Reserve would not be directly impacted by the NWRL and operations will be able to continue as usual. **Implications for Future Land Use** ▪ Operation of the NWRL at this station would likely see the surrounding area transformed through potential redevelopment opportunities. ▪ The nature of Showground Road is already changing from that of predominantly residential to a more mixed residential and business and commercial services character. The operation of Showground Station may accelerate this change, with strong links forming between business in the Castle Hill main centre and the area around this station. ▪ The area comprising the station precinct would be transformed through the introduction of new roads and footpaths and upgrades to existing facilities. The impact of these changes would be positive and long term and would ensure the precinct is highly accessible by all modes
Norwest Station (Site 7)	**Implications for Existing Land Use** ▪ The introduction of the major public transport system in this centre would provide increased options for existing residents and workers to connect to the wider transport system, further strengthening the appeal of the centre. ▪ Residents in the adjoining residential area would benefit from rapid transit service through the provision of a new activity centre and easy access to a frequent and high capacity public transport mode. **Implications for Future Land Use** ▪ In areas surrounding the Norwest Station further development opportunities may occur. ▪ With the operation of the rapid transit system, further economic investment into the area would be encouraged
Bella Vista Station (Site 8)	**Implications for Existing Land Use** ▪ No adverse land use impacts to the residential area west of the station are anticipated during operation due to the physical barriers of the T-way and Old Windsor Road. ▪ Pedestrian access would be via a pedestrian bridge link over Old Windsor Road. **Implications for Future Land Use** ▪ Urban development to the north has the potential to benefit from the proposed station through the development of TOD. ▪ The station would support development in the surrounding area including both business and residential development. ▪ The station could create a focus within the area around which an active precinct could develop to provide essential services. ▪ Bella Vista Station provides opportunities for new jobs and diverse housing options to meet the region's needs into the future.

14.6.2 Bella Vista to Rouse Hill

Rail corridors have the potential to physically divide a community and create movement barriers. The NWRL has minimised the chance of this occurring through maximising the use of a viaduct, allowing movement to continue unaffected beneath the corridor. The alignment is parallel to Old Windsor and Windsor Roads as well as the North West T-way in certain sections. This would ensure minimal disruption to existing and future land use as the area is already recognised as a major transport corridor.

Table 14.3 Operational Impacts Bella Vista to Rouse Hill

Site	Direct Impacts on existing land use and community facilities
Balmoral Road (Site 9) Memorial Avenue (Site 10)	**Implications for Existing Land Use** ▪ At the transition between underground and viaduct, north of Bella Vista Station, the NWRL would briefly run at grade along this section, introducing a parallel physical barrier. Impacts to the residents west of the alignment would be minimal due to the large area of separation that incorporates Old Windsor Road and the T-way. **Implications for Future Land Use** ▪ Land to the east of the NWRL alignment forms part of the Balmoral Road Release Area and will soon be developed. Due to the NWRL's operation along the boundary of this release area, land uses being developed to the east would need to consider and respond to the presence of a future railway. ▪ Land uses directly adjacent to the viaduct may be restricted to non-sensitive uses such as open space to minimise the impacts from the operation of the NWRL along the viaduct. These impacts may include overshadowing, privacy issues, noise and visual constraints and have been discussed in other sections of this EIS.
Kellyville Station (Site 11)	**Implications for Existing Land Use** ▪ The NWRL operation at this station would complement the existing North West T-way services. ▪ Residential development surrounds Kellyville Station to the west and north. These residential areas will benefit from the location of the station which will provide efficient public transport services. ▪ Improved pedestrian accessibility would be provided via a pedestrian bridge over Old Windsor Road. This would facilitate pedestrian movement between the east and west side of Old Windsor Road. **Implications for Future Land Use** ▪ Due to its location along major road connections and the potential that the greenfields development area presents, Kellyville Station is viewed as having potential to develop into a TOD. ▪ The viaduct is located within an area zoned for the NWRL corridor, buffered by a creek line and stormwater management area to the east where houses are located. It is unlikely that this land would be further developed regardless of the NWRL. Due to the allowance of the NWRL in this corridor and the buffer area to the sensitive receivers, there would be no impact incurred to current and future land uses as a result of the viaduct.
Samantha Riley Drive to Windsor Road (Site 12)	▪ This section of alignment is located within an open space corridor serving as a flood catchment area. Residential dwellings are located within close proximity of the alignment at some points along this site.
Old Windsor Road to White Hart Drive (Site 13)	▪ The northern section of the site is located within close proximity to new residential housing.
Rouse Hill Station (Site 14)	**Implications for Existing Land Use** ▪ Rouse Hill Station is located adjacent to the Rouse Hill Town Centre. The land uses would complement each other and allow the centre to grow and operate more sustainably. ▪ Impacts to the existing retail area would be positive and long term due to the effective integration of the station into this area and the provision of efficient transport services that would see increased pedestrian traffic through the centre. **Implications for Future Land Use** ▪ The area to the north west of the station is currently rural land which has been released for development as part of the Area 20 precinct. The land use at this site would be significantly impacted by the operation of the Rouse Hill Station with higher densities planned for the area. ▪ The town centre has been identified as a planned major centre, incorporating a mix of commercial and retail uses, and higher density housing. Increased residential density will allow for increased walk up patronage from this station.

14.6.3 Rouse Hill to Tallawong

In this area the rail would run parallel to the planned major upgrades to Schofields Road. Movement between the northern and southern areas would be restricted along the length of the corridor during operation.

Table 14.4 Operational Impacts Rouse Hill to Tallawong

Site	Direct Impacts on existing land use and community facilities
Windsor Road Viaduct (Site 15)	▪ The viaduct over Windsor Road would introduce a significant visual feature across Windsor Road. There would be no change to the operation of the existing land uses as a result of the NWRL being on a viaduct at this location. ▪ No disruption to traffic on Windsor Road would be experienced due to NWRL operation at the Windsor Road viaduct.
Windsor Road Viaduct to Cudgegong Road (Site 16)	▪ Increased level of physical separation between the areas north of the alignment and the south of Schofields Road would be created during the operation of the NWRL. Both Cudgegong and Tallawong Roads would continue to connect to Schofields Road via bridges over the rail alignment.
Cudgegong Road Station to Tallawong Stabling Facility (Site 17)	**Implications for Existing Land Use** ▪ The station and the stabling facility would be located within land that is currently rural and has been rezoned for NWRL. ▪ Land use to the south consists of a rapidly developing residential area. **Implications for Future Land Use** ▪ Cudgegong Road Station would integrate into new development allowing a connection between private and public spaces and the station. ▪ A large park and ride facility would be incorporated in the land uses of the station precinct thereby ensuring off street parking. ▪ Development is already planned for the overall area within which the station is located. ▪ The Stabling Facility falls within the Riverstone East precinct of the North West Growth Centre and as such has not yet been planned to the extent of preliminary zones in the surrounding area.

14.7 Impact Assessment – Construction

The Major Civil Construction Works described in EIS 1 have been assessed. Potential impacts on land use during construction works presented in EIS 2 Stations, Rail Infrastructure and Systems include the following:

- ❖ The existing land uses would already be construction sites and thus impacts at this stage of the project would be negligible. The construction period would vary at each site depending on the construction timetable and methodologies employed.
- ❖ No additional properties are anticipated to be acquired and demolished for EIS 2 Stations, Rail Infrastructure and Systems works over and above the properties acquired as part of the EIS 1 Major Civil Construction Works
- ❖ Construction works may impact on known future land use planning developments in the study area. In particular these include Epping Town Centre, Castle Towers Expansion, Balmoral Road Release Area, Rouse Hill Town Centre Northern Frame and the Area 20 precinct. The impact may not necessarily be negative with construction of the NWRL providing an opportunity to integrate sustainable transport options with new developments.
- ❖ Construction activities have the potential to physically divide a community via land severance. Construction of rail infrastructure can create physical barriers interrupting established social linkages, connections and travel patterns. However, this potential impact is likely to be minimal for the project. In established urban areas, the project would be located in a tunnel and the above ground works would be located in the vicinity of existing regional road infrastructure (Old Windsor Road/Windsor Road). With the implementation of mitigation measures, the severance impacts during construction would be minimal.
- ❖ Disruption and changes may occur to pedestrian access and vehicle movements around construction sites.
- ❖ Construction traffic accessing sites may cause impacts to traffic flow along the access roads, access to commercial and business buildings and existing sensitive land uses located along access roads which may affect how the land use operates.

Some community facilities may also be impacted by construction works. The potential impacts on community facilities include:

- ❖ Key community assets in the study area would be significantly altered during EIS 1 works but are still considered to be impacted by EIS 2 Stations, Rail Infrastructure and Systems construction due to the prolonged timeframe required for construction prior to the facilities being re-established.

A summary of direct land use and community impacts at each construction site as a result of the construction works is provided in the following tables.

14.7.1 Epping to Bella Vista

Construction works for the section of NWRL from Epping to Bella Vista would predominantly be carried out underground thereby reducing the degree of land use impacts potentially experienced during construction. There are some areas where surface construction is required including at the services facilities and station locations. Specific details regarding potential impacts at these locations are included in the table below.

Table 14.5 Construction Impacts Epping to Bella Vista

Site	Direct Impacts on existing land use and community facilities
Epping Services Facility (Site 1)	**Land use and property** ▪ Land uses surrounding the facility would not be significantly impacted in their daily operations with the most likely impacts pertaining to traffic disturbance. **Community** ▪ No community facilities would be acquired as part of the construction footprint. ▪ Surrounding community assets include places of worship (Epping Uniting Church and Epping Baptist Church), educational establishments (Arden Anglican School and Our Lady Help of Christians Primary School) and Essex Street Scout Hall. These assets may experience reduced amenity during construction works but no direct impacts on the facility itself. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).
Cheltenham Services Facility (Site 3)	**Land use and property** ▪ EIS 1 construction works would require demolition of Cheltenham Netball Training Courts and associated facilities and the removal of vegetation within Beecroft Reserve. Construction works for EIS 2 Stations, Rail Infrastructure and Systems would extend the timeframe for which this impact is experienced. ▪ There are no known future land use plans in the immediate vicinity of the proposed services facility. **Community** ▪ Construction works would result in the extended loss of an active recreation venue due to the demolition of Cheltenham Netball Training Courts, cricket nets and playground. ▪ Cheltenham Oval would not be directly impacted by the proposed works, however, users of the oval may experience reduced amenity during construction works with less parking available. ▪ Users of Beecroft Reserve may experience reduced amenity during the construction works. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10), Ecology (Chapter 15) and Air Quality (Chapter 19).
Cherrybrook Station (Site 4)	**Land use and property** ▪ There are no known future developments proposed in the immediate vicinity of the proposed station and therefore construction works would not impact other works. **Community** ▪ Community facilities such as Tangara Infants School, Tangara School for Girls, Inala Rudolf Steiner School, Kindalin Early Childhood Learning, Playdays Pre-School and Inala Dulkara Adult Day Service may experience reduced amenity during the construction period. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19). ▪ Two schools are located along Franklin Road, opposite to the proposed station construction site. There is potential for the access to these schools to be impacted from construction traffic access requirements.
Castle Hill Station (Site 5)	**Land use and property** ▪ Construction works would require the use of Arthur Whitling Park, part of the Old Northern Road reserve and demolition of two buildings and would see impacts incurred during EIS 1 continue into EIS 2 Stations, Rail Infrastructure and Systems. ▪ Cumulative impacts associated with the overlapping of construction works for NWRL and the expansion of Castle Towers Shopping Centre are considered in Chapter 20. **Community** ▪ Temporary loss of an open space area (Arthur Whitling Park) during construction. ▪ Temporary impact on the cultural values of the area due to removal of the war memorial and other monuments, structures and memorials located within Arthur Whitling Park. Events and ceremonies associated with these memorials would also be impacted during construction and would likely have to seek alternative locations. ▪ Potential amenity impacts on community facilities in close proximity to the construction works including Castle Hill Senior Citizens Centre, and St Bernadette's School. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19). ▪ Acquisition of the bus stop on Old Northern Road.

Site	Direct Impacts on existing land use and community facilities
Showground Station (Site 6)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. **Community** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. The Showground would remain accessible to local residents and major events would still be able to use the Showground as a venue during EIS 2 Stations, Rail Infrastructure and Systems works. ▪ Disruption to the amenity of Carrington Pre-School. Amenity impacts are discussed in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).
Norwest Station (Site 7)	**Land use and property** ▪ Works would be localised and confined to an already designated construction site, therefore impacts to surrounding land uses would be minimal. ▪ Businesses on Brookhollow Avenue may be impacted. ▪ The service station may be impacted through the construction of a bus stop on Norwest Boulevard and pedestrian movements may be constrained around the construction site. **Community** ▪ No direct impacts on community facilities are anticipated. ▪ Surrounding community assets may experience reduced amenity during construction works. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).
Bella Vista Station (Site 8)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. ▪ It is anticipated that McDonalds would have a portion of their car park temporarily unavailable during construction works. **Community** ▪ No direct impacts on community facilities are anticipated. ▪ Community facilities may experience reduced amenity during the construction works. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).

14.7.2 Bella Vista to Rouse Hill

From Bella Vista to Rouse Hill the majority of impacts experienced by areas through which the alignment passes would be mostly minor and could be minimised through mitigation measures. These impacts are discussed here with more detail provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10), Visual Amenity (Chapter 16) and Air Quality (Chapter 19).

Table 14.6 Construction Impacts Bella Vista to Rouse Hill

Site	Direct Impacts on existing land use and community facilities
Balmoral Road (Site 9)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. **Community** ▪ No direct or indirect impacts on community facilities are anticipated at this construction site.
Memorial Avenue (Site 10)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. **Community** ▪ No direct impacts on community facilities are anticipated. ▪ Temporary relocation of T-way car park to the eastern side of the bus station during construction works would have implications for commuter traffic accessing the T-way. Impacts would be minor with T-Way services remaining fully accessible.
Kellyville Station (Site 11)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. **Community** ▪ No direct impacts on community facilities are anticipated ▪ Temporary relocation of bus T-way car park during construction works would have implications for commuter traffic accessing the T-way. Impacts would be minor with T-Way services remaining fully accessible.
Samantha Riley Drive to Windsor Road (Site 12)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. **Community** No di6rect impacts on community facilities are anticipated. ▪ Nearby community facilities, may experience reduced amenity during the construction period. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).

Site	Direct Impacts on existing land use and community facilities
Windsor Road to White Hart Drive (Site 13)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. Impacts would mainly relate to amenity issues for which assessment has been carried out in in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19). **Community** ▪ No direct impacts on community facilities are anticipated. ▪ Nearby community facilities may experience reduced amenity during the construction period. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).
Rouse Hill Station (Site 14)	**Land use and property** ▪ Construction works would require continued possession of the construction area for Major Civil Construction Works as described in EIS 1. **Community** ▪ No direct impacts on community facilities are anticipated. ▪ Community facilities in close proximity to the construction works may have reduced amenity during the construction period. As these are not considered to be sensitive receivers the impact on these land uses is considered minor. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).

14.7.3 Rouse Hill to Tallawong

Impacts for this section of the NWRL from construction would mainly be felt to the south of Schofields Road where development of housing is rapidly underway within The Ponds area. This area would be mostly developed prior to the construction of the NWRL commencing and would place a large number of residents within close proximity to a construction zone.

Table 14.7 Construction Impacts Rouse Hill to Tallawong

Site	Direct Impacts on existing land use and community facilities
Windsor Road Viaduct (Site 15)	**Land use and property** ▪ This section of the alignment is within the Area 20 precinct. Although the Project is generally consistent with land use planning in the precinct, the vertical alignment at the corner of Windsor Road and Schofields Road has been modified as part of the current Project. The main change is that Rouse Hill Station is now an elevated station and a viaduct passes over Windsor Road. Current zoning in the area assumes an underground rail tunnel with planned open space and residential development over the rail alignment. This impact is unlikely to be major due to the opportunity to plan Area 20 from a greenfields situation around the NWRL design requirements. **Community** ▪ Community facilities in close proximity to the construction works may have reduced amenity during the construction period. Assessments of these impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19).
Windsor Road Viaduct to Cudgegong Road (Site 16)	**Land use and property** ▪ Potential severance of future Area 20 Precinct communities by the addition of a physical barrier (additional to Schofields Road). As planning for Area 20 accounts for the rail line and appropriate roads and other connections, land severance is likely to be minimal. **Community** ▪ The OK Caravan Park, Rouse Hill may experience reduced amenity during the construction period. Assessments of impacts are provided in the following chapters; Traffic (Chapter 9), Noise and Vibration (Chapter 10) and Air Quality (Chapter 19). ▪ No direct or indirect impacts on community facilities are anticipated.
Cudgegong Road Station to Tallawong Stabling Facility (Site 17)	**Land use and property** ▪ Minimal impacts are anticipated to this site due to the rural use of the land. **Community** ▪ No direct or indirect impacts on community facilities are anticipated.

14.8 Mitigation measures

Mitigation measures for the operational and construction phases have been developed to avoid, reduce and manage identified potential impacts. These mitigation measures and their application to the sites for the NWRL are presented in **Table 14.8** and **Table 14.9** respectively. In addition to the mitigation measures identified in this chapter, measures outlined in other EIS chapters would further mitigate land use and community facility impacts. These include:

- Amenity – Chapter 16 (Visual Amenity), Chapter 10 (Noise and Vibration) and Chapter 19 (Air quality) identify effective mitigation measures for controlling potential operating amenity impacts on community facilities.
- Transport – Chapter 9 (Traffic and Transport) identifies effective mitigation measures for the relocation of bus stops at the proposed Castle Hill and Rouse Hill Stations.

14.8.1 Operation

An Operational Environmental Management Plan (OEMP) would be developed to detail the processes to manage environmental impacts during the operation of the project.

Mitigation measures have been developed to avoid, reduce and manage identified potential impacts. These mitigation measures and their application to the operation of NWRL are presented in **Table 14.8**.

Table 14.8 Land Use and Community Facilities Operation Mitigation Measures

No.	Mitigation Measure	Applicable Areas
OpLC1	Consultation would continue between NWRL and DP&I to ensure the DP&I precinct planning process is integrated with NWRL station precinct planning so as to better integrate land use and transport connectivity.	Station precincts
OpLC2	It has been agreed with stakeholders that once operational, the completed precinct would incorporate appropriate recognition of the current war memorial.	Castle Hill Station

14.8.2 Construction

The 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 impacts. These mitigation measures and their application to the construction sites for NWRL are presented in **Table 14.9**.

Table 14.9 Land Use and Community Facilities Construction Mitigation Measures

No.	Mitigation Measure	Applicable Sites*
LC1	Liaison would continue with statutory organisations, DP&I and local Councils to ensure the Project is integrated with local and regional land use planning, and that environmental planning instruments reflect the planning, construction and operation of the Project, and include integrated planning provisions to enhance potential future development.	All
LC2	Consultation would continue with the community throughout the project planning and construction phases to ensure that community members have adequate information about the project, the timing and scope of activities in their local area and impacts on their local facilities and recreational areas. Area specific Place Managers have been allocated to undertake this ongoing consultation.	All
LC3	Further consultation regarding the implications of the Project in relation to the *Epping Town Centre Study* would be undertaken with Hornsby Shire Council, Parramatta City Council and DP&I.	1
LC4	Consultation with Cheltenham Oval user groups would be undertaken as part of identifying appropriate post-construction configuration and facilities for sporting activities.	3
LC5	Consultation with stakeholders of Beecroft Reserve would be undertaken as part of identifying appropriate adjustments to walking trails both during construction (temporary adjustments) and operational phases (permanent adjustments). Enhancements or modifications to the trail network would also be considered as part of this process.	3
LC6	Consultation with schools near the Cherrybrook site would be undertaken to develop specific mitigation measures to reduce impacts on their operation and amenity.	4
LC7	Consultation would be undertaken with the Castle Hill RSL Sub Branch and The Hills Shire Council regarding appropriate management of the war memorial in Arthur Whitling Park. This would include consideration of possible temporary relocation and an appropriate long term solution.	5
LC8	Activities occurring in Showground buildings and pavilions to be acquired as part of the construction footprint would be re-accommodated within the Showground precinct or as otherwise agreed with the Showground Trust.	6
LC9	Consultation with Hillsong Church would be undertaken prior to construction to identify specific mitigation measures to reduce operational and amenity impacts.	7
LC10	Consultation with Emmanuel Baptist Church and Anglican Technical College Western Sydney would be undertaken prior to construction to identify specific mitigation measures to reduce operational and amenity impacts.	8
LC11	Consultation regarding the implications of the Project in relation to the Balmoral Road Release Area would be undertaken with The Hills Shire Council.	9 – 11

No.	Mitigation Measure	Applicable Sites*
LC12	Consultation would be undertaken with relevant stakeholders regarding the implications of the project on the Rouse Hill Town Centre Northern Frame works.	14
LC13	Consultation regarding the implications of the project on the proposed land use plan for Area 20 would be undertaken with DP&I, Blacktown City Council and relevant stakeholders.	15 – 17
LC14	Opportunities to minimise temporary loss of land should be investigated through detailed construction planning and site layout, particularly in areas such as the Cheltenham Services Facility and Showground Station.	All
LC15	Consider staging construction, particularly at busy locations, to complement traffic management measures and assist in minimising disruption to key land uses and vehicle and pedestrian movements.	All

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 and Tunnels

CHAPTER 15

ECOLOGY

15 ECOLOGY

15.1 Introduction

This chapter provides an assessment of the terrestrial and aquatic ecology directly and indirectly impacted by the:

- construction of the NWRL stations, rail infrastructure and systems.
- operation of the NWRL project.

The aim of the assessment is to identify and determine the level of potential impact and to develop appropriate measures to mitigate and manage the impacts.

This chapter represents a summary of the following detailed assessments which have been prepared for the project:

- Terrestrial ecology assessment – Ecological Assessment for the North West Rail Link (Eco Logical Australia, 2012), included as Technical Paper 6a.
- Riparian and aquatic ecology assessment – Riparian Assessment for the North West Rail Link (Eco Logical Australia, 2012A), included as Technical Paper 6b.
- Groundwater dependent ecology assessment – Groundwater Dependent Ecosystem Risk Assessment for the North West Rail Link (Eco Logical Australia, 2012B), included as Technical Paper 6c.

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

Table 15.1 sets out the Conditions of Approval (CoA) and the Statement of Commitments (SoCs) as they relate to ecology, and where these have been addressed within this chapter. The Director-General's Requirements (DGRs) did not include any ecology related requirements. Unless otherwise stated, references are to chapters of EIS 2 in relation to the construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL project.

Table 15.1 Conditions of Approval and Statement of Commitments

Reference	Description	Addressed
2.8	**Performance Standards** The Proponent shall ensure that the biodiversity impacts associated with the project are offset consistent with the "improve and maintain" principles of the Growth Centres Biodiversity Certification process, in consultation with OEH and SLR.	EIS 1 - Section 15.6.1
3.1 d)	**Project Applications and Specific Requirements** Pursuant to section 75P(1)(a) of the Environmental Planning and Assessment Act 1979, the following environmental assessment requirements apply with respect to any projects related to this concept plan approval:... ▪ d) an assessment of Matters of National Environmental Significance, as relevant;	As noted in Section 15.3 an EPBC referral has been submitted to SEWPaC.
3.8 e)	**Geotechnical** The Proponent shall identify the following matters in relation to the bored tunnel components of the project: ▪ impacts to groundwater dependent ecological communities (GDE) (affected by groundwater drawdown) and to riparian and in stream ecology (affected by surface cracking and water flow impacts).	Section 15.5
3.12	**Surface Water and Hydrology** The Proponent shall identify impacts to riparian and instream ecology from any direct disturbances to waterways and to flora and fauna from changes to creek flow or flood behaviours, during construction or operation.	Section 15.5
3.13	**Flora and Fauna** The Proponent shall confirm the ecological impacts associated with the project with consideration to Condition 3.8 e) and 3.12, and identify measures to offset impacts, clearly distinguishing between measures to be provided as part of the Growth Centres Biodiversity Certification process and other measures. The Proponent shall describe how the effectiveness of the offset measure will be monitored, what actions shall be taken if measures are identified to be ineffective, the maintenance responsibilities, and timing of implementation of offset measures.	Section 15.5 and EIS 1 - Section 15.6.1
Statement of Commitments	**Description**	**Addressed**
1	**Sustainability strategies** Core sustainability principles would be developed for the design and construction of the project covering the following themes: ▪ Energy ▪ Greenhouse emissions ▪ Water ▪ Community and stakeholder involvement ▪ Biodiversity ▪ Resource recycling/minimisation To develop the principles a benchmarking exercise would be undertaken to enable sustainability goals and objectives to be determined, which would provide clear result areas and targets under each theme.	Chapter 4

Reference	Description	Addressed
25	**Flora and Fauna** Design of waterway crossings and structures would be undertaken with reference to the Guidelines for Design of Fish and Fauna Friendly Waterway Crossings (Fairfull and Witheridge 2003) and Fish Passage Requirements for Waterway Crossings (2003) and considering the quality of riparian habitat present, in consultation with the Department of Primary Industries (NSW Fisheries) and other relevant Government agencies.	Section 15.5
26	The location of structures associated with the rail tunnel, such as ventilation shafts, emergency egress/access points and discharge/runoff outlines, will be assessed with respect to the potential application of SEPP 19.	Not applicable as no new bushland is being cleared in Stage 2.
27	A detailed ecological assessment will be undertaken at all construction sites and along above-ground sections of the project corridor. The assessment will identify areas to be avoided (where practicable) construction related impacts and how these can be managed; and, where required, describe measures to offset significant impacts on threatened species and/or endangered ecological communities (EEC). This assessment will be undertaken in consultation with the DECC, the Growth Centres Commission, RailCorp, and the Commonwealth Department of Environment and Water Resources, as appropriate.	Section 15.5 and 15.6
28	'Improve and Maintain' assessment on biodiversity values will be undertaken to identify the potential impacts of the project and benefits from protection measures to be implemented. The methodology adopted for all parts of the project will be consistent with the draft Growth Centres Conservation Plan (GCC, 2007) and DEC's draft Guidelines for Biodiversity Certification of Environmental Planning Instruments (2007).	Section 15.5 and 15.6
37	**Hydrology and Surface Water** Investigations into the construction and operational impacts on the Elizabeth Macarthur Creek would be undertaken in accordance with relevant NSW Government guidelines.	Section 15.3.2 and 15.5

15.3 Methodology

The study area for the ecology assessment is the area which is potentially impacted by:

- construction of the NWRL stations, rail infrastructure and systems.
- operation of the NWRL project.

Stage 2 stations, rail infrastructure and systems construction works would not result in any additional bushland clearance compared to Stage 1 major civil construction works. For the purposes of assessing Stage 2 construction related impacts, vegetation would be cleared prior to Stage 2 constructions works commencing as a result of the major civil construction works, the impacts of which have been assessed as part of Stage 1.

Stage 2 works would result in the clearance of additional street trees. Five street trees located on a road traffic island on Castle Howard Road would be cleared to enable access to the Cheltenham Services Facility construction site and provide maintenance and emergency services access during operation.

Terrestrial, riparian, aquatic and groundwater dependent ecology within the study area were assessed by reviewing existing available information and conducting field surveys. Consultation with the OEH was carried out in October 2011 to inform the requirements and methodology of the ecology assessments.

The NSW Threatened Species Conservation (TSC) Act 1995 aims to protect and encourage the recovery of threatened species, populations, and communities listed under the Act. The assessment of impacts on threatened species, populations and ecological communities listed under the TSC Act has been completed in accordance with the Draft *Guidelines for Threatened Species Assessment* (DEC and Department of Primary Industries 2005). The assessment process included:

- Desktop review of literature and database searches.
- Field surveys to 'ground truth' the presence of threatened species, populations and Endangered Ecological Communities (EEC).
- Significance assessments to evaluate the potential impacts on threatened species, populations, habitats and EEC likely to be affected by the project.
- Identification of measures to avoid and minimise impacts, or offset strategies where impacts cannot be avoided or minimised.

The Commonwealth EPBC Act 1999 aims to 'provide for the protection of the environment, especially those aspects of the environment that are listed under the Act as matters of national environmental significance.' Matters of national environmental significance relevant to the study area include nationally listed threatened species and ecological communities and listed migratory species. A referral under the EPBC Act has been submitted to SEWPaC.

15.3.1 Terrestrial Ecology

The study area for the terrestrial ecology assessment includes the project's footprint in relation to the construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL project. The footprint has been typically extended to the edge of adjoining infrastructure (eg roads), urban development, or to a 100m buffer to account for any indirect impacts.

To identify flora and fauna likely to occur within the study area a desktop review of existing information was carried out. The data sources reviewed included the:

- National Parks and Wildlife Service Wildlife Database - Atlas of NSW Wildlife (a 10km buffer zone search around the study area was conducted).
- EPBC Act Protected Matters Search Tool (a 5km buffer zone search around the study area was conducted).
- Sydney Metropolitan and Western Sydney vegetation mapping.

The literature reviewed included ecological impact assessments and flora and fauna surveys conducted within the study area as well as records of threatened vegetation communities and flora and fauna species. High resolution aerial photographs of the study area were also used to investigate the extent of vegetation cover, landscape features and disturbance patterns in the study area. The information obtained from the desktop review was used to prepare a list of threatened and migratory flora and fauna species that may possibly occur within the study area.

An assessment of the likelihood of threatened and migratory flora and fauna occurring within the study area was then made, based on:

- The data and literature review
- Presence of suitable habitat within the study area.
- Information on the knowledge of species ecology.

The assessment results were used to inform the field surveys and targeted threatened species searches. Field flora and fauna surveys were undertaken to 'ground truth' the information obtained from the desktop review.

Flora Surveys

Field flora surveys of the study area were undertaken in spring 2011 (between 20 October and 7 December 2011). The flora surveys included:

- Plot based surveys (19 full-floristic plots 20m by 20m surveyed).
- Targeted threatened flora species searches.
- Vegetation type and condition mapping (rapid vegetation validation traverse).
- Random meander.

The purpose of the plot based surveys was to ensure that all vegetation types and condition states were sampled and vegetation boundaries were determined. The design of the survey considered the requirements of the *Threatened Biodiversity Survey and Assessment Guidelines* (working draft, Department of Environment and Conservation (DEC), 2004). However a modified BioBanking methodology (*BioBanking Operational Manual*, NSW DECC, Seidel & Briggs, 2008) was used to conduct the surveys. Data collected focused on identifying the species diversity, condition and structure within the plots and the overall distribution of vegetation types present.

Vegetation type and condition mapping was undertaken to verify the vegetation communities present across the study area and map their extent.

The targeted threatened flora species searches were undertaken in suitable habitat following the *Threatened Biodiversity Survey and Assessment Guidelines* (working draft, DEC, 2004).

Fauna Surveys

A habitat assessment was carried out to provide a detailed description of fauna resources and the study area's ability to support threatened species and determine species diversity and abundance.

The fauna field survey was designed to target key threatened fauna species identified as having suitable habitat within the study area. The surveys followed the draft *Threatened Biodiversity Survey and Assessment Guidelines* (DEC, 2004) and were conducted from 20 October to 7 December 2011.

Many species previously recorded in or near the study area (bird, reptile, microbat and mammal species identified during the desktop review) were not specifically targeted for survey, as these species were assumed to be present.

Targeted fauna species surveys were undertaken for the Green and Golden Bell Frog and the Cumberland Land Snail. The *Environmental Impact Assessment Guidelines; Cumberland Plain Large Land Snail* (NSW National Parks and Wildlife Service, 2000) was followed during the search for snails.

The targeted threatened amphibian surveys were conducted over four nights (21-23 and 29 November 2011) and included nocturnal and diurnal surveys following the *Survey Guidelines for Australia's Threatened Frogs* (Australian Government Department of the Environment, Water, Heritage and the Arts, 2010).

In addition to the targeted surveys, fauna were continuously surveyed for and recorded during the daytime flora surveys.

Survey Limitations

Except for the targeted threatened flora survey undertaken in March 2012 at Cheltenham, the surveys for the terrestrial ecological assessment were undertaken over a single season (spring) and the surveys were stratified by vegetation types. However, the assessment assumes the presence of many species known to occur in the study area (identified from data and literature reviewed).

It should be noted that detailed ecological investigations were carried out in 2010 on the Area 20 precinct. The data gathered from these investigations was used to inform the NWRL ecology assessment. No field surveys were undertaken as part of the *Ecological Assessment* (Eco Logical Australia, 2011) within the Area 20 precinct.

Hollow bearing tree surveys were not carried out for the westernmost portion of the Cheltenham site. The conclusions relating to species reliant on tree hollows for roosting / breeding habitat may therefore not apply to these areas.

15.3.2 Riparian and Aquatic Ecology

The NWRL alignment would cross or be located adjacent to many creeks of varying size, condition and regional importance. To determine potential impacts of the project on the riparian and aquatic ecology, an assessment was undertaken guided by the *Riparian Corridor Management Study* (NSW DIPNR, 2004). The assessment included a desktop review of data/ literature and field inspections (undertaken between 24 October and 10 November 2011). The study area for the assessment includes the project's footprint in relation to the construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL project and creeks and their tributaries upstream and downstream of the footprint.

The following watercourses located within or near the study area were assessed:

- Devlins Creek and two tributaries to the creek.
- Pyes Creek.
- Excelsior Creek.
- Cattai Creek and a tributary to the creek.
- Strangers Creek and a tributary to the creek.
- Elizabeth Macarthur Creek.
- Caddies Creek and two tributaries to the creek.
- Second Ponds Creek.
- First Ponds Creek.

To determine the current condition of the watercourses (listed above) and the extent of riparian and aquatic habitat the following assessments were undertaken:

Top of Bank Mapping

The top of bank for each watercourse was mapped to determine the extent of each watercourse.

Riparian Condition Assessment

An assessment of riparian condition and recovery potential was conducted for each watercourse. This assessment considered native vegetation cover and quality, bed and bank stability and habitat diversity as described in the document *'Geomorphic Categorisation of Streams in the Hawkesbury Nepean Catchment'* (NSW DLWC, 2001).

Ecological Assessment

An assessment of the biodiversity values of each watercourse was conducted in conjunction with the two assessments listed above. The quality of aquatic and riparian habitats was assessed, including vegetation structure, regeneration, weed infestation, woody debris, fish habitat, patch size and connectivity potential.

Rehabilitation Assessment

An assessment of the rehabilitation requirements of each of the watercourses was conducted. Appropriate local native species for impacted waterways within the study area were identified. Significant weed species were also documented, and methods for removal recommended.

15.3.3 Groundwater Dependent Ecosystems

The groundwater dependent ecology (GDE) assessment targeted creeks, wetlands and riparian vegetation within and close to the construction and operational footprint.

The assessment carried out includes only the terrestrially expressed GDEs.

Current geological and hydrological knowledge of the region was used in combination with inspections to identify potential GDEs within the study area. The creeks, wetlands and riparian vegetation within the study area were surveyed on 24 October and 25 October 2011 and 10 November 2011.

A risk assessment framework was then used to assess the potential impacts to GDEs and any groundwater related aquatic environments (refer to Section 15.5.4 for further information).

15.4 Existing Environmental Conditions

15.4.1 Context

The study area for the ecology assessment is the area which is potentially impacted by construction and operation activities being:

- construction of the NWRL stations, rail infrastructure and systems.
- operation of the NWRL project.

Stage 2 stations, rail infrastructure and systems construction works would not result in any additional bushland clearance compared to Stage 1 major civil construction works. For the purposes of assessing Stage 2 construction related impacts, vegetation would be cleared prior to Stage 2 constructions works commencing as a result of the major civil construction works, the impacts of which have been assessed as part of Stage 1.

Stage 2 works would result in the clearance of additional street trees. Five street trees located on a road traffic island on Castle Howard Road would be cleared to enable access to the Cheltenham Services Facility construction site and provide maintenance and emergency services access during operation.

For information on the existing environment assessed as part of EIS1, refer to the following detailed assessments which have been prepared for the project:

- Terrestrial ecology assessment – Ecological Assessment for the North West Rail Link (Eco Logical Australia, 2012), included as Technical Paper 6a.
- Riparian and aquatic ecology assessment – Riparian Assessment for the North West Rail Link (Eco Logical Australia, 2012A), included as Technical Paper 6b.
- Groundwater dependent ecology assessment – Groundwater Dependent Ecosystem Risk Assessment for the North West Rail Link (Eco Logical Australia, 2012B), included as Technical Paper 6c.

15.4.2 Terrestrial Flora

Bushland within the construction footprint of stations, rail infrastructure and systems would have been cleared as part of Stage 1 of the NWRL project (the Major Civil Construction Works). These impacts have been assessed and mitigated as part of EIS1.

Additionally, protective fencing and signage would have been installed (as an EIS1 mitigation measure in accordance with Australian Standard 4970 – 2009 Protection of Trees) where native vegetation is retained adjacent to or within construction sites.

Street trees may need to be cleared to facilitate construction of the NWRL stations, rail infrastructure and systems and provide access (e.g. cycle ways, emergency access) during operation of the NWRL. For example, five street trees located on a road traffic island on Castle Howard Road would be cleared to enable access to the Cheltenham Services Facility construction site and provide maintenance and emergency services access during operation.

15.4.3 Terrestrial Fauna

The majority of the construction and operational footprint would not provide habitat for fauna. However, as previously mentioned, the study area includes a buffer zone beyond the footprint (to a 100m buffer) to account for any indirect impacts to vegetation which may provide fauna habitat.

The following species have been recorded within the study area (identified during the desktop review and/or during the field surveys):

- 140 birds.
- 38 reptiles.
- 18 frogs.
- 11 flying mammals (bats).
- 16 non-flying mammals (including ten introduced species).
- 2 snail species (including one introduced species).
- 13 fish species (including three introduced species).

15.4.4 Threatened Fauna

During the field survey two migratory bird species listed under the EPBC Act were identified:

- Cattle Egret.
- Latham's Snipe.

Additional targeted field surveys were also undertaken for the Green and Golden Bell Frog and Cumberland Land Snail to supplement existing data.

No live snails or empty shells of Cumberland Land Snail were found during the targeted field survey in areas of know habitat. However, the species has been previously found (2004 and 2010) within or close to the study area.

The Green and Golden Bell Frog was not detected during the targeted field survey, despite optimal weather conditions and survey season. However, this does not preclude the possibility of the species utilising habitat at these locations at other times or transiently moving through these areas during dispersal.

Table 15.2 lists threatened fauna species recorded within a 10km radius of the projects footprint for which the study area (prior to clearing) was likely to provide habitat. The table provides information on the likelihood of occurrence of the threatened species (listed above) in the study area. No threatened fish or reptiles are considered likely to occur in the study area.

As previously mentioned, the assessment undertaken adopts a conservative and precautionary approach, hence for the purposes of the ecology assessment all of the species listed in the table were assumed to be present in the study area.

Table 15.2 Threatened Fauna Species likely, or with the potential, to occur in the Study Area.

Scientific Name	Common Name	TSC Act Status	EPBC Act Status	Likelihood of occurrence
AMPHIBIANS				
Litoria aurea	Green and Golden Bell Frog	E	V	Potential
DIURNAL BIRDS				
Anthochaera phrygia	Regent Honeyeater	E	E & M	Potential
Callocephalon fimbriatum	Gang-gang Cockatoo	V, E2	-	Likely
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Likely
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	Potential
Daphoenositta chrysoptera	Varied Sittella	V	-	Potential
Lathamus discolor	Swift Parrot	E	E	Likely
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Potential
Neophema pulchella	Turquoise Parrot	V	-	Potential
Petroica boodang	Scarlet Robin	V	-	Potential
Ptilinopus superbus	Superb Fruit-Dove	V	-	Potential
NOCTURNAL BIRDS				
Ninox connivens	Barking Owl	V	-	Potential
Ninox strenua	Powerful Owl	V	-	Likely
MAMMALS (excluding bats)				
Dasyurus maculatus maculatus	Spotted-tailed Quoll (SE Mainland Population)	V	E	Potential
MAMMALS (bats)				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Potential
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Likely
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Likely
Mormopterus norfolkensis	East Coast Freetail Bat	V	-	Likely
Myotis macropus	Southern / Large-footed Myotis	V	-	Potential
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Potential
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Potential
INVERTEBRATES				
Meridolum corneovirens	Cumberland Plain Land Snail	E	-	Potential
MIGRATORY BIRDS				
Apus pacificus	Fork-tailed Swift	-	M	Potential
Hirundapus caudacutus	White-throated Needletail	-	M	Potential
Monarcha melanopsis	Black-faced Monarch	-	M	Potential
Myiagra cyanoleuca	Satin Flycatcher	-	M	Potential
Rhipidura rufifrons	Rufous Fantail	-	M	Potential
Ardea alba	Great Egret	-	M	Potential
Ardea ibis	Cattle Egret	-	M	Yes
Gallinago hardwickii	Latham's Snipe	-	M	Yes

Note: M: migratory, V: vulnerable, E: endangered, E2: endangered population, - : not listed.

Terrestrial fauna habitat

The study area provides a variety of habitat features for a range of threatened fauna species. Vegetation condition and the availability of habitat features varied across the study area. Vegetation within the eastern part of the study area (including suburbs of Epping, Beecroft, Cheltenham, Cherrybrook and Castle Hill) contained dense patches of vegetation strongly influenced by sandstone/shale geology providing some reptile habitat and a more diverse vegetation structure. A total of four native vegetation communities were represented within the eastern part of the study area, including several EEC and Critically Endangered Ecological Community (CEEC).

In contrast, extensive vegetation clearing, grazing and weed infestation has resulted in much of the native vegetation within the western part of the study area (from Bella Vista Station) being of poor condition.

The following provides a summary of fauna habitat along the study area:

- Habitat at Epping has been affected by small remnant patch size, adjacent urban areas, and weed species.
- The eastern part of the study area although fragmented by urban development contained scattered urban trees and riparian corridors (the term riparian corridor refers to land directly adjacent to or surrounding a waterway) providing suitable connectivity between habitat patches only for highly mobile species.
- At the Cheltenham Service Facility site native species were represented within each vegetative stratum and habitats provided a number of different foraging and roosting resources for a diversity of fauna species. A recent burn within the site has reduced weed coverage and encouraged germination of native groundcover species and bush regeneration works were observed along Devlins Creek.

- At the Cherrybrook Station site native shrubs and groundcover species were poorly represented in areas of high weed infestation and mechanical disturbance. The Blue Gum High Forest within the site is in poor condition with severe weed infestation. The Blue Gum High Forest located outside of the site (to the north east) is classified as in good condition and contains regenerating native species.
- The Showground Station site contained the only patch of Shale/Sandstone Transition Forest (EEC) with native shrubs and groundcover species poorly represented and areas of high weed infestation and disturbance. The Showground Station area contained scattered Narrow-leaved Scribbly/Snappy Gum (Eucalyptus racemosa) with several hollows of varying size and shape in each tree. Hollow-dependant avian species including, migratory species such as Dollarbird (Eurystomus orientalis) were observed nesting in hollows and foraging in tree canopy.
- The north-western portion of the study area (from Bella Vista Station to Rouse Hill Station) contains large tracts of exotic weed grasses and shrubs with low native species richness. Clearing of vegetation, underscrubbing and grazing have led to the area having poor condition habitat. A few small pockets of moderate Cumberland Plain Woodland (CEEC) vegetation in moderate condition were retained in private lots. Some regenerating Cumberland Plain Woodland canopy trees (Eucalyptus tereticornis and crebra) were present, which could provide foraging resources for winter migrant bird species. Occasional mature canopy trees were present with hollows. Primary and secondary habitat for the threatened Cumberland Plain Land Snail is defined as all areas of Cumberland Plain Woodland and River Flat Eucalypt Forest in moderate or good condition.
- The north-western portion of the study area contained limited habitat resources for small terrestrial fauna such as reptiles and midstorey foraging habitat for avian species. The native shrub layer was absent over much of the area and weed infestation was high. Rocks and logs were only recorded within riparian corridors during the field inspection however, disused building material including timber and metal sheeting within private lots provided supplementary habitat for reptiles and their prey items. Overall, habitat complexity was low.
- Many bat and bird species use tree hollows for breeding / roosting. The greatest number of hollows was recorded in large Forest Red Gum and Cabbage Gum trees, which are the most common tree species in the Cumberland Plain Woodland and River Flat Eucalyptus Forest communities.

Temporary and permanent water bodies are located within the north-western portion of the study area, including:

- **Minor creeks** – Elizabeth Macarthur and Caddies Creeks.
- **Secondary drainage lines** – Charlies Creek.
- **Farm dams**.
- **Constructed wetlands** around the Bella Vista Station (Celebration Drive) and Norwest Station sites (Norwest Boulevard).

The general existing condition of these water bodies is poor, with nutrient enrichment and an absence of native vegetation cover. However, they provided habitat to reptile, amphibian and wading avian species (noted during the field inspection). Noxious weeds such as Narrow and Broad Leaved Privet were present along riparian corridors and in general native flora resilience was low, particularly in areas of high weed infestation.

The survey identified substantial areas of potential primary and secondary habitat for the Green and Golden Bell Frog, including potential breeding sites (consisting of seven water bodies likely to support breeding located between First Ponds Creek and Samantha Riley Drive) and movement corridors along Caddies Creek and Elizabeth Macarthur Creek.

15.4.5 Riparian and Aquatic Environment

The project crosses many sub-catchments of the Lane Cove River, Hawkesbury River and Parramatta River. Major creeks in and around the study area include:

- Devlins Creek (flows to Lane Cove River).
- Pyes Creek (flows to Berowra Creek).
- Excelsior Creek (flows to Darling Mills Creek and then Parramatta River).
- Cattai Creek (flows to Hawkesbury River).
- Strangers, Elizabeth Macarthur, Caddies, First Ponds and Second Ponds Creeks (all flowing to Cattai Creek).

These creeks are located in the residential suburbs of Hornsby, Baulkham Hills and Blacktown Local Government Areas. Further downstream, all creeks and rivers flow through at least one conservation reserve (eg Lane Cove National Park, Berowra Valley Regional Park, Cattai National Park) plus many other regional reserves and parks. The existing condition of riparian communities and aquatic habitats is summarised in **Table 15.3**.

Table 15.3 Summary of Existing Riparian and Aquatic Condition

Watercourse Name	Riparian Condition	Aquatic Condition
Tributary to Devlins Creek (Edensor Street)	Degraded	Degraded
Devlins Creek (downstream of the M2 Motorway)	Moderate	Good
Tributary to Devlins Creek (Chilworth/Beecroft Reserve)	Near intact	Good
Devlins Creek (at Fearnley Park)	Moderate	Moderate
Pyes Creek (upstream of Robert Road)	Degraded	Degraded-Moderate
Excelsior Creek (upstream of Highs Road)	Degraded	Degraded
Cattai Creek (upstream of Showground Road)	Moderate	Degraded-Moderate
Tributary to Cattai Creek (Anella Avenue)	Moderate	Degraded
Strangers Creek (Norwest Boulevard)	Moderate	Degraded
Tributary to Strangers Creek (Edgewater Drive)	Moderate	Moderate
Elizabeth Macarthur Creek (Norwest Boulevard to Celebration Drive)	Moderate	Moderate
Elizabeth Macarthur Creek (Celebration Drive to Balmoral Road)	Degraded	Moderate
Elizabeth Macarthur Creek (Balmoral Road to Memorial Avenue)	Degraded	Degraded
Elizabeth Macarthur Creek (Memorial Avenue to Samantha Riley Drive)	Moderate	Moderate
Elizabeth Macarthur Creek (Samantha Riley Drive to Windsor Road)	Degraded-Moderate	Moderate
Caddies Creek (downstream of Windsor Road)	Moderate	Moderate
Tributary to Caddies Creek (opposite Ettamogah Pub)	Degraded-Moderate	Degraded-Moderate
Tributary to Caddies Creek (White Hart Drive)	Moderate	Degraded-Moderate
Second Ponds Creek (downstream of Schofields Road)	Degraded	Degraded
First Ponds Creek (downstream of Schofields Road)	Poor	Degraded

Threatened aquatic species

Literature and database searches were undertaken for any threatened aquatic species listed on the schedules of the *Fisheries Management Act 1994* which may occur within the locality. No threatened aquatic species or endangered aquatic populations were identified as likely to occur within the watercourses of the study area.

15.4.6 Groundwater Dependent Ecosystems

GDEs rely on a supply of groundwater to function. If the supply or quality of groundwater is altered for a sufficient length of time detrimental changes can occur to the function of GDEs. It should be noted that groundwater use does not necessarily equate to groundwater dependence and there are varying degrees of dependency on groundwater, which is partially determined by underlying geology and groundwater hydrology.

Table 15.4 provides a summary of the existing condition of GDEs within the study area.

Table 15.4 Existing Condition of GDEs Located within the Study Area

Groundwater Dependent Ecosystem	Condition
Floodplains and wetlands communities (Caddies Creek and Elizabeth Macarthur Creek)	Good
Coastal Shale - Sandstone Forest around Devlins Creek and tributaries	Degraded to good
Sydney Turpentine- Ironbark Forest in Cattai Creek	Degraded
Sydney Turpentine- Ironbark Forest near Beecroft Road	Degraded
Instream ecosystems dependent on groundwater derived base flows	Predominately degraded
Riparian vegetation along creeks within the Study Area	Generally degraded

The geology of the study area is comprised of Hawkesbury Sandstone and Ashfield Shale. Areas of Hawkesbury Sandstone are overlain by a varying thickness of alluvium and the Ashfield Shale (Wianamatta Group rocks) occurs mostly as a 'capping layer' on elevated ridgelines.

Two major aquifers within the broader study area comprise of (Coffey, 2011; AECOM, 2011);

- Hawkesbury Sandstone
  - Essentially a fractured rock aquifer, with groundwater present within the primary matrix as well as fractures, joints and bedding planes.
  - Groundwater levels are typically uneven due to variations in topography created by the Hawkesbury Sandstone formations.
  - Groundwater quality is generally good.
- Parts of alluvium associated with drainage channels.

The current condition of GDEs is a reflection of encroaching urban development creating disturbances to ecosystems within the catchment, rather than any stress associated with changes to the aquifers. Water quality within the area is unknown, however most creeks display signs of increased turbidity, nutrient enrichment, and, potentially, oxygen depletion.

GDEs have varying degrees of dependency on groundwater, which is determined by underlying geology and groundwater hydrology. The likelihood that ecosystems are dependent on groundwater has also been assessed. The likelihood of GDEs is classified as either:

- **Likely** – groundwater use inferred from hydrogeological information (eg, depth to groundwater and geological matrix). These ecosystems are likely to be closely linked to groundwater, with some degree of dependency.
- **Potential** – areas where ecosystems could potentially use groundwater, however the affinity with groundwater may be limited by geological substrate or deep groundwater levels.
- **Unlikely** – with current knowledge of geology and groundwater levels in the area, these ecosystems are unlikely to be supported or dependent on groundwater for their survival.

The following provides a summarised description of the groundwater dependent likelihood and existing condition of: aquifer ecosystems; river base flow systems; groundwater dependent vegetation communities; and wetlands within the study area.

Aquifer ecosystems

Stygofauna are mostly crustacean invertebrates that live within aquifers. The Hawkesbury Sandstone potentially provides suitable habitat for stygofauna throughout the study area. The extent of stygofauna in the region is likely to be limited in areas overlain by shales of the Wianamatta group.

Given the expanse of the Hawkesbury Sandstone, it is unlikely that there will be any endemic species of stygofauna in the section of the aquifer impacted by the rail corridor. Hence, the threat to this ecosystem is anticipated to be minimal.

River base flow systems

Many rivers in Australia rely (at some point) on base flow derived from groundwater sources. This base flow can be critical in maintaining ecological communities, in-channel biological processes, and riparian communities.

An assessment of river base flow systems within the study area was undertaken, based on field inspections and available hydrogeological information.

Sections of Devlins Creek, Cattai Creek, Elizabeth Macarthur Creek and Caddies Creek are potentially dependent on groundwater base flow, as outlined below:

- Devlins Creek (Cheltenham Services Facility site)
  - Portions of the creek **potentially** have some groundwater base flow.
  - Geology in the region is sandstone and alluvium, hence connectivity to groundwater is **likely**.
  - The level of groundwater dependency is likely to be low.
- Cattai Creek (Showground Station site)
  - The creek **potentially** relies on groundwater base flow.
  - Geology in the region is sandstone and alluvium, hence connectivity to groundwater is **likely**.
  - The level of groundwater dependency is likely to be low.
- Elizabeth Macarthur Creek – section to the north of Celebration Drive (north of the Bella Vista Station site)
  - It is **likely** that this section of creek relies on groundwater base flow.
  - The creekline extends onto floodplains and a series of natural wetlands.
- Caddies Creek – section near the intersection with Elizabeth Macarthur Creek (Samantha Riley Drive to Windsor Road site)
  - It is *likely* that this section of creek relies on groundwater base flow.
  - The creek is located on a floodplain.

It is **unlikely** that Pyes Creek, Strangers Creek (including surrounding lakes) would rely on groundwater for base flow.

Groundwater dependent terrestrial vegetation communities

The use and level of dependency on groundwater is likely to vary across the study area. The following summarises the potential groundwater dependent vegetation communities.

- Sydney Turpentine-Ironbark Forest - areas located at Cattai Creek
  - This vegetation community would potentially use groundwater, however the dependency on groundwater is expected to be low.
  - Surrounding Cattai Creek trees are likely to tap into groundwater at periods of low surface water. Large riparian trees in the region may rely on groundwater discharged as surface flows.
- River-Flat Eucalypt Forest
  - This vegetation community is *likely* to be groundwater dependent.
  - Roots of Casuarina and Eucalyptus tree species in this floodplain vegetation community are likely to tap into groundwater. Riparian tree species may rely on groundwater discharged as surface flows, particularly during periods of low surface flow.
- Coastal Shale-Sandstone Forest - small areas located near Devlins Creek
  - This vegetation community would potentially only use groundwater opportunistically when surface water was in limited supply.
- Cumberland Plain Woodlands
  - This vegetation community is likely to be groundwater dependent.
  - The distance this community is located from Elizabeth Macarthur Creek at Bella Vista Station site suggests that it is reliant on groundwater discharged as surface water as well as Eucalyptus tree species potentially tapping into groundwater.
- Floodplains
  - It is likely that vegetation communities located on the floodplain would be groundwater dependent and all tree species located on the floodplains may rely on groundwater discharged as surface flows.
  - All tree species located on the floodplains may rely on groundwater discharged as surface flows. It is also likely that large trees along the Elizabeth Macarthur Creek / Caddies Creek floodplain would tap into groundwater during periods of low surface flow.
  - Alterations to hydrological regimes (both surface and groundwater) threaten this community.

The areas of Sydney Turpentine-Ironbark Forest and Coastal Shale-Sandstone Forest located near Beecroft Road are *unlikely* to use groundwater due to the geology in the region and as the creekline is a concrete lined channel.

It is *unlikely* that the Blue Gum High Forest and Shale / Sandstone Transition Forest vegetation communities located within the study area are dependent on groundwater.

Wetlands

Wetland ecosystems are expected to have a strong connection to groundwater in the study area.

Natural wetlands located on the Elizabeth Macarthur Creek / Caddies Creek floodplain (near Windsor Road) are *likely* to be dependent on groundwater. All natural wetland species may rely on groundwater discharged as surface flows.

Artificial wetlands within the area (for example those located around the proposed Norwest Station) are assumed to be man-made and lined with clay. These wetlands are *unlikely* to be dependent on groundwater as the clay lining prevents a direct connection to groundwater. Farm dams and other artificial wetlands scattered across the study area are *unlikely* to rely on groundwater as they are located along drainage lines and would be fed by rainfall and surface runoff.

15.5 Impact Assessment - Operation

The cumulative impacts associated with Stage 1 (Major Civil Construction Works) and Stage 2 (Stations, Rail Infrastructure and Systems) of the NWRL project are addressed in Chapter 20 Cumulative Impacts of this EIS.

The impacts outlined below are considered 'worst case' project impacts. The assessment undertaken adopts a conservative and precautionary approach. Any impacts outside of the operational footprint were considered to be indirect impacts.

Subsections below summarise impacts to native vegetation communities, riparian and aquatic environments and flora and fauna species.

15.5.1 Terrestrial Flora

As noted in previous sections, all of the bushland within the operational footprint would have been cleared as part of Stage 1 of the NWRL project (the Major Civil Construction Works) and these impacts have been assessed and mitigated as part of EIS1. In addition protective fencing would be in place (as an EIS1 mitigation measure) where native vegetation is retained adjacent to or within construction sites. Therefore there are no expected direct flora impacts associated with the operation of the NWRL.

For information on the terrestrial flora impacts assessed as part of EIS1, refer to the detailed terrestrial ecology assessment which has been prepared for the project, *Ecological Assessment for the North West Rail Link* (Eco Logical Australia, 2012), included as Technical Paper 6a.

Indirect impacts to nearby remnant vegetation communities would be avoided through the ongoing implementation of mitigation measures (such as sedimentation and erosion control measures and active weed removal and control).

15.5.2 Terrestrial Fauna

Operation of the NWRL would result in edge effects and increased noise, vibration and light along the length of the aboveground section of the railway and at the stations, service facilities and stabling facility. The above ground elements, including moving trains and static structures, also present a potential collision hazard to fauna.

Impact assessments were undertaken for each of the threatened species listed under the TSC Act, with potential habitat in the study area (refer **Table 15.3**). The following provides a brief description of each of the species and discusses potential operational impacts.

Cumberland Plain Land Snail

The Cumberland Plain Land Snail requires fallen logs, leaf litter and bark usually at the base of trees in good condition such as Cumberland Plain Woodland and River Flat Eucalypt Forest to breed and forage. The snails are unlikely to use patches of habitat located more than 350m apart. The snail uses the same habitat for breeding and foraging purposes.

As previously discussed in Section 15.4.3, the snail was not recorded during the targeted search undertaken in potential habitat. However, the species has been previously recorded in past ecological surveys in the proposed Showground Station, Cudgegong Road Station and Tallawong Stabling Facility site areas.

The magnitude of disturbance from noise, light and vibration during the operation of the NWRL on the lifecycle of the Cumberland Plain Land Snail is unknown. Given that Cumberland Plain Land Snails are nocturnal and forage at night, it is possible that the species will be disturbed by light and vibration to the point that they will avoid patches of habitat along the edges of the railway track and stations. It is assumed that the species is unlikely to cross the ground level railway track.

Green and Golden Bell Frog

The Green and Golden Bell Frog require riparian zones and water bodies (including farm dams) with well-established fringing vegetation adjacent to open grassland areas for foraging. Preferable breeding habitat are unpolluted shallow, slow or still flowing water bodies that do not contain predatory fish and are not heavily shaded. Ponds that are typically inhabited by the frogs tend to be free from predatory fish such as Mosquito Fish (Gambusia holbrooki).

As discussed previously in Section 15.4.3, seven water bodies located between First Ponds Creek (the Tallawong Stabling Facility site) and the Kellyville Station site have been identified as potential breeding habitat for the frog.

Secondary habitat for the Green and Golden Bell Frog is defined as movement corridors. Impacts to secondary habitat resulting from the NWRL would include a reduction and disruption to the potential movement corridor habitat, particular east of, and at the confluence of Caddies Creek and Elizabeth Macarthur Creek. However, at this location, the presence of roads and other development already renders potential habitat values as low.

Given the scattered distribution, and relative isolation between populations of Green and Golden Bell Frog, the area of regional habitat was not able to be determined by this study and is not known from background research.

Whilst it is not possible to rule out an occasional presence of Green and Golden Bell Frog from time to time, it is unlikely that the species is currently present at the proposed NWRL operational site. The likelihood of occasional use of the NWRL site during operation is most reasonably determined by connectivity to the nearest known site, plus other factors such as presence of introduced fish. The Riverstone East Precinct of the NWGC is the nearest known site (with the most recent sighting records) to the NWRL, located approximately 3 km from the Tallawong Stabling Facility site. Drainage from the westernmost sections of the NWRL corridor is part of the First Ponds Creek sub-catchment of Eastern Creek, which drains to the north-west through Riverstone to Eastern Creek. Due to the presence of introduced fish, extent of roads and other development between the Tallawong Stabling Facility site and the Riverstone East Precinct (except via drainage lines) it is unlikely that the Green and Golden Bell Frog would use the site.

Noise, vibration and artificial light and potential modifications to the ground surface as a result of changes to drainage patters may indirectly impact on potential species habitat during operation. However, indirect impacts are unlikely to cause too much disturbance to the species which has been known to breed in excavation pits during construction works.

It is unlikely that the operation of the NWRL would significantly or directly impact on the Green and Golden Bell Frog.

Glossy Black-Cockatoo

The Glossy Black-Cockatoo inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1,000m in which stands of She-oak species occur. It feeds almost exclusively on the seeds of several species of She-oak (*Casuarina* and *Allocasuarina* species).

The Glossy Black-Cockatoo nests in large hollow-bearing eucalypts and breeding pairs are known to show a high fidelity to nesting sites, selecting hollows of particular shape, position and structure.

Little is known of how the Glossy Black-Cockatoo will respond to noise and light and the extent to which they could avoid habitat degraded by these disturbances. However, noise, vibration and artificial light and edge effects during operation may lead to nests being abandoned during breeding, or the hollow not being selected as a breeding site. These indirect impacts have the potential to reduce the breeding success of the species.

It is considered unlikely that the Glossy Black-Cockatoo will be detrimentally impacted by the operation of the NWRL while roosting and/or breeding (though they may choose to roost away from a disturbed area).

Glossy Black-Cockatoos are often observed in urban environments experiencing noise disturbance, hence it is considered unlikely that the Glossy Black-Cockatoo will avoid edges or be disturbed by this increased noise while foraging.

Gang-gang Cockatoo

An endangered population of Gang-gang Cockatoo persists in the Hornsby and Ku-ring-gai LGAs. This population is believed to be largely confined to an area bounded by Thornleigh and Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west and Turramurra / South Turramurra to the east. This small population (estimated to be between 18-40 pairs) is the last known breeding population in the Sydney Metropolitan area.

The Gang-gang Cockatoo may forage throughout the study area and feeds on seeds of eucalypts and wattles, berries, fruits, nuts, insects and their larvae.

Little is known of how the Gang-gang Cockatoo will respond to noise and light and the extent to which they could avoid habitat degraded by these disturbances. However, noise, vibration and artificial light and edge effects during operation may lead to nests being abandoned during breeding, or the hollow not being selected as a breeding site. These indirect impacts have the potential to reduce the breeding success of the species.

It is considered unlikely that the Gang-gang Cockatoo will be detrimentally impacted by the operation of the NWRL while roosting and/or breeding (though they may choose to roost away from a disturbed area).

It is considered unlikely that the Gang-gang Cockatoo will avoid edges or be disturbed by this increased noise while foraging.

Swift Parrot

The Swift Parrot breeds in Tasmania so no impacts to breeding habitat would occur as a result of the project. In the autumn and winter months the parrot migrates and in NSW occurs mostly on the coast and South West Slopes. Previous studies in or close to the study area have not detected this species, however there are records (ranging from 1,982-2,010) of the species occurring within the 10km search area. Most of these records occur within the Cumberland Plain.

The Swift Parrot feeds in areas where eucalypts flower or where there are lerp (from sap sucking bugs) infestations.

Little is known of how the Swift Parrot will respond to noise and light and the extent to which they could avoid habitat degraded by these disturbances. However, Swift Parrots are often observed in urban environments experiencing noise disturbance. Hence it is considered unlikely that the Swift Parrot will avoid edges or be disturbed by this increased noise while foraging.

Turquoise Parrot

The Turquoise Parrot lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland and requires hollows for breeding.

The Turquoise Parrot forages quietly and may be quite tolerant of disturbance. This parrot prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds of grasses and herbaceous plants, or browsing vegetable matter. Foraging habitat for the parrot is defined as good to moderate condition Cumberland Plain Woodland and River Flat Eucalypt Forest.

Little is known of how the Turquoise Parrot will respond to noise and light and the extent to which they could avoid habitat degraded by these disturbances. However, noise, vibration and artificial light and edge effects during operation may lead to nests being abandoned during breeding, or the hollow not being selected as a breeding site. These indirect impacts have the potential to reduce the breeding success of the species.

It is considered unlikely that the Turquoise Parrot will be detrimentally impacted by the operation of the NWRL while roosting and/or breeding (though they may choose to roost away from a disturbed area).

It is considered unlikely that the Turquoise Parrot will avoid edges or be disturbed by the increased noise while foraging.

Powerful and Barking Owls

Both the Powerful Owl and the Barking Owl require large tracts of forest or woodland habitat and the Powerful Owl can also occur in fragmented landscapes (DECC, 2005).

If a Powerful and/or Barking Owl nesting site occur within the study area, it may be impacted through noise, vibration and artificial light during the operation of the NWRL.

The Powerful Owl is known to be extremely sensitive to disturbance around the nest site, particularly during pre-laying, laying and downy chick stages. Nesting occurs from late autumn to mid-winter, and disturbance during these stages may affect breeding success (DECC 2005).

The operation of the NWRL is only likely to impact the owls if a nesting tree is located within 200m of the aboveground railway line, station, service facility or stabling facility.

Scarlet Robin

The Scarlet Robin lives in dry eucalypt forests and woodlands and requires abundant logs and fallen timber. The bird feeds on insects and uses the same habitat for breeding and foraging purposes. The bird breeds in forested areas, thus only potential foraging and sheltering habitat for this species would be impacted by the project.

Noise, vibration and artificial light and edge effects during operation may result in the Scarlet Robin avoiding the operating area. In addition the operating area is likely to provide a suitable avenue for introduced predators such as rats and cats which may increase predation.

The aboveground railway may also create a barrier for the woodland birds accessing adjacent habitats.

Varied Sittells

Varied Sittells prefer to inhabit areas of rough-barked eucalypt tree species and mature smooth-barked gums with dead branches. The Varied Sittells is an insect feeder and uses the same habitat for breeding and foraging purposes.

The Varied Sittells was previously recorded within the study area during an ecological assessment undertaken by AECOM in 2010.

Noise, vibration and artificial light and edge effects during operation may result in the Varied Sittells avoiding the operating area. In addition the operating area is likely to provide a suitable avenue for introduced predators such as rats and cats which may increase predation.

The aboveground railway is may also create a barrier for the woodland birds accessing adjacent habitats.

Brown Treecreeper

The Brown Treecreeper mainly inhabits dry open woodlands dominated by stringybarks and or other rough-barked eucalypts, usually with an open grassy understorey.

Noise, vibration and artificial light and edge effects during operation may result in the Brown Treecreeper avoiding the operating area. In addition the operating area is likely to provide a suitable avenue for introduced predators such as rats and cats which may increase predation.

Woodland Birds – canopy foraging (excluding parrots)

Three canopy foraging woodland birds (excluding parrots) were previously recorded in the study area: Regent Honeyeater, Black-chinned Honeyeater and Superb Fruit-dove. However, the study area does not contain known suitable breeding sites for these species.

The Black-chinned and Regent Honeyeater and Superb Fruit-dove are highly mobile species. They exhibit seasonal migratory patterns or local migration within suitable habitats in response to food availability. Studies of woodland birds and noise indicate a trend of avoidance to noise disturbance for woodland bird species.

The Regent Honeyeater and Superb Fruit-dove are known to utilise urban environments to substitute foraging resources. There is no evidence these species will avoid foraging in edge habitats. Additionally, the disturbance of noise and ground vibrations is unlikely to impact the ability of the Regent Honeyeater and Superb Fruit-dove to access suitable foraging habitats. It is not known if the Black-chinned Honeyeater will utilise edge habitats or avoid urban areas. Preferred habitat for this species includes large intact vegetation with large home range in excess of 5 ha. The Black-chinned Honeyeater ability to access foraging habitat may decline due to its potential avoidance of disturbances. However, the Black-chinned Honeyeater is an infrequent visitor from the western side of the Great Dividing Range.

There is evidence that the Superb Fruit-dove can navigate at night and several recorded incidences have involved Superb Fruit-dove birds flying into lit windows.

Bats – predominantly tree-roosting

Four predominantly tree-roosting bat species were recorded within the study area: Yellow-bellied Sheathtail-bat, Eastern False Pipistrelle Bat, East Coast Freetail Bat, and Greater Broad-nosed Bat.

The bats usually roost in tree hollows or bark crevices and 19 hollows would be indirectly impacted (for example by artificial lighting) during operation. All of these hollows are located outside of the North West Growth Centre.

Noise, vibration and artificial light during operation may disturb bats roosting in the vicinity of the NWRL during breeding and also restrict their foraging habitat. However, there is a lack of research on these potential impacts to be conclusive.

The application of pesticides/herbicides during operation to vegetated areas may also result in detrimental impacts to these bats, as pesticides/herbicides can impact on bat health and availability of prey insects.

Bats - predominantly cave-roosting

Three predominantly cave roosting and breeding bats (Eastern Bent-wing Bat, Large-footed (Southern) Myotis and Large-eared Pied Bat) have potential foraging habitat within the study area. The project is unlikely to impact caves and potential breeding habitat for these bats located within the study area.

Noise, vibration and artificial light during operation may impact on the suitability of man-made roosting structures. However little is known about the indirect impacts on these species. The Eastern Bent-wing Bat is known to roost in culverts across Devlins Creek. Bridges, culverts and other man-made structures are often used as roost sites by this species. As these sites are regularly subject to significant noise and vibration levels, which do not appear to deter this species, it is unlikely that the Bent-wing Bat colony in the M2 culverts would be detrimentally impact by the proposal.

Increased edge effects and noise may also influence the way in which bats use the operational area and immediate surrounds. However, these species are mobile and able to move to adjacent patches outside the operational area should they be disturbed.

Grey-headed Flying-Fox

The Grey-headed Flying Fox is a mega-bat which feeds on the nectar and pollen of native trees, particularly Eucalyptus, Melaleuca and Banksia and also forages in cultivated gardens and fruit crops. The operation of the project would not impact any known flying fox roosting camps nor breeding habitat.

During operation of the NWRL, the foraging habitat for the species may be impacted by artificial light and noise. However, little is known of how the Grey-headed Flying-fox will respond to noise and light and the extent to which they could avoid habitat degraded by these disturbances. Artificial night lighting probably increases the risk of being killed by a predator, which will include the Powerful Owl, and decreases food consumption. Given the species has become somewhat habituated to artificial light sources throughout the urban environment, if light was constant and penetrated only a small distance into intact habitat, it is considered unlikely that Grey-headed Flying-fox will be impacted while foraging.

Noise is used to discourage Grey-headed Flying-fox from foraging and roosting in certain areas (NSW Scientific Committee 2011). Therefore, it is possible that the Grey-headed Flying-fox will be disturbed by noise to the point that they will avoid stations and areas along the railway line during noisy periods (i.e. when a train arrives or travels past).

There is also the increased likelihood of collision with the electrified railway lines that will cause fatality of the Grey-headed Flying-fox. However, given the species has adapted to the urban environment, which already includes a dense network of overhead power lines and existing railway lines, the construction of a 7km section electrified line for the NWRL is unlikely to significantly increase the fatality rate of Grey-headed Flying-fox during foraging in the area.

Given a number of measures are proposed to avoid, mitigate and offset any potential impacts, it is considered unlikely that the proposal will impact on the lifecycle of Grey-headed Flying-foxes. Only foraging habitat for the Grey-headed Flying-fox will be impacted. Such habitat is likely to be impacted by increased edge effects, noise and artificial light, which may discourage foraging by the Grey-headed Flying-fox. However, Grey-headed Flying-foxes are highly mobile and will move to more favourable patches of foraging habitat within the locality, should they be disturbed by noise and light.

Spotted-tailed Quoll

The Spotted-tailed Quoll is mostly nocturnal and has been recorded in the north east of the search area, most likely due to the presence of large good condition native forest in Ku-ring-gai National Park. It is highly possible that individuals may wander into the study area from time to time from areas of habitat located nearby.

The Quoll is unlikely to breed within the study area, however it is likely that potential foraging habitat is present at the Epping and Cheltenham sites.

As the Quoll is unlikely to reside within the study area, increases in noise, vibration and light are likely to result in minimal impacts for this species.

The following provides a summary of the impacts associated with fauna collision and increased light and noise impacts.

Risk of Fauna Collision with Trains or Other Infrastructure

While there is a risk that the operation of the NWRL would increase the injury/mortality rates of wildlife due to collision with trains or static infrastructure, this risk is considered to be low. The highest risk would be for birds and bats, within the western extent of the NWRL where the landscape is least developed. Predicting the level of risk is difficult due to the lack of research on train collisions with birds and bats. However, the visual and noise disturbance associated with a moving train are expected to significantly reduce the risk of collision.

The NWRL would operate within a landscape containing numerous other collision risks including traffic on roads, buildings and overhead powerlines. Therefore, resident fauna typical of developed areas are likely to have developed some habituation to these urban and peri urban habitats.

It is likely that most fauna would detect solid above ground structures and be able to avoid collisions. Wires or other smaller elements may be more difficult to detect.

Factors reducing the likelihood of ground dwelling fauna being at risk include fencing to be erected around project sites and the rareness of ground dwelling native mammals present, or likely to be present, in the study area.

Many migratory and regional movements of bird species (for example the Regent Honeyeater) tend to fly at altitudes well above the viaducts when on migratory paths, decreasing the potential for accidental collisions when these species are migrating.

Increased Light

Operation of the NWRL will result in increased light levels in the study area. Potential impacts that could result from the introduction of artificial light during operation of the NWRL include:

- Altered movements of nocturnal species, specifically bats and owls, which may become disoriented by artificial light, resulting in changes in foraging success and reduced fitness in some species.
- Increased likelihood of predation and changes in prey behaviour.
- Potential changes in species composition.
- Increased foraging activity by some species around light sources which attract insect prey.

However, the presence of multiple existing artificial light sources within the surrounding urban area, such as high illumination street lighting along major roads, is likely to have habituated threatened fauna with habitat in the study area to high levels of artificial light. During operation, increased light levels will be most pronounced surrounding the stations, which are predominately not associated with large areas of habitat. Therefore, indirect impacts of artificial light on fauna species due to the NWRL are likely to be negligible.

Increased Noise

Operation of the NWRL will result in increased noise levels as noise would be generated by operating trains, stations and the stabling facility works. In addition the stations would generate increased human activity and noise at/around the stations. Refer to Chapter 10 (Noise and Vibration) for an assessment of potential noise impacts and mitigation measures.

Increased and ongoing noise levels can disturb fauna, altering their movement patterns or behaviour (e.g. singing behaviour and in extreme cases breeding), potentially resulting in reductions in reproductive output or overall fitness. Little is known of the impact thresholds of noise disturbance on fauna.

A review of studies has indicated that threatened microbat species and birds that occur, or have the potential to occur, in the study area would be impacted by noise to some degree, both existing noise and increases resulting from the Project. The species that may be particularly sensitive to increased noise include the Barking Owl and Powerful Owl when breeding, nesting Glossy Black-cockatoo, and bats that listen for their prey as well as detecting prey via echolocation.

Increased noise during operation may also result in some species avoiding foraging activity in/around the area.

Generally the fauna habitat within the study comprises relatively small patches of fragmented disturbed native vegetation within an urban environment. Fauna species in the study area are already exposed to relatively high noise levels from major roads, such as the M2 in eastern alignment and Windsor Road and associated commuter bus T-way in the western alignment.

Although there will be cumulative impacts from the project associated with increased noise levels, these impacts are unlikely to affect threatened fauna to a degree greater than that already in place in what is a predominately urban habitat.

It is expected that the mitigation measures listed in Section 15.7 would reduce the likelihood and consequence of these impacts.

15.5.3 Riparian and Aquatic Environment

During operation groundwater may accumulate in/around the tunnels and stations. This groundwater would be collected and transferred to the existing ECRL water treatment plant (at Lady Game Drive) prior to being discharged into the Lane Cove River.

Under this arrangement, during operation groundwater would not be discharged into any of the following creeks (and tributaries to these watercourses):

- Devlins Creek
- Pyes Creek
- Excelsior Creek
- Cattai Creek
- Strangers Creek
- Elizabeth Macarthur Creek
- Caddies Creek
- Second Ponds Creek
- First Ponds Creek

The stations, service facilities and stabling facility (including car parks) have been designed so that surface water would be collected and reused onsite/offsite. Under normal operating conditions surface water would not be discharged into any of the nearby creeks (listed above).

15.5.4 Groundwater Dependent Ecosystems

A risk assessment framework has been used to assess the potential impacts to GDEs and any groundwater related aquatic environments. The risk assessment illustrated that the project is unlikely to change groundwater regimes such that GDEs would be significantly impacted.

It is considered that the operation of tunnels and underground stations is unlikely to influence the groundwater in the area as the tunnels and stations would be lined with concrete to limit groundwater flow into the constructed cavities.

As detailed in Chapter 8 Soils and Groundwater, any groundwater inflow is expected to be captured and transferred to the existing Lady Game Drive water treatment plant prior to being discharged. The water treatment plant is currently in operation as part of the approval requirements of the completed ECRL project. It is understood that the predicted daily volume from the NWRL could be accommodated within the existing capacity of the Lady Game Drive water treatment plant as long as existing water quality standards can be maintained.

Potential impacts to water quality and the surrounding environment as a result of groundwater treatment and disposal at Lady Game Drive water treatment plant are considered to be minor. It is anticipated that the increase in water treated at the Lady Game Drive water treatment plant and the quality of this water would be within the current design capacity of 2.9ML/day applied to that site. Potential impacts to the surrounding environment were considered in the determination of water quality criteria for the Lady Game Drive water treatment plant as part of ECRL project and discussed in Chapter 8. Potential impacts to waterways are described in Chapter 15 Surface Water and Flooding.

In addition, stringent onsite sedimentation and erosion control measures would be implemented (refer to the mitigation measures Section 15.7 for details) to reduce the likelihood and consequences for untreated water to pollute waterways.

15.6 Impact Assessment – Construction

The cumulative impacts associated with Stage 1 (Major Civil Construction Works) and Stage 2 (Stations, Rail Infrastructure and Systems) of the NWRL project are addressed in Chapter 20 Cumulative Impacts of this EIS.

The impacts outlined below are considered 'worst case' project impacts. The assessment undertaken adopts a conservative and precautionary approach. Any impacts outside of the construction footprint were considered to be indirect impacts.

Subsections below summarise impacts to native vegetation communities, riparian and aquatic environments and flora and fauna species.

15.6.1 Terrestrial Flora

As noted in previous sections, all of the bushland within the construction footprint (excluding some street trees) would have been cleared as part of Stage 1 of the NWRL project (the Major Civil Construction Works) and these impacts have been assessed and mitigated as part of EIS1. In addition protective fencing would be in place (as an EIS1 mitigation measure) where native vegetation is retained adjacent to or within construction sites. Therefore there are no expected direct flora impacts associated with the construction of the stations, rail infrastructure and services.

For information on the terrestrial flora impacts assessed as part of EIS1, refer to the detailed terrestrial ecology assessment which has been prepared for the project, Ecological Assessment for the North West Rail Link (Eco Logical Australia, 2012), included as Technical Paper 6a.

Indirect impacts to nearby remnant vegetation communities would be avoided through the ongoing implementation of mitigation measures (such as: sedimentation and erosion control measures and active weed removal and control).

15.6.2 Terrestrial Fauna

As discussed in section 15.4.2, the construction footprint would not provide habitat for fauna.

In addition protective fencing (in place as a mitigation measure for the major civil construction works) would prevent some fauna from accessing construction sites.

The risk that the construction would increase the injury/mortality rates of fauna due to collision with construction equipment or static infrastructure is considered to be low. The highest risk would be for birds and bats, within the western extent of the NWRL where the landscape is least developed. Predicting the level of risk is difficult due to the lack of research on collisions with birds and bats. However, the visual and noise disturbance associated with construction equipment are expected to significantly reduce the risk of collision. It is likely that most fauna would detect solid above ground structures and be able to avoid collisions. Wires or other smaller elements may be more difficult to detect.

Factors reducing the likelihood of ground dwelling fauna being at risk include fencing to be erected around project sites and the rareness of ground dwelling native mammals present, or likely to be present, in the study area. Many migratory and regional movements of bird species (for example the Regent Honeyeater) tend to fly at altitudes well above the viaducts when on migratory paths, decreasing the potential for accidental collisions when these species are migrating.

The study area includes an extended footprint (e.g. to a 100m buffer) to account for any indirect impacts to vegetation which may provide fauna habitat. This extended footprint provides a variety of habitat features for a range of species. The following provides a brief description of potential indirect impacts associated with the construction of the stations, rail infrastructure and systems:

- Weed invasion
  - Vegetation clearance would increase the potential for weed invasion in adjacent retained vegetation.
- Habitat loss and fragmentation
  - Fragmentation can impact on fauna species by creating barriers to movement, which can result in genetic isolation of populations.
  - For most threatened fauna species, the project is unlikely to result in significant fragmentation as much of the impacted area already comprises relatively small native vegetation patches within a fragmented landscape. The project is also unlikely to restrict movement for many species to and from areas of potential habitat.
- Hydrological changes
  - Run-off from impervious areas is likely to contain elevated levels of sediment, nutrients, hydrocarbons and other pollutants. Permanent changes to stormwater run-off may result in increased weed invasion and general degradation of impacted native vegetation along affected drainage lines, with corresponding impacts to the habitat of amphibian and other fauna species.
- Sediment, erosion and pollution
  - Sedimentation, erosion and pollution of creeklines and native vegetation across the construction footprint.
  - Increased noise
  - Increased and ongoing noise levels can disturb fauna, altering their movement patterns or behaviour (eg singing behaviour and in extreme cases breeding), potentially resulting in reductions in reproductive output or overall fitness. Little is known of the impact thresholds of noise disturbance on fauna.
  - A study of Mexican Spotted Owls found that noise sources on the ground are of greater concern than noise sources in the air. Noise can cause owls to flush and also affect foraging behaviour as some owls listen for their prey (Konishi, 2003).
  - Bats, particularly those that listen for their prey in addition to echolocating, may also be impacted by noise. Overseas bat studies found that the bats avoid areas with noise disturbance while foraging (Schaub

et al., 2008; Siemers and Schaub, 2011). However, responses to noise may be dependent on activities.

- Studies of woodland birds and noise indicate a trend of avoidance to noise disturbance for woodland bird species.
- A review of studies has indicated that threatened microbat species and birds that occur, or have the potential to occur, in the study area would be impacted by noise to some degree, both existing noise and increases resulting from construction activities. The species that may be particularly sensitive to increased noise include the Barking Owl and Powerful Owl when breeding, nesting Glossy Black-cockatoo, and bats that listen for their prey as well as detecting prey via echolocation.

❖ Increased light

- Altered movements of nocturnal species, specifically bats and owls, which may become disoriented by artificial light, resulting in changes in foraging success and reduced fitness in some species.
- Increased likelihood of predation and changes in prey behaviour.
- Potential changes in species composition.
- Increased foraging activity by some species around light sources which attract insect prey.
- It has been assessed that in general indirect impacts of artificial light on fauna species due to construction activities are likely to be negligible.
- It is expected that the mitigation measures listed in Section 15.7 would reduce the likelihood and consequence of these impacts.

15.6.3 Riparian and Aquatic Environment

Potential impacts on stream condition are primarily related to Stage 1 major civil construction works and include:

❖ Groundwater discharge.
❖ Weed invasion.
❖ Polluted surface water runoff.
❖ Increased velocity of surface runoff.
❖ Surface erosion and sedimentation .
❖ Altered fluvial hydrology.

Stage 2 construction works are not expected to add significant new impacts to the riparian and aquatic environment and the mitigation measures listed in Section 15.7 (including sediment and erosion control and active weed control) would reduce the likelihood and consequence of these impacts.

15.6.4 Groundwater Dependent Ecosystems

A risk assessment framework has been used to assess the potential impacts to GDEs and any groundwater related aquatic environments. The risk assessment illustrated that the project is *unlikely* to change groundwater regimes such that GDEs would be significantly impacted.

Refer to technical paper 6c for details on risk assessment methodolgy.

The GDEs likely to occur are located in the western section of the proposed alignment, predominantly in the floodplain. The elevated viaduct would be located in this area.

Potential impacts to GDEs are primarily associated with Stage 1 works and include:

❖ Loss of fauna habitat resources.
❖ Loss of aquatic habitat.
❖ Contamination
  - Fuel and chemical spills could contaminate groundwater. Tunnel discharges would also contain pollutants associated with leaks, spills, and accidents. These would contain hydrocarbons, metals, and suspended solids.

The potential impacts to groundwater dependent ecosystems within the study area have been rated as high, moderate, low or no impact, as described below:

❖ High Impact
  - Impacts with serious, long-term, and possibly irreversible, effects leading to serious damage, degradation or loss of entire ecosystem. Requires a major re-scope of concept, design, location and justification.
❖ Moderate Impact
  - Impacts may be short, medium or long-term. Impacts would probably respond to management actions.
❖ Low Impact
  - Probably short-term, able to be managed or mitigated and would not cause substantial detrimental effects. May be confined to a small area.

The risk level is determined from a risk assessment matrix based **Table 15.5** table below.

Table 15.5 Risk Level Matrix

Dependency on groundwater	Potential Impacts		
	Low	**Moderate**	**High**
Entirely	Moderate	High	Extreme
Highly	Moderate	High	Extreme
Proportionally	Low	Moderate	High
Minimally	Low	Low	Moderate

The risk levels are described as:

❖ **Extreme**
  - **High priority risks.** Impacts are most likely to result in significant impacts on threatened species, populations or ecological communities. Impacts unlikely to be adequately offset, instead seek to avoid impacts to the maximum extent practicable.
❖ **High**
  - **High priority risks.** Potential impacts which could result in significant effects on threatened species, populations or ecological communities or cause other legislative risk. Impacts would require significant offsets.
❖ **Moderate**
  - **Medium priority risk.** Potential impacts which require improved levels of control, and/or where higher level management input is required to ensure adequate risk prevention, reporting and investigation. Impacts would require offsets.
❖ **Low**
  - **Low priority risk.** Potential impacts which can be prevented and/or managed by applying standard management controls. Offsets generally not required.

The following summarises the degree of dependency, potential impact and risk level for GDEs within the study area which have a *moderate* or *high* risk level.

❖ The loss of aquatic habitat has been assessed as a moderate risk for river base flow systems (as discussed in Section 15.4.5, sections of Devlins, Cattai, Elizabeth Macarthur and Caddies Creeks). River base flow systems are assessed as being proportionally dependent on groundwater and the potential impact associated with loss of aquatic habitat would be moderate.
❖ The contamination of groundwater has been assessed as a moderate risk for terrestrial vegetation. Terrestrial vegetation is assessed as being proportionally dependent on groundwater and the potential impact associated with contamination would be moderate.

- ❖ The contamination of groundwater has been assessed as a high risk for wetland vegetation. Wetland vegetation is assessed as being proportionally dependent on groundwater and the potential impact associated with contamination would be high.
- ❖ The contamination of groundwater has been assessed as a moderate risk to river base flow systems (such as sections of Devlins, Cattai, Elizabeth Macarthur and Caddies Creeks). River base flow systems are assessed as being proportionally dependent on groundwater and the potential impact associated with contamination would be moderate.
- ❖ The potential impacts and risk level associated with the loss of aquatic fauna habitat have been rated as *low*.
- ❖ Subsurface groundwater dependent ecosystems have not been considered in this impact assessment because there have been no previous stygofauna samples collected from the area and there is insufficient information on groundwater hydrology at this stage.

15.7 Mitigation measures

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.

Ecology mitigation measures have been developed to avoid, reduce and manage identified potential impacts. These mitigation measures and their application to the construction and operation of the NWRL are presented in **Table 15.6**.

A number of mitigation measures detailed in other chapters would also be relevant to ecology. These include:

- ❖ Mitigation relating to ongoing erosion and sediment control (including operational maintenance and monitoring), and the storage and handling of hazardous substances and dangerous good are detailed in Chapter 18 (Surface Water and Hydrology).
- ❖ Mitigation measures relevant to groundwater monitoring, capture, treatment and reuse/ discharge are detailed in Chapter 8 (Soils and Groundwater).
- ❖ Mitigation measures relevant to lighting are detailed in Chapter 19 (Non Key Issues).
- ❖ Mitigation measures relevant to noise and vibration are detailed in Chapter 10 (Noise and Vibration).

Table 15.6 Ecology Mitigation Measures

No.	Mitigation Measure	Applicable to*
Operations		
OpE2	Noxious and environmental weeds would be controlled within the operational site boundary.	Within the operational site boundary.
OpE4	The *Best Practice Guidelines – Green and Golden Bell Frog Habitat* (DECC, 2008) would be followed during operation to protect and maintain any ephemeral breeding habitat for Green and Golden Bell Frog established as a result of the project.	Ephemeral breeding habitat for Green and Golden Bell Frog established as a result of the project.
OpE5	Regular visual inspections would be undertaken of creeks above tunnel sections and underground NWRL infrastructure, during operation, for a time period to be agreed with the NOW. Inspections would target permanent pools and be compared to pre-bore data collected and non-impacted reference sites. In the event that substantial drops in the water level of permanent pools are detected, further investigations would be undertaken to determine the cause. If changes are determined to be caused by, or suspected to be caused by, tunnels, mitigation measures would be discussed with the NOW and implemented as appropriate.	Creeks above tunnels/ NWRL infrastructure
OpE6	To reduce disturbance to bats and nocturnal birds where reasonable and feasible, a range of measures would be undertaken, such as: ▪ Artificial lighting would be directed to where it is needed and in a downwards orientation to avoid light spillage, Artificial light would be positioned to face away from areas of native vegetation. ▪ Low-pressure sodium lamps would be used instead of high-pressure sodium or mercury lights. Where mercury lights are used, UV filters would be fitted. ▪ The brightness of lights would be reduced to as low as legally possible, and in conformance with workplace health and safety standards. ▪ Amplified speakers would be directed downwards and away from areas of native vegetation	Surface track Stations Stabling facility Service facilities
OpE7	Maintenance of waterway crossings and structures would be undertaken in accordance with relevant guidelines such as *Fish and Fauna Friendly Waterway Crossings* (Fairfull & Witheridge, 2003) and *Fish Passage Requirements of Waterway Crossings* (2003).	Waterway crossings and structures

No.	Mitigation Measure	Applicable to*
OpE9	The areas identified as 'likely' or 'potential' Groundwater Dependent Ecosystems (GDEs) would be monitored during operations in accordance with the groundwater monitoring plan (refer to Chapter 8 Soils and Groundwater for further details).	'likely' or 'potential' GDEs
Construction		
E1	The ecological component of the site induction would include information on: ▪ Sensitivity of surrounding vegetation (particularly threatened vegetation). ▪ Sensitivity of threatened fauna species (birds and bats). ▪ Site environmental procedures (vegetation management, sediment and erosion control, protective fencing, weed control). ▪ Emergency and incident response/ spill management (chemical spills, fire, injured fauna).	All sites[2]
E2	Pre-clearing surveys would be undertaken to identify the presence of: ▪ Hollow bearing trees and other habitat features ▪ Threatened flora and fauna.	Street trees which need to be cleared
E6	Trees containing hollows would be felled using "Slow drop" technique (or similar as agreed with OEH). The slow-drop technique involves nudging and shaking the tree, followed by a controlled lowering of the tree to the ground.	Street trees which need to be cleared
E7	Where feasible and reasonable, topsoil and habitat elements (eg logs and felled trees) from sites that have few weed species would be stored and reused onsite.	All sites
E8	Site offices, stockpiles, machinery wash down areas, and plant storage areas would be located outside of any ecologically sensitive areas being retained onsite.	All sites
E9	Fuel (or other chemical) storage would be located outside all riparian zones, and at least 10m from any retained ecologically sensitive areas onsite.	All sites
E10	Construction sites would be revegetated using endemic native plant species where appropriate.	All sites
E12	To prevent establishment or spread of weeds: ▪ Machinery would be cleaned before entering work sites ▪ Weeds would be removed from within the mapped native vegetation areas at least 10m from the edge of the construction footprint (where access allows). ▪ Cleared weed material would be disposed of at a site licensed to receive green waste.	All sites
E15	To reduce disturbance to bats and nocturnal birds where reasonable and feasible, a range of measures would be undertaken, such as: ▪ Artificial lighting would be directed to where it is needed and in a downwards orientation to avoid light spillage, Artificial light would be positioned to face away from areas of native vegetation. ▪ Low-pressure sodium lamps would be used instead of high-pressure sodium or mercury lights. Where mercury lights are used, UV filters would be fitted. ▪ The brightness of lights would be reduced to as low as legally possible, and in conformance with workplace health and safety standards. ▪ Amplified speakers would be directed downwards and away from areas of native vegetation	All sites
E21	*Maintenance* of waterway crossings and structures would be undertaken in accordance with relevant guidelines such as Fish and Fauna Friendly Waterway Crossings (Fairfull & Witheridge, 2003) and Fish Passage Requirements of Waterway Crossings (2003).	All sites
E22	Where native vegetation is to be retained adjacent to or within construction sites, protective fencing and signage (installed as part of EIS1) would be *maintained* in accordance with Australian Standard 4970 – 2009 Protection of Trees.	All sites

*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 16

VISUAL AMENITY

16 VISUAL AMENITY

16.1 Introduction

This chapter evaluates the visual impacts of Stations, Rail Infrastructure and Systems associated with the NWRL project.

The assessment addresses the relevant Director General's Requirements, Conditions of Approval and Statement of Commitments associated with the existing Staged Infrastructure Approval for the project (**Table 16.1**).

Table 16.1 Director-General's requirements, Conditions of Approval and Statements of Commitment

DGR Reference	Description	Addressed
	No DGR's issued in relation to visual amenity or urban design.	
CoA Reference	**Description**	**Addressed**
3.16	The Proponent shall review the visual and urban design impacts and mitigation requirements for the project in accordance with Statement of Commitment 40 to 44; identifying the timing of implementation of urban design and landscaping measures, how the effectiveness of landscaping measures would be monitored, and maintenance responsibilities for relevant urban design and landscape measures.	ReferSection16.5
Statement of Commitments	**Description**	**Addressed**
Desired Outcome	The project design is informed by best practise landscape and urban design principles and minimises visual impacts.	Chapter 6 and 16
40	The following architectural, landscape and urban design principles would be used to guide the design of the new stations and transport interchanges, civil works (such as noise walls, embankments and the viaduct section) and/or the stabling facility concepts: ▪ Reinforce the role of the station and transport interchange within its surrounding neighbourhood as the principal transport and community facility within the locality. ▪ Stations and the stabling facility would be designed in the context of the scale, character and image of the surrounding area and enhance the presentation of the area to visitors, residents and travellers. ▪ Maintain or improve the links across the project and to surrounding areas and activities. Where a connection between adjacent areas is desirable, pedestrian bridges or underpasses would be considered. ▪ Easy access facilities would be incorporated into the station designs and integrated with the associated transport interchanges. ▪ Movement networks should improve existing, or establish new comfortable and inviting pedestrian environments, including equitable access within the railway station and adjoining areas. ▪ A design theme would be established for bridges/viaduct to link the overall rail design together. The design would ensure that the structures are simple, integrated with the surrounding area and finished to a high quality. Fencing, parapets and any railing on the bridges would also be integrated with the overall design. ▪ Establish a hierarchy of access to stations consistent with NSW Govt policy package "Integrating land –use and transport" ie prioritise public transport and other non car-based access to the rail stations and adjoining areas where possible. ▪ Station precinct design should facilitate new development that reflects the highest standards and quality of design.	Refer Chapter 6

DGR Reference	Description	Addressed
41	Visual impact assessment of the project would be undertaken as part of design development. This would consider both the existing and future urban environment to identify impacts and potential mitigation measures, such as architectural, landscape and/or urban design treatments. Additional assessments would apply to pedestrian and cycle facilities; proposed bridging structures; cutting and embankment treatments; landscape treatment projects; design of the stations and stabling facility; proposed acoustic treatments; and any visual buffer areas as required.	Chapter 16
42	Measures to mitigate visual impacts and deliver high quality design outcomes would include: ▪ Where noise walls are proposed, potential visual impacts would be minimised by implementation of urban design measures, developed in consultation with adjacent property owners (mitigation measures might include plantings and high quality facings near residential areas). ▪ Earth mounding would be considered where space allows and where significant vegetation would not be lost. ▪ The design of any civil works, such as noise walls, retaining walls, the viaduct and underpasses would adopt CPTED [Crime Prevention Through Environmental Design] principles, including the need for unobstructed views into and outside of the underpass, effective drainage and ventilation, wide corridors and good lighting. ▪ Light spill would be minimised as much as possible to reduce impacts on surrounding existing and future residents in accordance with relevant standards.	Refer Section 16.8
43	TIDC's Design Review Panel would guide the application of architectural, landscape and urban design principles throughout the design development.	Not an assessment requirement
44	Public art and interpretation would be incorporated into architectural elements or urban design treatments and would be assessed and implemented with design themes and urban design criteria (eg Graffiti management).	Refer Section 16.8

16.2 Methodology

The assessment of visual impact is based on the identification of the level of visual modification created by the NWRL, and the sensitivity of the viewer. Combined, these characteristics of the view are then considered to assign a level of likely visual impact. This methodology is explained below.

Study Area

The term study area in this chapter refers to the area potentially subject to visual impact of Stations, Rail Infrastructure and Systems associated with the NWRL project.

Visual Modification

Visual modification refers to the change to the landscape that may occur as a result of development from a given viewpoint. This includes what has changed, and how it has changed. Visual modification describes the extent of change and identifies elements which are removed or added, changed in scale, form, shape, pattern, colour and texture, and compatibility of new elements with the existing landscape. Visual modification can result in an improvement or reduction in visual amenity.

A high degree of visual modification would result if the development contrasts strongly with the existing landscape. A low degree of visual modification occurs if there is minimal visual contrast and a high level of integration of form, line, shape, pattern, colour or texture values between the development and the environment in which it sits. In this situation the development may be noticeable, but does not markedly contrast with the existing modified landscape. **Table 16.2** lists the terminology used to describe the level of visual modification.

Visual Sensitivity

Visual sensitivity refers to the nature and duration of views. Locations from which a view would potentially be seen for a longer duration, where there are higher numbers of potential viewers and where visual amenity is important to viewers can be regarded as having a higher visual sensitivity. Distance also contributes to the sensitivity of a view.

In order to assist in the assessment of visual impact, the sensitivity of a viewpoint should be considered in the broadest context of possible views, from those of national importance through to those considered to have a neighbourhood visual importance. For this reason the following terminology is used to describe the level of visual sensitivity, see **Table 16.3**.

Table 16.2 Visual modification levels

Visual modification	Description
Considerable reduction or improvement in visual amenity	Substantial part of the view is altered
Noticeable reduction or improvement in visual amenity	Alteration to the view is clearly visible
No perceived reduction or improvement in visual amenity	Either the development is not visible, or if it is, the change in the view is generally unlikely to be perceived by viewers.

Table 16.3 Visual sensitivity levels

Visual sensitivity	Description
National	Heavily experienced view to a national icon, e.g. view to Sydney Opera House from Circular Quay or Lady Macquarie's Chair, view to Parliament House Canberra along Anzac Parade.
State	Heavily experienced view to a feature or landscape that is iconic to the State, e.g. Viewpoint to the Three Sisters at Echo Point in the Blue Mountains National Park.
Regional	Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space. e.g. Rouse Hill House & Farm.
Local	High quality view experienced by concentrations of residents and/or local recreational users, and/or large numbers of road or rail users. e.g. expansive urban or bushland views from residential areas or local open space.
Neighbourhood	Views where visual amenity is not particularly important, such as lesser quality views briefly glimpsed from roads.

Visual Impact

Although there are no recognised standards for determining the significance of visual impact, there is a need to assign significance to this assessment so that there can be a clear and consistent means of evaluating visual impact. The following significance criteria have been developed specifically for this project to allow for this consistency to occur (**Table 16.4**).

Table 16.4 Visual impact significance levels

Visual Modification	Visual Sensitivity				
	National visual sensitivity	State level visual sensitivity	Regional visual sensitivity	Local visual sensitivity	Neighbourhood sensitivity
Considerable reduction	Major adverse	Major adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	Major Adverse	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived reduction or improvement	Negligible	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	Major Beneficial	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Major Beneficial	Major beneficial	High beneficial	Moderate beneficial	Minor beneficial

Mitigation and Residual Effects

For those areas identified as likely to result in a visual impact, as a result of the project, methods for reducing these impacts have been considered and specific mitigation approaches recommended. These mitigation techniques may include the use of vegetation for screening, materials selection, colour and treatment of structures, and adjustments to the location of elements for example.

Assessment of Night Time Impacts

The assessment of night time impacts has been undertaken in a similar methodology, however, rather than assessing particular viewpoints, this assessment draws upon the guidance of the Institution of Lighting Engineers (UK), and their 'Guidance for the reduction of obtrusive light' (2005). This guidance note identifies environmental zones, useful for the categorising of night time landscape settings. These zones are:

- **E1:** Intrinsically dark landscapes – National Parks, Areas of Outstanding Natural Beauty, etc.
- **E2:** Low district brightness areas – Rural, small village, or relatively dark urban locations.
- **E3:** Medium district brightness areas – Small town centres or urban locations.
- **E4:** High district brightness areas – Town/city centres with high levels of nighttime activity.

Specific features of the lit landscape are then described in terms of:

- **Sky glow** – the brightening of the night sky above our towns, cities and countryside.
- **Glare** – the uncomfortable brightness of a light source when viewed against a dark background.
- **Light Trespass** – the spilling of light beyond the boundary of the property or area being lit.

From this analysis, the level of impact is assessed according to the impact levels identified in **Table 16.5**

Table 16.5 Night time visual impact significance criteria

Visual Modification	Visual Sensitivity			
	E1: Intrinsically dark landscapes	E2: Low district brightness	E3: Medium district brightness	E4: High district brightness
Considerable reduction	Major adverse	High adverse	Moderate adverse	Minor adverse
Noticeable reduction	High adverse	Moderate adverse	Minor adverse	Negligible
No perceived reduction or improvement	Negligible	Negligible	Negligible	Negligible
Noticeable improvement	High beneficial	Moderate beneficial	Minor beneficial	Negligible
Considerable improvement	Major beneficial	High beneficial	Moderate beneficial	Minor beneficial

Preparation of Photomontages

A number of photomontages were prepared for the project based on concept level site layouts, typical design drawings for station buildings, viaduct, services buildings and landscape plans. These photomontages are intended to act as artist's impressions, illustrating the general location, scale, and relationship of key visual elements with the surrounding landscape. These simulations were created using site photographs, computer modelling and photo editing as follows:

1. Photographs were taken with a digital camera using a 50mm equivalent focal length
2. A 3D computer model was developed based on a digital terrain model with one metre contour data;
3. Finally the model was composited over the existing photograph using the GPS coordinates of the location, and a minimum of three existing elements within the photograph as reference points;
4. The photographs have been edited using Photoshop to reflect the likely changes to the view.

There is an element of judgement used in the changes shown in these photomontages. Due to the complexity of the sites, these simulations show the indicative location and height of services buildings; station buildings; viaduct; car parking areas, etc and the indicative location of landscaping within the site boundary and along street frontages. The built form has been illustrated in computer rendered form using a grey colour, to illustrate their potential location, form, and potential to block other elements within the existing view. These simulations are not intended to be an exact representation of the final development, as the site layout and extent of features may change as the project progresses through design development.

The locations of these visual simulations were selected to illustrate the range of impacts likely for the project. A priority was given to the potential visual impact of stations, service facilities, viaduct and the stabling facility, due to the visual scale of these elements. Viewpoints have been selected to illustrate areas of most significant visual impact; those areas where large numbers of viewers congregate; where visually prominent development and / or vegetation is to be removed; and where the site can be clearly seen.

16.3 Existing Visual Environment

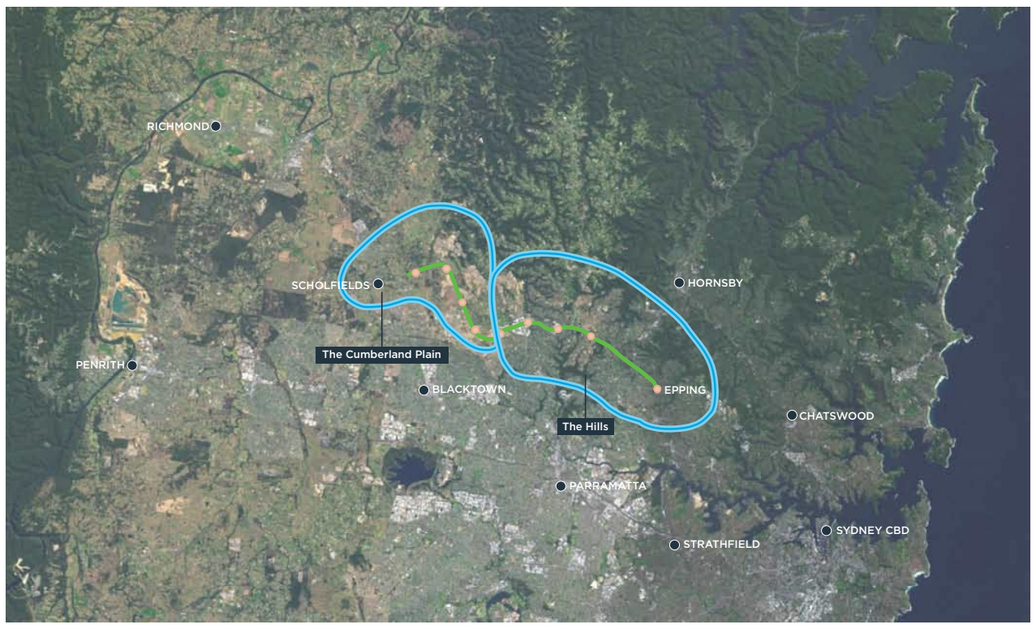
The following section describes the existing visual conditions of the study area.

The site is located between Epping in the east, and Rouse Hill in the west, extending approximately 23km, including some 15km of tunnel. There are two distinctive landscapes which comprise this corridor, the Hills District in the east, and the Cumberland Plain to the west (**Figure 16.1**). The character of these landscapes is important in determining the landscape's ability to visually absorb the proposed infrastructure. For this reason the character of the landscape is based primarily on topography and vegetative cover. The following section describes each of these landscape character areas in greater detail.

16.3.1 The Hills

The Hills character type, as its name suggests, has a generally undulating landform characterised by mature vegetation, established residential areas, and views across the plains.

Figure 16.1 Broad landscape type



Beginning at Epping, the Hills comprises densely vegetated streets and nature reserves, with the nearby Lane Cove National Park providing a green backdrop to this predominantly low density residential area. A mixture of high density residential and commercial exists around Epping station, which services the surrounding area. Housing in the Epping area is generally traditional in nature, with single storey brick dwellings making up a large proportion of housing in the area.

Between Epping and Cherrybrook, the landscape character is fairly consistent; however views to the south and west across surrounding suburbs open up due to elevated ridges and slopes falling away steeply. Views are generally confined to suburbs immediately adjacent, as the ridges and valleys enclose the area. Castle Hill Road, which runs from West Pennant Hills and through Cherrybrook provide glimpses across Baulkham Hills and West Pennant Hills. Pockets of open space exist throughout, with local parks and steep valleys providing dense vegetative cover.

From Cherrybrook to Castle Hill, views are fairly localised, with glimpses of Bella Vista and Kellyville in more elevated areas of Castle Hill. As Castle Hill Road transitions to Old Northern Road the road hierarchy changes with large signalised intersections and pedestrian footpaths on both sides running down to Castle Hill Towers Shopping Centre. This commercial precinct punctuates the landscape with undercover parking running along most of its boundary and boasts the largest cinema complex in the Sydney Basin. Castle Hill Park sits at the intersections of Old Northern Road and Old Castle Hill Road. The park contains mature cultural plantings and decommissioned railway infrastructure provides echoes of its railway past. As Old Northern Road intersects Castle Street, the development of Castle Towers continues, with newer multi-storey developments such as The Piazza, surrounded by older single storey shop fronts which line the street.

Continuing along the corridor from Castle Hill to the Showground, the landscape character returns to one that is dominated by low density residential with heavily vegetated streetscapes and nature reserves. The topography is flatter in this area, with gentler slopes allowing less visual access to surrounding suburbs. Showground includes Castle Hill Showground, adjacent to Hills Shire Council Chambers. The showground has retained its rural past with the preservation of corrugated metal cattle sheds, pavilions and stables, scattered around the main oval and bounded by Showground and Carrington Roads. Housing in the area is mainly one to two storey brick dwellings, and maintains the same character as Cherrybrook and Castle Hill.

From Showground to Norwest Business Park, the heavily forested ridges, valleys and nature reserves have been replaced with flatter gently sloping hills and small local parks. The low density one to two storey brick dwellings have also been replaced with larger two to three storey concrete dwellings, part of the Bella Vista Waters master planned residential communities. Norwest Business Park itself is a densely developed commercial precinct with wide roadways, fast moving traffic and insufficient pedestrian connectivity. Views are restricted to the immediate area and carry only to the nearby ridges of Bella Vista Farm. Moving into the surrounding residential areas, views carry further to Bella Vista and Kellyville, due to elevated hills and reduced vegetative cover.

16.3.2 Cumberland Plain

The Cumberland Plain is a broad plain with undulating hills spanning from Parramatta in the east to the Hawkesbury-Nepean River in the west and from Windsor in the north to Thirlmere in the south. The Cumberland Plain is one of the most highly developed portions of the Sydney Basin and has been the focus of agricultural development since European settlement in 1788. Today the area is increasingly under pressure from residential, industrial and commercial development, leaving very little native vegetative cover.

The NWRL runs generally through the centre of a broad flood plain. This plain is bounded to the east by Beaumont Hills and to the west by Kellyville Ridge. Hills on both sides of the NWRL rise markedly, visually enclosing it from surrounding areas. Although unified by the boundaries of the catchment, the character of the area transitions from established residential and commercial precincts in the east to a patchwork of residential and commercial development in the west, sitting within open space and rural character landscapes. Punctuated by the Rouse Hill Town Centre, these open space and rural character landscapes are planned for residential expansion, which would transform the area into a densely developed residential landscape.

Running generally south east to north west is Old Windsor Road, which follows the historic agricultural transport route to Windsor. This road is up to 6 lanes across in some areas, with large signalised intersections and a stream of fast moving traffic. Running in parallel to this major roadway is the T-way, a dedicated two lane bus way, with stations and large commuter surface car parking areas. Currently, mature remnant eucalypts line the T-way, reducing the visual dominance of this combined infrastructure corridor. Adjacent to John XXIII Catholic Primary School, Old Windsor Road becomes Windsor Road at a large signalised T- intersection. The T-way continues along Windsor Road and terminates at Rouse Hill Town Centre.

The Cumberland Plain character area begins in the east at the Norwest Business Park; a high density commercial precinct with large contemporary office buildings; wide tree lined avenues and manicured gardens. Large areas of the landscape are dedicated to car parking and broad roadways and roundabouts. The Norwest Business Park and surrounding residential development is far from its agricultural past, however Bella Vista Park provides an echo of its rural past. Nestled on the ridgeline of Bella Vista, the former farm provides views down to Norwest Business Park to the north east and residential development to the west.

From Norwest Business Park to Bella Vista, the landscape character changes with the introduction of low density residential development to the east and west of Old Windsor Road. To the east of Old Windsor Road is predominantly cul-de-sac streets with large lots and modern one to two storey dwellings. The streets are tree lined, which provide shade and a visual softening between the built form and the street. Residential development to the west of Old Windsor Road has a similar street layout, however the lots are smaller with one to two storey dwellings, a more traditional character and lesser tree cover.

Between Bella Vista and Kellyville, the landscape character changes to a mixture of open space and large residential lots to the east of Old Windsor Road, with a more concentrated low density residential development to the west. Native vegetation in this area is largely confined to the creek lines and buffer zones of the T-way bus lanes. With residential expansion planned for Kellyville and the surrounding suburbs, the landscape character would change from its rural setting to one that is dominated by urban development.

From Kellyville to Rouse Hill the landscape character is a mix of low density residential, medium density commercial development and rural lots. A lawn cemetery and crematorium to the west provides a green backdrop to the Rouse Hill town centre, with low undulating hills and cultural plantings dotting the landscape. Native vegetative cover is confined again to creek lines, the T-way bus corridor and The Outlook Nature Reserve. Residential development around the town centre consists of one to two storey dwellings, rising gently to the east towards Beaumont Hills. The dominant ridgeline in this area provide regional views to the distant Blue Mountain ranges to the west and more locally to the Rouse Hill Town Centre and NWRL corridor.

To the north of Schofields Road lies Cudgegong Road, where the landscape character changes dramatically from dense residential to a more homogenous rural setting. The area consists of large lots dominated by grazing land and pockets of dense native vegetative cover. The land is gently undulating with clumps of remnant bushland vegetation throughout, however residential expansion is planned for this area and would eventually exhibit the same characteristics of Rouse Hill and surrounding residential developments to the south.

16.4 Visual Character of the Proposal

The project comprises the following typical situations:

- **Station Buildings within the tunnel section** resulting in some visual contrast to the surrounding residential land uses and less contrast with commercial land uses.
- **Station Buildings on Viaduct** –resulting in a major visual contrast to the surrounding residential land uses and some visual contrast with commercial land uses due to elevated position.
- **Station Buildings in Cut** –resulting in some visual contrast to the surrounding residential land uses and less visual contrast with commercial land uses; slightly concealed by retaining walls.
- **Viaduct and Embankment Structures** –includes power lines and poles and running at a consistent level over the undulating landform. The viaduct structure sits on pylons and has a nominally 13m wide headstock.
- **Future Development Sites** – cleared and used for construction works. These sites would be progressively rehabilitated.

At night, it is assumed that:

- **During construction** sites would be sufficiently lit as required for security purposes.
- **Service compounds** would be lit during operation as required for security purposes.
- **Station Precincts** would be well lit to facilitate night services and safe use of the facility. This would include bus, taxi and kiss-and-ride zones; connecting roads, main cycle and pedestrian routes.
- **Viaducts** would not be lit, however the trains using them would have illuminated windows that may be seen moving across the landscape in an elevated location.
- **All lighting** would be directed and use 'cut off' fittings to minimise light spill, glare and skyglow as much as possible.

The visible components of each site and the visual impacts associated with each of the sites are described below.

16.5 Visual Impacts, Epping to Bella Vista

16.5.1 Epping Services Facility

Visual Sensitivity

Generally, views in this area are considered to be of **local** to **neighbourhood** visual sensitivity as the study area includes mainly local roads, residential and commercial land uses. Beecroft Road is the most significant roadway and is moderately trafficked. The undulating landform, blocks of vegetation and a mix of residential and infrastructure create a visually diverse landscape.

Visible Components of the Proposal

The following elements and activities would be likely to be visible during Stage 2 construction:

- Construction of the services building, access roads and parking areas.
- Future development site between Beecroft and Ray Roads.
- Establishment of landscape buffer and new pedestrian footpath along Beecroft Road.

The following elements and activities are likely to be visible during operation:

- Services building approximately 10m above ground level (RL 82.0), facing Beecroft Road. The rear of the building (faces Devlins Creek) would rise to approximately 15m above ground level (RL 77.0)
- Buffer vegetation adjacent to Devlins Creek, landscaping within the site boundary adjacent to Beecroft Road, and streetscape planting along Beecroft Road
- Vehicular entry from Beecroft Road.

Views from Major Routes

There would be a noticeable change in the character of Beecroft Road where it runs along the eastern boundary of the site. Views would include glimpses of the services building mainly filtered by a landscape buffer along Beecroft Road. Views into the site would be visible at the vehicular access point, where site car parking as well as maintenance traffic movements to and from the site would be visible. Streetscape planting and new footpath would be visible along Beecroft Road.

The future development site would allow views to the service building from Beecroft Road when approached from the south, however it is expected that this visibility would be lost after the development of the future development site occurs. When approached from the north, the retained bushland patch would further screen the site within this view. From this road there would be a **minor adverse** visual impact during operation and Stage 2 construction of the Epping Services Facility due to a noticeable reduction in visual amenity from a location of local visual sensitivity.

Train passengers using the Main North Rail Line would have some filtered views to the site, diminishing over time as buffer vegetation matures; this would include the service building possibly rising above the vegetation. The visual context of adjacent multi-unit residential properties and future development sites on Beecroft Road would reduce the visual contrast of these elements in the view. Rail passengers would view the site in the middle ground of the view, and would be moving past the site, reducing the duration of the impact. From the railway, it is considered that there would be a **minor adverse** visual impact, as there would be a noticeable reduction in the amenity of views during operation and Stage 2 construction of the facility, from a location of local visual sensitivity.

Views from Public Open Space and Viewpoints

Due to local landform and the type of land uses in the area there are not expected to be any changes to views from local open space.

The Epping Baptist Church is located at the corner of Carlingford and Ray Roads and includes the site in the foreground and middle ground of views from its entry. Views would be directed across the future development site, opening up visibility to the Services building, Beecroft Road and the rail corridor in the background. From the Epping Baptist Church, it is considered that there would be a **moderate adverse** visual impact as there would be a considerable reduction in the amenity of views of local visual sensitivity during operation and Stage 2 construction.

Before and after views of the site from the corner of Ray and Carlingford Roads, outside the Epping Baptist Church, are shown in **Figure 16.2** and **Figure 16.3**

Views from Residential Areas

Residential properties on Edensor Street and Ray Road, located to the west of the site, include a mix of single dwelling and multi-unit residential properties. The landform rises from the tributary of Devlins Creek and bushland adjacent to the site, toward the corner of Kandy Avenue and Ray Road to the north east of the site. The properties along Edensor Street and part way up Canberra Street would be likely to experience views to the services building filtered by intervening buffer vegetation which would screen the lower portions of the structure. There is likely to be a **minor adverse** visual impact during construction as there would be a considerable reduction in the amenity of views of local visual sensitivity. This would reduce to a **negligible** impact during operation as there would be no perceived reduction or improvement in visual amenity when compared with the existing situation.

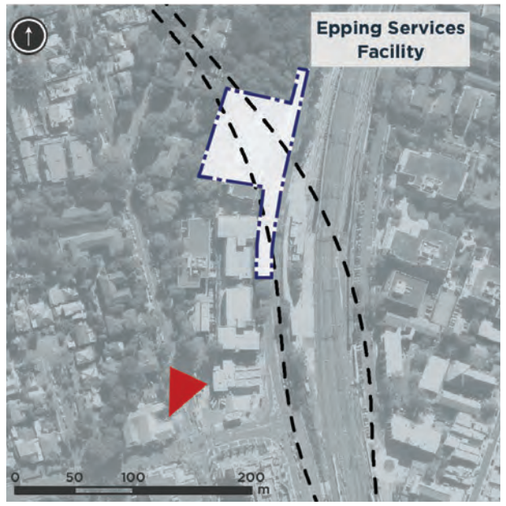
The properties along Ray Road are located directly adjacent to the site and would experience views into and across the future development site. Preparation of this area of the site for future development would open up views to Beecroft Road and the rail corridor beyond. These elements would be visible with minimal screening and filtering due to their proximity to the site boundary and absence of roadside and site vegetation. Overall, there is likely to be a **minor adverse** visual impact during both operation and Stage 2 construction, due to the considerable reduction to the amenity of views from a location of neighbourhood visual sensitivity.

Residential apartments located on Carlingford Road, spanning the corner with Beecroft and Rawson Street, rise seven storeys from a locally elevated site. The site would be visible in the middle ground of panoramic views from residences in this building from a range of elevated perspectives. In these views the future development site would be seen, as would the service facility building to the northern end of the site. Due to the elevation of this viewing location, these views are likely to include internal roads and parking within the site. From this location it is considered that there would be a **minor adverse** visual impact during Stage 2 construction due to the considerable reduction to the amenity of views from a location of neighbourhood visual sensitivity. During operation the impacts would be **negligible** due to there being a noticeable reduction to the amenity of these views.

Residential areas in the vicinity of Cambridge Street, approximately 100m to the east of the railway line, are located on land rising from the existing railway line eastward toward Oxford Street. Views from these properties are likely to include portions of the service facility across the railway corridor, filtered and screened somewhat by adjacent vegetation located along the railway corridor. There would also be the potential for views across the future development site to Carlingford Road and residential areas beyond. From these locations it is considered that there would be a **negligible** visual impact during both operation and Stage 2 construction due to the noticeable reduction to the amenity of views from a location of neighbourhood visual sensitivity.

Figure 16.2 Epping Services Facility, from the corner of Ray Rd and Carlingford Rd – before development

Figure 16.3 Epping Services Facility, from the corner of Ray Rd and Carlingford Rd – after development (showing general form and scale of development only)



Views from Commercial Areas

There would be limited visibility from the Epping town centre. The views that would occur would include the services building, filtered by buffer vegetation in the background. The visual impact of this change would be expected to be **minor adverse** during Stage 2 construction as there would be a noticeable reduction in the amenity of views from a location of local visual sensitivity. During operation the impacts would be **negligible** due to there being no perceived reduction or improvement to the amenity of these views.

Views at Night

The visual setting of this area is considered to be an **E4: High district brightness** area, and generally includes lighting associated with Beecroft Road and commercial development on Beecroft Road, local roads, the railway line, and from the illuminated windows of adjacent residential areas. This setting includes considerable sky glow caused by this densely urbanised area.

During construction there may be security lighting visible, located in the northern portions of the site. During operation the lighting associated with the project would be located primarily along Beecroft Road and within the northern portions of the site, filtered to the east and west by vegetation. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected that the change in visual amenity at night would not be noticeable, due to the existing setting of high district brightness, and therefore there would be **negligible** visual impact to views at night during both operation and Stage 2 construction.

16.5.2 Cheltenham Services Facility

Visual Sensitivity

Generally, views in this area are considered to be of **local** to **neighbourhood** visual sensitivity as the study area includes mainly local roads and residential areas. The oval, netball training courts and bushland contribute to the visual character of this area, and the mature street and garden trees create a landscape visually unified by vegetation.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Construction of the services/community building, access roads and parking areas.
- Relocation of multi-use courts (behind the services/community building).
- Removal of existing trees in the centre island of Castle Howard Road (adjacent to site entry).

The following elements and activities are likely to be visible during operation:

- Services / community building approximately 4m above ground level (RL 87.6), located between the existing courts and oval.
- Buffer vegetation between relocated multi-use courts and existing residential.
- Landscaping around the reinstated recreational facilities and northern corner of Cheltenham Oval.
- Hardstand and vehicular entry adjacent to services / community building.

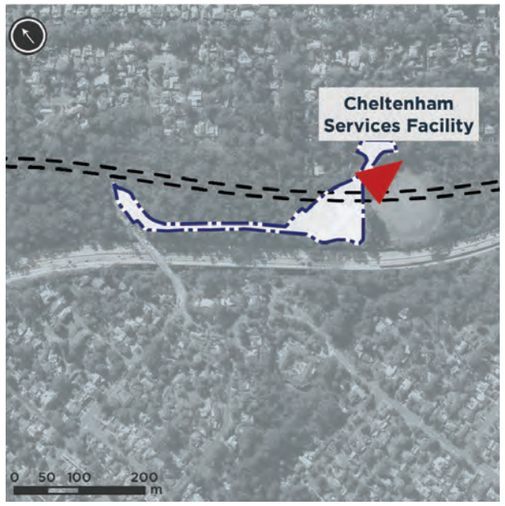
Views from Major Routes

In views from the M2 Motorway travelling east and west it is unlikely that the proposed buildings would be visible. This is due to the acoustic walls being erected as part of the M2 upgrade. Any views that do occur would be for a short duration. Therefore, from the M2 Motorway there would be a **negligible** visual impact due to there being no perceived reduction or improvement in visual amenity from a location of local visual sensitivity.

In views from vehicles travelling along Kirkham Road, a corridor of vegetation cleared to provide access to the site during the Stage 1 construction (major civil works) would be used for Stage 2 construction and revegetated at the completion of construction along with other areas of the site not required for operational purposes. Construction vehicles using Kirkham Road would be visible during this time. There would be a **minor adverse** visual impact on views from Kirkham Road during Stage 2 construction reducing to **negligible** during operation. This is due to a considerable reduction in visual amenity during construction and noticeable reduction in the visual amenity during operation from a location of neighbourhood visual sensitivity.

Views from Public Open Space and Viewpoints

The site is located adjacent to the Cheltenham Oval. The visual character of the construction of the service facility and associated local road upgrades would be clearly visible from the oval and associated facilities, and contrast in character. Upon completion the site would be somewhat integrated into the surrounding landscape. The length of the structure (approximately 40m), would be noticeably larger in scale to the surrounding built form, however the proposed landscape areas and relocation of the multi-use courts would create a context of planted areas that would visually filter the built form. It is expected that there would be a **moderate adverse** visual impact during Stage 2 construction due to a considerable reduction in amenity from a location of local visual sensitivity. This would change to **minor adverse** during operation as the reduction on visual amenity would reduce to noticeable.



Views from Residential Areas

Residential properties on the northern side of Castle Howard Road, to the north east of the site, are likely to experience views to the construction of the services / community building, relocation of multi-use courts and landscaped areas. Views to the built form would be filtered by the existing and proposed street and garden trees, and the integration of community facilities into the structure would create a more visually appropriate elevation to views from this location. Overall it is considered that there would be a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity and therefore a **negligible** visual impact during both operation and Stage 2 construction on views from residences on the northern side of Castle Howard Road.

Before and after views of the site from Castle Howard Road adjacent to the sports field are shown in **Figure 16.4** and **Figure 16.5**.

Figure 16.4 Cheltenham Services Facility, from Castle Howard Road – before development

Figure 16.5 Cheltenham Services Facility, from Castle Howard Road – after development (showing general form and scale of development only)

On the southern side of Castle Howard Road there are a number of properties that sit directly adjacent to the site boundary and have views south west toward the site. From these locations, views would be to retained vegetation and new areas of buffer vegetation beyond. The services / community building would be visible, filtered by this vegetation, and would include the long side of the building running away from the viewer. From these properties there would be a **minor adverse** visual impact during Stage 2 construction, due to there being a considerable change in the amenity of views from a location of neighbourhood visual sensitivity. During operation this would be a **negligible** visual impact as there would be a noticeable change in the amenity of views from a location of neighbourhood visual sensitivity.

Residential areas in the vicinity of Murray Farm and Bingara Roads approximately 150m to the south west of the site, and beyond the M2 Motorway, are located on an undulating landform. The site would be visible in views toward the Beecroft Reserve and Cheltenham Oval. The service building would be viewed across the M2 Motorway, filtered and screened somewhat by local built form and vegetation. From these locations it is considered that there would be a **negligible** visual impact during both operation and Stage 2 construction due to a noticeable reduction in the amenity of views from a location of neighbourhood visual sensitivity.

Views at Night

The visual setting of this area is considered to be an **E3: Medium district brightness** area, and generally includes lighting associated with local streets and illuminated windows of surrounding residential properties, floodlighting of the Cheltenham Oval and clubhouse facility, as well as skyglow from traffic on the M2 beyond.

The project would introduce additional light into an area visually dominated by a regularly floodlit sports field. During construction, the project would require security lighting associated with site access points and within the site itself. During operation, there would be minimal lighting associated with the service facility, however, there may be lighting associated with the community building to allow for night use. Lighting on the services / community building would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected, however, that the change in visual amenity at night would give rise to a **minor adverse** visual impact during both operation and Stage 2 construction.

16.5.3 Cherrybrook Station

Visual Sensitivity

Generally, views in this area are considered to be of **local** to **neighbourhood** visual sensitivity as the study area includes mainly local roads and residential areas. The study area includes some community uses including a Steiner School and Child Care Centre, both of which are considered more visually sensitive.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Construction of the station building, services buildings, ancillary buildings, access roads and car parks.
- Construction of landscape works and new pedestrian footpath along Castle Hill Road.
- Future development site adjacent to the new access road.
- Road works and construction of new signalised intersection where Glenhope Road meets Castle Hill Road.

The following elements and activities are likely to be visible during operation:

- Station building 6.5m high from concourse level and sitting approximately 4m below Castle Hill Road.
- Station services building 6m high from concourse level and located at the northern end of the station platform. Building partly set into the batter along Castle Hill Road.
- Station services building and associated retail concessions (approximately 6m high from concourse level) located at the southern end of the station platform. Building partly concealed by multi-storey park-and-ride structure above.
- Two to three storey stepped park-and-ride structure provided over service facilities building.
- Upgrade to Franklin Road including kerb and gutter, resurfacing and landscaping.
- Bus zones, kiss-and-ride, and taxi zones along new internal two lane access road extending from Robert Road through to Franklin Road.
- On-grade park-and-ride located in the south eastern corner of the site.
- 4-6m wide landscape buffer along the boundary to existing residences.
- Street tree planting along Castle Hill, Robert and Franklin Roads, and the new internal two lane access roads.
- Signalised intersection where Glenhope Road and Robert Road meets Castle Hill Road.
- Future development area adjoining new internal access road.

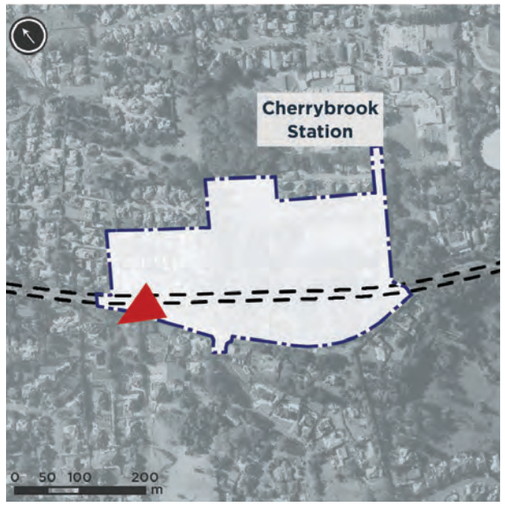
Views from Major Routes

In views from Castle Hill Road, travelling east and west, the station building, services buildings and the park-and-ride structure would sit parallel to the road and would be nestled into the existing landform. Therefore, views would predominantly include the upper portions of these structures. The visible components of these buildings would be filtered by tree planting. The architecture of the station and framework of proposed vegetation would offset the initial vegetation removal, and with the park-and-ride structure being of relatively low prominence there would not be expected to be an improvement or reduction in visual amenity.

The site would be visible for a short duration as these views would be from vehicles moving past the site. During operation, it is expected that there would be a **negligible** visual impact, due to there being no perceived improvement or reduction in visual amenity, from a location of local visual sensitivity. There would be a **minor adverse** visual impact during Stage 2 construction due to there being a noticeable change in visual amenity.

Before and after views of the site from Castle Hill Road near the corner of Glenhope Road, are shown in **Figure 16.6** and **Figure 16.7**.

Views from Franklin Road would include various site elements beyond the vacant future development site, adjustment to the roadway itself as it is widened, and the introduction of a new access road into the station. From Franklin Road there would be a **negligible** visual impact, due to there being no perceived improvement or reduction in visual amenity, from a location of local visual sensitivity. There would be a minor adverse visual impact during Stage 2 construction due to there being a noticeable change in visual amenity.



Views from Public Open Space and Viewpoints

A local park with playground is located on the corner of Robert and Dalkeith Roads, approximately 200m north of the site. Currently, the northern edge of the site is screened by mature bushland vegetation on properties north of the site. It is unlikely that the station and service buildings would be visible due to buffering vegetation and existing built form. Users of the parkland are considered to be sensitive, however, there is expected to be no perceived reduction or improvement in visual amenity during operation and Stage 2 construction, and therefore a **negligible** visual impact.

Views from Residential Areas

Residential properties on Robert Road and Oliver Way, to the north west of the site, are located directly adjacent to the site and currently experience leafy residential views. These properties would have views to the new internal access road; future development sites; on-site stormwater detention and treatment area, filtered by buffering vegetation in the foreground of views. Beyond these foreground elements the service facility located closest to

Figure 16.6 Cherrybrook Station from Castle Hill Road – before development

Figure 16.7 Cherrybrook Station from Castle Hill Road – after development (showing general form and scale of development only)

Robert Road would be visible, protruding one storey above ground level, as well as the station building, protruding 6.5m high from concourse level. The plaza spaces including kiss-and-ride, taxi and bus drop off area would be visible in front of the station. It is considered that there would be a **minor adverse** visual impact during operation and Stage 2 construction due to considerable reduction in the amenity of views from a location of neighbourhood visual sensitivity.

Residential properties on Franklin Road and Kayla Way to the east of the site, particularly those that sit directly adjacent to the site boundary, will experience views to the site. These views currently are of a leafy residential character. Upon completion of the project, they would be likely to see the on-grade park-and-ride area, new internal access road and vacant future development sites in the foreground. Beyond this, there would be views to landscaped areas and the park-and-ride structure. The station building would also be visible in the centre of the site, protruding 6.5m above ground level with plaza space and drop off zones in front. All of these elements would be filtered somewhat by buffer vegetation along the rear of these properties. From this location there is likely to be a **minor adverse** visual impact during operation and Stage 2 construction, due to the considerable reduction in the amenity of views from a location of neighbourhood visual sensitivity.

Residential properties on Castle Hill Road are likely to experience views to the site across the road, filtered by landscape areas. The uppermost portions of the station; service buildings; and park-and-ride structure, which are all 'tucked' within the sloping landform to reduce their visual prominence, will also be visible from this location. This treatment would allow the station to sit comfortably within the relatively fine grain and leafy character of the surrounding residential areas. Overall, during construction there would be a considerable reduction in visual amenity from this location of neighbourhood visual sensitivity resulting in a **minor adverse** visual impact. There would likely be a **negligible** visual impact during operation, due to a noticeable reduction to the amenity of views from a location of neighbourhood visual sensitivity.

Views from Community Facilities

The Inala Rudolf Steiner School is located on the corner of Franklin Road and Castle Hill Road and directly opposite the site. The buildings are mainly set back around 50m from Franklin Road. There would be views across the future development site on Franklin Road and beyond into the site, across landscape areas under the high voltage power lines and eastern edge of the park-and-ride structure. These built elements would however not be prominent as they would be filtered by vegetation on the school site and road verge. Views from the school would also include traffic associated with the connection of the new internal access road to Franklin Road. It is expected that views from the school would experience a noticeable reduction in visual amenity. Due to the local sensitivity of this location, it is expected that the school would experience a **minor adverse** visual impact during both operation and Stage 2 construction.

Views at Night

The visual setting of this area is considered to be an **E3: Medium district brightness** area, and generally includes lighting associated with Castle Hill Road, local streets and illuminated windows of surrounding residential properties. This setting includes sky glow caused by this moderately urbanised area.

The project would introduce additional light into what is a lowly lit site. During construction there would be sufficient lighting of the site area for security purposes. During operation, station, plaza spaces, internal access roads, park-and-ride areas and pedestrian linkages would be lit. Lighting on the site would range in intensities, but it is expected that the areas running parallel with Castle Hill Road and the new internal access road in particular would be brightly lit. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected, there would be a considerable reduction in night-time visual amenity, resulting in a **moderate adverse** visual impact during operation. Night-time visual impacts would be expected to be **minor adverse** during Stage 2 construction.

16.5.4 Castle Hill Station

Visual Sensitivity

Generally, views in this area are considered to be of **local** visual sensitivity as the site is located within close proximity to the Castle Hill main street, parallels the route of a regional connector road with a series of bus stops, and is adjacent to the Castle Towers Shopping Centre. Each are community gathering places where the potential for large numbers of viewers.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Construction of the station building, services buildings and ancillary buildings.
- Construction of landscape works through Arthur Whitling Park and new pedestrian footpath along Old Northern Road.
- Road works and construction of new signalised intersection where Old Northern Road meets Terminus Street.
- Road works along Old Castle Hill Road.

The following elements and activities are likely to be visible during operation:

- Station building 8m high from entry level at the western end of Arthur Whitling Park.
- Pedestrian plaza space at the western end of Arthur Whitling Park and terraced plaza along Old Castle Hill Road
- Station services building approximately 6m high and located on the southern boundary of existing commercial buildings.
- Precinct activation building (retail) approximately 6m high located on Old Castle Hill Road.
- New access road extending from Old Castle Hill Road to services building.
- Upgrade to Old Castle Hill Road including road widening, resurfacing, two pedestrian crossings, kiss-and-ride, and taxi zone provisions, bus zones and shelters along Old Northern Road.
- Street tree planting along Old Castle Hill and Old Northern Roads and McMullen Avenue.
- Signalised intersection where Old Northern Road meets Terminus Street.
- Skylight structures through Arthur Whitling Park.
- Appropriate recognition of the current war memorial.

Views from Major Routes

When travelling north east on Old Northern Road, Arthur Whitling Park is central to the view, particularly at the intersection with Castle Street and Crane Road. In these views, the parkland and visible portion of Old Northern Road would be replaced by a new plaza space with a focal point clearly visible and the station building set within the centre middleground of the view. Beyond the plaza and station would be reinstated parkland with new trees and landscape areas. This view would not initially have the mature framework of trees that are characteristic of the existing park. The site is visible for a considerable duration from this location when traffic is stationary at the signalised intersection. It is expected that there would be a **moderate adverse** visual impact to views from this intersection during both operation and Stage 2 construction, due to a noticeable reduction in visual amenity from a location of local visual sensitivity. Over time, as trees and planting mature and begin to become more visually dominant, this impact would be reduced.

Before and after views of the site from the corner of Old Northern, Castle, Old Castle Hill and Crane Roads are shown in **Figure 16.8** and **Figure 16.9**.

When travelling north east along Old Castle Hill Road a terraced plaza would be visible rising from the edge of the site. This steep rise would result in limited views into the site beyond this edge. This more urban treatment would alter the existing leafy character. From McMullen Avenue, for about 50m approaching the intersection with Old Northern Road, there would be buffer planting and landscape areas. These elements would be new and thus would not initially have the maturity and visual prominence of the existing parkland. The character of Old Northern Road between McMullen and Terminus Street would be altered as the width of the intersection with Terminus Street is reduced in size and the parkland is expanded. Views from Old Northern Road would change as a portion of the road, between Crane Road and Terminus Street becomes a dedicated bus zone and is integrated into the pedestrian plaza space. During Stage 2 construction it is expected that each of these roads would be used as a heavy vehicle route. During this time, views into the site would be restricted by site perimeter hoarding.

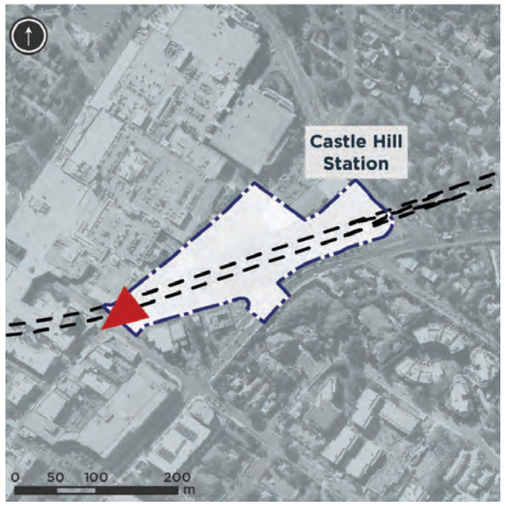
Overall, it is expected that there would be a **moderate adverse** visual impact to views from Old Northern Road, Old Castle Hill Road and McMullen Avenue during Stage 2 construction due to a considerable reduction in visual amenity from a location of local visual sensitivity. Terminus Street would experience a **minor adverse** visual impact during Stage 2 construction due to a noticeable reduction in visual amenity from a location of local visual sensitivity. During operation, the impact at all these locations would be **minor adverse,** as there would be a noticeable reduction in visual amenity.

Views from Public Open Space and Viewpoints

Due to closure of Arthur Whitling Park for the duration of construction, there would not be any views available from within the parkland. During operation, views within the park would be changed from the existing views that include mature, well maintained parkland, with some signs of wear, to newly constructed parkland with large pedestrian plaza spaces, visible skylight structures and a train station entry building. The character of the western portions of the park would be more urban than the existing park, with an effect of changing the essential character of the park into a more transit oriented public space. In the east of the parkland an important internal view within the park would also be changed. Overall, it is considered that there would be a **minor adverse** impact on views within Arthur Whitling Park during operation as there would be noticeable reduction in visual amenity from a location of local visual sensitivity.

Figure 16.8 Castle Hill Station from Old Northern Road – before development

Figure 16.9 Castle Hill Station from Castle Hill Road – after development (showing general form and scale of development only)



Views from Commercial Areas

Views from the entries to the Castle Towers Shopping Centre, opposite the site, are currently characterised by busy traffic and buses stopping adjacent to Arthur Whitling Reserve. Mature trees shade and overhang the roadway, and provide some amenity to these views. The character of these views would change as the vegetation in the park is replaced with hoarding during construction. During operation there would be a more urban view as the view would include paved terraces and newly planted trees within the park. Due to the local sensitivity of these views, and considerable change in amenity, views from the entries to Castle Towers Shopping Centre would experience a **moderate adverse** visual impact during both operation and Stage 2 construction. This would be expected to reduce as the planted trees mature.

Commercial properties on Old Northern Road, directly adjacent to and overlooking the site, would have unfiltered views to the hoarding and site during Stage 2 construction. During operation, views would be to a bus zone which would lead directly to a large urban plaza space, and station entry building. This view would be more urban in character, with tree planting initially being smaller in scale and maturity than the existing. Due to the proximity of these properties, and therefore the extent of visual modification, there would be a **minor adverse** visual impact as a considerable change in the amenity of these views would be experienced from a location of neighbourhood sensitivity.

Views at Night

The visual setting of this area is considered to be an **E4: High district brightness** area, and generally includes lighting associated with Old Northern Road, Castle Hill Road, the Castle Towers Shopping Centre, and surrounding commercial areas and local roads. This setting includes sky glow caused by this highly urbanised area.

The project involves the construction and operation of a well-lit station, plaza spaces and formal parkland. Lighting on the site would range in intensities, but it is expected that the areas to the south west corner and near the intersection of Old Northern Road and Old Castle Hill Roads in particular would be brightly lit. Areas of the parkland likely to be used by pedestrians at night, particularly areas along Old Northern Road and Old Castle Hill Roads, would also be well lit. Directed and cut-off fittings would be used as appropriate, with lighting designed to limit light trespass onto neighbouring properties. It is therefore expected that as the change in visual amenity at night would be considerable, there would be a **minor adverse** visual impact on views at night during both operation and Stage 2 construction.

16.5.5 Showground Station

Visual Sensitivity

Views in this area range between **neighbourhood, local** and **regional** visual sensitivity as the study area includes differing land uses and activities. Views from the showground are generally regarded as being of **regional** sensitivity because of the nature and intensity of uses that occur there.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Construction of the station building, services buildings, ancillary buildings, access roads and multi-storey park-and-ride.
- Construction of landscape works and new pedestrian footpath along Carrington Road
- Stabilisation of future development site
- Road works and construction of new signalised intersection at Showground Road
- Demolition of the Hills Centre building.

The following elements and activities are likely to be visible during operation:

- Station building 6m high from entry level.
- Three storey, 600 space car park-and-ride with services building at basement level.
- Station services building 10m high from ground level and located on the corner of Carrington and Middleton Roads.
- New two lane access roads creating a grid throughout the station precinct.
- Signalised intersection at Showground Road.
- Upgrade to Doran Drive including kerb & gutter, resurfacing, landscaping and pedestrian plaza, Bus zones, kiss-and-ride and taxi zones.
- Kiss-and-ride and taxi zones along access roads adjacent to station building.
- Footpath connections on both sides of Carrington Road, Middleton Road and Doran Drive, and station side of road along new access road to Showground Road.
- Landscape buffer in the north west corner of the site.
- Bus shelters along Doran Drive and bicycle storage facilities adjacent to station building.
- Skylight structures through station precinct.
- Vacant future development area.

Views from Major Routes

The visual character of views from Carrington Road would change markedly. Currently views include the Hills Centre entertainment complex and The Hills Shire Council buildings, which comprise two large 1980s style brick office buildings and ancillary buildings sitting within large on grade car parking areas, mature landscaped grounds, and depot buildings. In particular, the loss of mature eucalypt trees located between the site and the road would change the scale and visual enclosure of views from Carrington Road. During Stage 2 construction, hoarding would be erected and construction activity would include the construction of station and service buildings. Views would also include construction vehicle access and associated vehicle movements along Carrington Road.

During operation, the dominant features of views from Carrington Road would be the multi-storey park-and-ride structure, station building, and surrounding access roads and landscaped areas. Overall, the character of the site would be more urban than the existing situation and some mature trees would be lost. However, a high quality architectural and urban landscape treatment would create a coordinated and contemporary character to this precinct.

It is expected that there would be a **minor adverse** impact on views from Carrington Road during both operation and Stage 2 construction, due to a considerable reduction in visual amenity from a location of neighbourhood visual sensitivity.

From Showground Road, a signalised intersection and new entry road would be visible. Other site elements would be less visible, as the main station area would be located in the background of views. The multi-storey park-and-ride structure is likely to be visible but not prominent. During Stage 2 construction, Showground Road would be an access route with increased truck movements and maneuvering into the site. It is expected that there would be a **minor adverse** visual impact to views from Showground Road during both operation and Stage 2 construction due to a noticeable reduction in visual amenity from a location of local visual sensitivity.

Views from Residential Areas

Views from residential properties in the vicinity of Ashford Avenue and Carrington Road, to the south of the site, would experience a considerable change in the amenity of views, as roadside vegetation and the Hills Centre are removed and replaced by station buildings. The multi-storey park-and-ride structure would be particularly prominent. There would also be additional traffic and activity associated with the station. During construction this area would be surrounded by hoarding with construction traffic likely to be visible. Overall, there would be a **minor adverse** visual impact to views during both operation and Stage 2 construction due to a considerable reduction in visual amenity from a location of neighbourhood visual sensitivity. Over time this impact would be reduced as landscape planting establishes and softens the appearance of the station area.

Before and after views of the site from the corner of Carrington Road and Ashford Avenue are shown in **Figure 16.10** and **Figure 16.11**.

Views from Public Open Space and Viewpoints

The project would be visually prominent in many views from the Showground as it would run along the entire southern boundary of the Showground site. During Stage 2 construction views would include hoarding along this edge, construction activity protruding above the hoarding, and additional traffic along Showground Road, which would be used as a site access route. In the background of these views the station building, new road network and plazas would be visible. To the west of the site, where the landform is falling towards Cattai Creek, the multi-storey park-and-ride structure would be prominent. The prominence of the site in views from the showground would result in a **high adverse** visual impact during both operation and Stage 2 construction due to a considerable reduction in the amenity of a view of regional visual sensitivity.

Views from Community Facilities

Views from the childcare centre on Carrington Road would change from views to a depot and vegetated creekline filtered through roadside vegetation, to views of the multi-storey park-and-ride structure; buffer landscaping; signalised intersection; station building and plaza. There would be a **moderate adverse** visual impact during both operation and Stage 2 construction, due to a considerable reduction in visual amenity from a location of local visual sensitivity.

Views at Night

The visual setting of this area is considered to be an E3: Medium district brightness area, and generally includes lighting associated with Showground and Carrington Roads, the illuminated windows of surrounding offices and residential areas, lit local roads and security lighting in commercial areas. However, during events at the showground this area would experience additional floodlighting and elevate this area to an area of E4 High district brightness. This setting includes sky glow caused by this urban setting.

The project involves the construction and operation of a well-lit station entry, plaza spaces and a three storey park-and-ride structure. Lighting on the site would range in intensities, but it is expected that the areas to the south running along Carrington Road in particular would be brightly lit. Landscape areas and plaza spaces likely to be used by pedestrians at night, particularly Doran Drive, would also be well lit. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected, however, that as the change in visual amenity at night would be considerable, from a location of regional visual sensitivity, there would be a moderate adverse visual impact on views at night during both operation and Stage 2 construction.

Figure 16.10 Figure 16.10 Showground Station from the corner of Carrington Road and Ashford Avenue – before development

Figure 16.11 Figure 16.11 Showground Station from the corner of Carrington Road and Ashford Avenue – after development (showing general form and character of development only)

16.5.6 Norwest Station

Visual Sensitivity

Views in this area are considered to be of **neighbourhood** and **local** visual sensitivity. Neighbourhood views include those from surrounding commercial uses. Norwest Boulevard and the Hillsong Church are considered to be of **local** visual sensitivity as they are likely to attract more viewers.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Construction of the station building, services buildings and ancillary buildings.
- Construction of landscape works along Norwest Boulevard and Brookhollow Avenue.
- Stabilisation of a future development site, between Brookhollow Avenue and Norwest Boulevard.
- Road works and construction of a new signalised intersection where Brookhollow Avenue meets Norwest Boulevard.

The following elements and activities are likely to be visible during operation:

- Station building 6m high from entry level located on the corner of Norwest Boulevard and Brookhollow Avenue.
- Two station services buildings one located on the eastern boundary above the station platform and one on the eastern boundary adjoining Brookhollow Avenue.
- Road widening to Norwest Boulevard and Brookhollow Avenue to allow bus, park-and-ride and taxi zones.
- Bus zones, along Norwest Boulevard; kiss-and-ride and taxi zones along Brookhollow Avenue.
- Landscape buffer area extending from Brookhollow Avenue to Norwest Boulevard between station plaza and services facility.
- Streetscape planting along Norwest Boulevard and Brookhollow Avenue.

- Pedestrian plaza space along Norwest Boulevard and Brookhollow Avenue and adjoining the station building and bicycle storage facilities, skylight structures extending from the station building to the services building.
- Signalised intersection where Norwest Boulevard meets Brookhollow Avenue.
- Bus shelters along Norwest Boulevard and bicycle storage facilities adjacent to precinct activation building (retail).

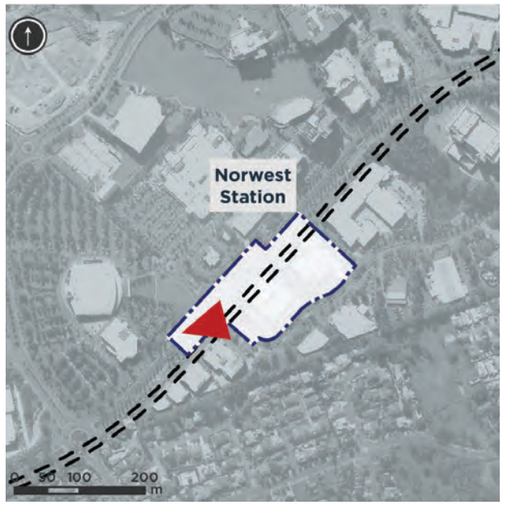
Views from Major Routes

Views from Norwest Boulevard would include a new signalised intersection and new slip lanes being added for traffic turning into Brookhollow Avenue and Century Circuit, replacing the existing roundabout. This would be seen as a broader expanse of asphalt and less leafy character. Views from vehicles travelling along the Boulevard would include the station entry building, pedestrian plaza, service buildings, bus stops, and kiss-and-ride zones. Median planting along the Boulevard would be retained and would filter views to the site. During construction the site would be surrounded by site boundary hoarding and construction activity would be visible. It is expected that there would be a **minor adverse** visual impact during Stage 2 construction due to a noticeable reduction in amenity from a view of local visual sensitivity. During operation the impact would be **negligible** as there would not be no perceived improvement or reduction in visual amenity.

Before and after views of the site from Norwest Boulevard, taken from the bus stop outside the Hill Song Church, are shown in **Figure 16.12** and **Figure 16.13**.

Views from Public Open Space and Viewpoints

Views from the elevated Bella Vista Farm site include broad panoramic views to the north and south. The views to the north would include Norwest Station in the background of a broad and complex view; with existing built form and vegetation filtering and largely obscuring it from this location. Due to the project not having a perceived improvement or reduction on the amenity of this view and the regional visual sensitivity of this location, there is expected to be a **negligible** visual impact during both operation and Stage 2 construction.



Views from Commercial Areas

Views from The Norwest Market Town Shopping Centre would be changed as the Boulevard is reconfigured to allow for the signalised intersection. The station entry building would be visible in the middle ground of views from this location, filtered through new median planting along Norwest Boulevard. From within the Norwest Market Town Shopping Centre, these views would be partly screened and filtered by vegetation and buildings located within the car parks. It is not considered that there would be a perceived change in visual amenity from this location. Therefore, during both operation and Stage 2 construction there would be a **negligible** visual impact to views in this area from a location of local visual sensitivity.

Views from commercial developments on Brookhollow Avenue would include the site in the foreground and middle ground of views. Views would include the station entry building, service facilities, bus stops, and kiss-and-ride zones, a signalised intersection at Norwest Boulevard and landscaping. As the distance increases, views from offices on Brookhollow Avenue would be largely filtered and screened by street trees and gardens within their grounds. During construction the site would be surrounded by hoarding and some construction activity would be visible. It is expected that there would be a **negligible** visual impact during operation due to a noticeable reduction in amenity of views of neighbourhood visual sensitivity. During Stage 2 construction there would be a considerable reduction in visual amenity which would result in a **minor adverse** visual impact.

Figure 16.12 Norwest Station from Norwest Boulevard – before development

Figure 16.13 Norwest Station from Norwest Boulevard – after development (showing general form and character of development only)

Views from Community Facilities

The character of views from the Hillsong Church on Norwest Boulevard diagonally opposite the site would also be changed. The new signalised intersection on Norwest Boulevard would be visible, replacing the existing planted roundabout in the foreground of the view. Beyond this, would be the station building, bus zones and the associated pedestrian plaza space. There would be a **minor adverse** visual impact during operation to views from this location due to a noticeable reduction in amenity of views from a location of local visual sensitivity. During Stage 2 construction there would be a **negligible** impact on views from this location as there would be no perceived reduction or improvement in the amenity of views.

Views at Night

The visual setting of this area is considered to be an **E4: High district brightness** area, and generally includes lighting associated with Norwest Boulevard, the Norwest Market Town Shopping Centre, the Hillsong Church buildings, surrounding office complexes and local roads. This setting includes sky glow caused by this highly urbanised area.

The project involves the construction and operation of a well-lit station entry, plaza spaces and skylight structures. Lighting on the site would range in intensities, but it is expected that the areas running along Norwest Boulevard in particular would be brightly lit. Kiss-and-ride and bicycle storage facilities along Brookhollow Avenue would also be well lit. It is expected that the change in visual amenity at night would be noticeable and therefore there would be a negligible to minor adverse visual impact on views in this vicinity at night during both operation and Stage 2 construction.

16.5.7 Bella Vista Station

Visual Sensitivity

Most views in this area are considered to be of **neighbourhood** visual sensitivity as the site is surrounded by predominantly commercial and residential areas. Windsor Road and local parkland, however, are considered to be of **local** visual sensitivity.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Laying rail track.
- Erecting power lines above rail track.
- Construction of the station building, services buildings, ancillary buildings, access roads and parking areas.
- Construction of landscape works and new pedestrian footpath along Celebration Drive and Lexington Drive.
- Road works and construction of new signalised intersection where Lexington Drive meets Celebration Drive.
- Future development site, between Celebration Drive and Lexington Drive Extension.
- Construction of cycleway along existing T-way.
- Construction of new pedestrian bridge over Old Windsor Road.

The following elements and activities are likely to be visible during operation:

- Station facilities building approximately 6m high from entry level.
- Station services building located north of the station, adjacent to the T-way.
- New two lane access road extending from Celebration Drive Extension to the service road; four lane extension of Lexington Drive running north south; and two lane link road to connect Celebration Drive to Lexington Drive, including kerb & gutter, resurfacing and streetscape planting along existing roads.
- Rail corridor in cut and under Lexington Drive Extension.
- Pedestrian plaza extends along Lexington Drive Extension and continues through to existing McDonalds Restaurant.
- Pedestrian bridge over Old Windsor Road.
- Bus zones, kiss-and-ride, and taxi zones along Lexington Drive Extension; kiss-and-ride, taxi zones along new link road.
- One two storey and two on-grade park and ride facilities for around 800 car spaces in total.
- 5m wide landscape buffer provided along Celebration Drive Extension and connecting access road.
- Streetscape planting along Celebration Drive Extension, Lexington Drive Extension and link road.
- Car park access road extending from existing service road to existing McDonalds Restaurant.
- Shared pedestrian cycleway extending from Service Road to Celebration Drive.
- Signalised intersection where Lexington Drive Extension meets Celebration Drive.
- Bus shelters along Lexington Drive Extension and bicycle storage facilities adjacent to McDonalds Restaurant.
- Vacant land (future development area).

Views from Major Routes

Views from Old Windsor Road would experience some change in character as it runs parallel to the site. The existing Homemaker Centre and existing rural residential buildings would be removed. At the intersection with Celebration Drive, the retained service station and fast food outlet are elevated above the roadway and would intervene to obscure much of the project works. In this area a pedestrian bridge would be built over Old Windsor Road. Tall concrete retaining walls of the existing T-way decline create a partial visual barrier to the site. The visible elements of the project would include the construction and operation of the upper portions of a two level park-and-ride structure. Overall, views from Old Windsor Road are likely to have a **minor adverse** visual impact during operation and Stage 2 construction, as there would be a noticeable reduction in visual amenity from a location of local visual sensitivity.

Views from Public Open Space and Viewpoints

Views from the linear parkland and shared pathways adjacent to the lake on Celebration Drive are currently dominated by the Homemaker Centre and are filtered through existing trees, and obscured somewhat by intervening landform. The site would replace the Homemaker Centre in these views. Views from this parkland are likely to experience a **negligible** visual impact during operation and Stage 2 construction as there would be no perceived improvement or reduction in visual amenity from a location of local visual sensitivity.

Views from Residential Areas

Rural residential properties to the north and east of the site would have clear, open views to the site. These views would include the station building, services buildings and a two storey park-and-ride structure adjacent to the T-way. These views currently include the T-way development; however, this is filtered by distance and mature vegetation. Overall, during both operation and Stage 2 construction there would be a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity, and therefore a negligible visual impact.

A townhouse development sits in close proximity to the site, between Celebration Drive and Brighton Drive. An existing vegetated buffer sits to the east of Celebration Drive, screening and filtering views to the site from this area. With additional streetscape planting on Celebration Drive and within the site, there may be filtered views toward the site and across future development areas. Views to the site approximately 50m directly west would include the station building, service building, two storey park-and-ride structure and stair tower. In views to the north west, at a distance of over 100m, the station building, service building, and two storey park-and-ride structure would be visible in the middle ground of the view.

The character of this development is in keeping with the surrounding business uses and previous commercial uses on the site. During the construction of these buildings the project would be more visually prominent as the site itself would be surrounded by site hoarding and there would be heavy vehicle access. Overall, views from this area would experience a **negligible** visual impact during Stage 2 construction as there would be a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity. During operation there would be no perceived reduction or improvement in visual amenity and therefore a **negligible** visual impact.

It is likely that views from residential areas on the elevated land east of Brighton Drive would include the station building, service building, two storey park-and-ride structure, pedestrian bridge, and landscape works, seen in locations where views across the plains are currently possible. During the construction of these buildings the project would be more visually prominent as the site would be surrounded by hoarding. Overall, views from this area would experience a **negligible** visual impact during Stage 2 construction as there would be a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity. During operation there would be no perceived reduction or improvement in visual amenity and therefore a **negligible** visual impact.

Views from Business and Commercial Areas

There would be views directly down Lexington Drive toward the station building and facilities replacing views of the Homemaker Centre. Views from the office complexes in this vicinity would experience no perceived reduction or improvement in the visual amenity of views towards the site, from a location of neighbourhood visual sensitivity. This would result in **negligible** visual impact during both operation and Stage 2 construction.

Before and after views of the site from the corner of Celebration and Lexington Drives, are shown in **Figure 16.14** and **Figure 16.15**.

Figure 16.14 Bella Vista Station from the corner of Celebration and Lexington Drives – before development

Figure 16.15 Bella Vista Station from the corner of Celebration and Lexington Drives – after development (showing general scale and form of development only)

Views at Night

The visual setting of this area is considered to be an **E4: High district brightness area,** and generally includes lighting associated with Windsor Road, the Homemaker Centre, from surrounding office complexes, local roads and the illuminated windows of nearby residential properties. This setting includes sky glow caused by this highly urbanised area.

The project would result in the removal of the Homemaker Centre and its brightly lit car parking areas and buildings. The lighting associated with the project would be mainly within the site and associated with the station platform, station buildings, and car parking facilities. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected that as the change in visual amenity at night would be a noticeable improvement due to the removal of the brightly lit Homemaker Centre. Overall, there would be a **negligible** visual impact during operation and Stage 2 construction.

16.6 Visual Impacts, Bella Vista to Rouse Hill

16.6.1 Bella Vista Rail Corridor, Balmoral Road and Memorial Avenue

Visual Sensitivity

Most views in this area are considered to be of **neighbourhood** visual sensitivity as the site is surrounded by predominantly rural and residential areas. Old Windsor Road and adjoining shared pathway, T-way and T-way Station, however, are considered to be of **local** visual sensitivity.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Laying rail track.
- Erecting power lines on viaduct.

The following elements and activities are likely to be visible during operation:

- Rail line in cut travelling between Bella Vista and under Balmoral Road.
- Rail line emerging from cut between Balmoral Road and Memorial Avenue and rising into viaduct to approximately 15m above ground level.
- Trains would be seen running along the viaduct.

Views from Major Routes

Viewers on Old Windsor Road would experience a change in character where the railway corridor parallels the road. During construction there would be fit out works including the erection of the electricity lines and laying of tracks. During operation, trains would be visible elevated on viaduct above shared pedestrian networks and landscape areas. These would be seen in the middle ground of views across the roadway and the T-way, which is on grade in this area. There would be little vegetation remaining on the eastern side of Old Windsor Road to filter views to these trains, although proposed new landscape areas would mature over time and provide some filtering.

The project is visually compatible with the nearby road environment and T-way, due to its linear form and urban character. However, the development of the project would widen the overall transport corridor, visually connecting these uses into one broad infrastructure corridor as well as adding an elevated component. Overall, the project would result in a more urban and less leafy character. There is likely to be **minor adverse** visual impact on views from Old Windsor Road during operation and Stage 2 construction, as there would be a noticeable reduction in visual amenity from a location of local visual sensitivity.

Shared cycle and footpaths run along the east and west of Old Windsor Road. Pedestrians would appreciate views for a longer duration, whereas cyclists are moving more quickly past the site. Vegetation located between the T-way and the viaduct would be removed. The shared path on the western side of the road would include views to the site across Old Windsor Road. These viewers would experience a **minor adverse** visual impact, as there would be a noticeable reduction in the amenity of views from a location of local visual sensitivity during operation and Stage 2 construction. From the shared path to the east, running between Old Windsor Road and the T-way, there would be a considerable change in visual amenity, resulting in a **moderate adverse** visual impact during operation and Stage 2 construction.

From Balmoral Road visibility is influenced by a steep rise east from Old Windsor Road. In views directly adjacent to the alignment and, on the western slopes of the ridge, the site would be visible running across the view. Further to the east, visibility of the viaduct would reduce as landform and vegetation on adjacent properties intervene. Views would include the rail corridor in cut and passing under Balmoral Road. At surface level, shared pathways running parallel with the alignment and surface landscape works would visually integrate the works. In views from Balmoral Road it is expected that the visual impact would be **negligible** during both operation and Stage 2 construction due to the noticeable reduction in visual amenity from a location of neighbourhood sensitivity.

Views from Memorial Avenue would also be influenced by the steep rise from Old Windsor Road. In views directly adjacent, and on the west facing slopes of the ridge, the site would be visible. This includes the viaduct structure which would span Memorial Avenue and shared pathways and surface landscape works running underneath the viaduct structure. From beyond the ridgeline and further to the east, visibility of the site would reduce as landform and vegetation on adjacent properties intervene. These views would also include the intermittent passing of trains running along the viaduct. It is expected that due to the noticeable reduction in visual amenity, the visual impact would be **negligible** during both operation and Stage 2 construction from this location of neighbourhood visual sensitivity.

The character of views from the T-way and T-way station would change considerably as the rail corridor passes within close proximity. Views to the project would be limited where the corridor is in cut, although the loss of mature vegetation and rural residential properties would change the character to a less leafy character. As the corridor rises onto viaduct, views would include the viaduct rising to a height of nominally 15m. At the Memorial Road T-way Station the viaduct would run over the top of the existing on-grade car park. The intermittent passing of trains would be visible from the buses and station area.
The loss of vegetation would result in limited filtering and softening of views. New landscaped areas would create some visual relief and have a parkland character. Users of the T-way are therefore likely to experience a considerable reduction in the visual amenity of views from a location of local visual sensitivity, therefore resulting in a **moderate adverse** visual impact during operation and Stage 2 construction.

Views from Residential Areas

A townhouse development is located between Celebration Drive and Brighton Drive. To the north of this development, between Bella Vista Station and Balmoral Road is open rural residential land, with vegetation largely screening and filtering views to the site. During operation, views from this location would include the cleared corridor with railway line in cut, and crossing under Balmoral Road in the background of the view. Overall, views from this area would experience a **negligible** visual impact during both operation and Stage 2 construction as there would be a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity.

Rural and rural residential properties between Balmoral Road and Memorial Avenue which are in close proximity to the site would have views to the corridor rising from cut to an elevated viaduct structure. These views would be mainly obscured by landform and filtered through existing vegetation within these properties. These views would also include the intermittent passing of trains. From this location there would be a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity, and therefore there would be **negligible** visual impact during both operation and Stage 2 construction.

Residential properties in the vicinity of Arnold Avenue, to the east of the site, are located beyond Macarthur Creek at a distance of around 300m. The mature vegetation which runs along this creek creates a buffer that obscures and filters views to the site from this location. It is unlikely that the project would be visible from this residential area. Therefore, the views from this area would experience a **negligible** visual impact during operation and Stage 2 construction.

Residential properties west of Old Windsor Road, in Glenwood, may have some views to the viaduct structure, as the landform generally falls away from the site. If visible, the viaduct would be viewed over Old Windsor Road and the T-way, through roadside buffer planting and through intervening built form and vegetation. Due to the neighbourhood visual sensitivity of these views and noticeable reduction in visual amenity, it is considered that there would be a **negligible** visual impact to views from Glenwood during operation and Stage 2 construction.

Views from Commercial Areas

Commercial development located between Old Windsor Road and Almona Street in Glenwood, is located opposite and faces the viaduct structure. There would be views to the viaduct in the middle ground of the view, as well as passing trains during operation. The mature backdrop of trees would be

lost and parkland planting would be newly planted and less visually prominent. The views would be across Old Windsor Road, the T-way and filtered by intervening roadside vegetation. Due to the neighbourhood visual sensitivity of these views and noticeable reduction in visual amenity, there would be a negligible visual impact during operation and Stage 2 construction.

Views at Night

The visual setting of this area is considered to be an **E3: Medium district brightness area**, and generally includes lighting associated with Old Windsor Road, the T-way and car parking areas, commercial areas, illuminated windows of surrounding residential areas, and lit local roads. This setting includes sky glow caused by this urban setting.

It is not expected that the viaduct structure would be lit, however the illuminated windows of trains travelling would be visible above the surrounding landscape. Lighting during Stage 2 construction would be for security purposes only. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. Although it is expected that the change in visual amenity at night would be noticeable, due to the existing setting of moderate district brightness, there would be an overall **minor adverse** visual impact on views in this vicinity at night.

16.6.2 Memorial Avenue to Kellyville Station

Visual Sensitivity

Generally views in this area are considered to be of neighbourhood visual sensitivity as the site is surrounded by predominantly rural and residential areas. Old Windsor Road and the pathway running along Old Windsor Road, the T-way and T-way Station, however, are considered to be of local visual sensitivity as they are likely to attract more viewers.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 Construction:

- Laying rail track.
- Erecting power lines on viaduct.
- Construction of the Station building, Services buildings, ancillary buildings, viaduct, access roads and parking areas.
- Future development site between Samantha Riley Drive and the new access roads.
- Road works and construction of new signalised intersection where the new access road meets Samantha Riley Drive.
- Construction of new pedestrian bridge over Old Windsor Road.

The following elements and activities are likely to be visible during operation:

- Station entry building located under viaduct structure and station platform.
- Station platform located on viaduct structure approximately 18m high from entry level and running parallel with Old Windsor Road. Station platform 165m long starting from Samantha Riley Drive.
- Station services facility under viaduct structure.
- Signalised intersection where new access road meets Samantha Riley Drive.
- Pedestrian plaza underneath station platform and viaduct structure, extending along four lane access road and around to T-way.
- Pedestrian bridge over Old Windsor Road.
- Bus zones; kiss-and-ride, and taxi zones.
- Two storey, 390 space park-and-ride located in the south east corner of the site.
- On-grade park-and-ride located north and south of Samantha Riley Drive.
- Landscape buffer 10-20m wide between T-way and on-grade park-and-ride area.
- Streetscape planting along Samantha Riley Drive, access and link roads.
- Electricity lines above the viaduct to power trains.
- Trains moving along the viaduct.
- Vacant land (future development area).

Views from Major Routes

From Old Windsor Road viaduct and station would be visually dominant running parallel to the roadway, with an on-grade park-and-ride area, service building and potential precinct activation building (retail) under. Beyond this and partly obscured by the station would be a multi-storey park-and-ride structure in the background of the view. The viaduct would include overhead electricity lines and trains running along the viaduct. There would be little mature vegetation remaining on the eastern side of Old Windsor Road to filter views to the station, however some trees and buffer vegetation is proposed between the viaduct and T-way. This would only filter the lower portions of the station and lower level buildings.

As the landform slopes, the viaduct would stay at a consistent level across the landscape, resulting in a lower structure in the south, where proposed planting may filter views to the viaduct structure, whereas to the north and within the vicinity of the station, the level is lower, resulting in the viaduct sitting above intervening vegetation.

Overall, views from Windsor Road are likely to have a **moderate adverse** visual impact during operation and Stage 2 construction, as there would be a considerable reduction in visual amenity from a location of local visual sensitivity.

Before and after views of the site from the corner of Old Windsor Road at the intersection with Samantha Riley Drive, are shown in **Figure 16.16** and **Figure 16.17**.

Views from Samantha Riley Drive would change with views including the viaduct crossing over the roadway with overhead lines and moving trains. To the south of the Drive would be a plaza space with the station behind. The station precinct would be developed with on-grade parking adjacent to the T-way, service buildings and potential precinct activation building (retail) located within the precinct. In the background of the view would be a multi-storey park-and-ride structure, viewed across future development sites. It is expected that due to the neighbourhood visual sensitivity of these views, and considerable reduction in visual amenity, there would be a **minor adverse** visual impact during operation and Stage 2 construction, from vehicles using Samantha Riley Drive.

The character of views from the T-way and T-way station would change as the viaduct runs parallel to and in close proximity to the site. The T-way station would be maintained in its current location, with the viaduct overhead and Kellyville Station in the centre of views. Views would include the on-grade parking area, an urban plaza space surrounding the station, service building and potential precinct activation building (retail). In the background of views would be the multi-storey park-and-ride structure to the south east of the precinct.

During construction, the T-way station would continue to be used and the car parking relocated to a temporary location to the east of the station. During construction, due to the close proximity and extent of change to the entire precinct, users of the T-way are likely to experience a considerable reduction in visual amenity from a location of local visual sensitivity, therefore resulting in a **moderate adverse** visual impact.

During operation, it is considered that the character of the proposed station precinct is in keeping with the character of the T-way station but a noticeable change in scale. Therefore there would be a **minor adverse** visual impact.

Views from Public Open Space and Viewpoints

Views from the Newbury Avenue Parkland would include the viaduct running across the view, crossing Samantha Riley Drive, with overhead power lines and trains visible running along the viaduct. The station and lower levels of the site would not be visible due to the sloping landform of the park which falls away from the road. The viaduct would be visible in the mid to background of views, and viewed in the context of Old Windsor Road. Due to the local visual sensitivity of this location and noticeable reduction in visual amenity, there is expected to be a **minor adverse** visual impact on views from this parkland during operation and Stage 2 construction.

Figure 16.16 Kellyville Station from the corner of Old Windsor Road and Samantha Riley Drive – before development

Figure 16.17 Kellyville Station from the corner of Old Windsor Road and Samantha Riley Drive – after development (showing general form and scale of development only)

Views from Residential Areas

Residential properties in the vicinity of Arnold Avenue to the east of the site are located beyond Elizabeth Macarthur Creek. The vegetation associated with the creek creates a buffer that filters and obscures views to the site from this location. At a distance of around 300m and with intervening vegetation it is unlikely that the site would be visible from this residential area. These views would experience a **negligible** visual impact during operation and Stage 2 construction.

Residential areas east of Elizabeth Macarthur Creek and off Samantha Riley Drive, including Landy Place, would have views to the site heavily filtered by vegetation located along the creek. These views would include the multi-storey park-and-ride structure in the middle ground, and the station and viaduct viewed over the future development sites in the background. As existing views are to a T-way station, and there is considerable buffering and filtering, it is considered that there would be no perceived reduction or improvement in visual amenity. Therefore there would be a **negligible** visual impact from this location of neighbourhood visual sensitivity during operation and Stage 2 construction.

Residential properties west of Old Windsor Road, in Stanhope Gardens, may have some views to the project area as the landform is relatively flat. If visible, the project area would be viewed over Old Windsor Road, through roadside buffer planting and through intervening built form and vegetation. Due to the neighbourhood visual sensitivity of these views and noticeable reduction in visual amenity, it is considered that there would be a **negligible** visual impact during operation and Stage 2 construction.

Views at Night

The visual setting of this area is considered to be an **E3: Medium district brightness** area, and generally includes lighting associated with Windsor Road, the T-way and car parking areas, illuminated windows of surrounding residential areas, and lit local roads. This setting includes sky glow caused by this urban setting.

The project would result in the introduction of lit car parking areas, and moderately lit station buildings, as well as illuminated windows from the trains elevated and travelling along the viaduct. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected, however, that as the change in visual amenity at night would be considerable there would be a **moderate adverse** visual impact overall on views in this vicinity at night.

16.6.3 Samantha Riley Drive to Windsor Road and Old Windsor Road to White Hart Drive

Visual Sensitivity

Views in this area are considered to be of **local** and **neighbourhood** visual sensitivity as the study area includes main roads, high density residential and commercial land uses. Old Windsor Road is the most significant roadway and is heavily trafficked along its length. The pathway running along Old Windsor Road and the T-way are also considered to be of **local** visual sensitivity. Views from the lawn cemetery and crematorium are also considered to be of **local** visual sensitivity due to the nature of its use. Views from Mungerie House are considered to be of regional visual sensitivity as it is publicly accessible and well used heritage property, Note that a heritage impacts on Mungerie House are discussed in Section 11.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Laying rail track.
- Erecting power lines on viaduct.

The following elements and activities are likely to be visible during operation:

- Viaduct continues along Old Windsor Road and Windsor Road, sitting approximately 15m above ground (including power lines and poles).
- Electricity lines above the viaduct to power trains.
- Trains running along the viaduct.

Views from Major Routes

Viewers on Old Windsor Road, which transitions into Windsor Road, would experience a change in character as a result of the viaduct which parallels the roadway. During construction there would be some viaduct fit out works including the erection of the overhead power lines and tracks. During operation, this structure would be visually prominent, being elevated above the surrounding flat landscape and with moving trains visible. A cleared corridor would result in little planting remaining on the eastern side of the road to filter views. Views to the viaduct would be seen in the context of the roadway and T-way, which is on grade in this area.

The project is visually compatible with the nearby road environment and T-way, due to its linear form and urban character. The development of the project would widen the overall transport corridor, visually connecting these uses into one broad infrastructure corridor as well as adding an elevated component. From this location views are likely to have a **moderate adverse** visual impact during operation and Stage 2 construction, as there would be a considerable reduction in visual amenity from a location of local visual sensitivity.

Before and after views of the site from Windsor Road in the vicinity of the Merriville Street intersection and T-way stop, are shown in **Figure 16.18** and **Figure 16.19**.

The character of views from the T-way would change as views would include the viaduct overhead and its supporting structures. The Merriville T-way stop would sit alongside the viaduct and passengers waiting at this stop would experience change in visual character. Users of the T-way are therefore likely to

experience a noticeable reduction in the visual amenity of views from a location of local visual sensitivity resulting in a **minor adverse** visual impact during operation and Stage 2 construction.

Views from Public Open Space and Viewpoints

Views from the Newbury Avenue Parkland, and from parkland in the vicinity of Bentwood Terrace, would include the viaduct and supporting structures across the view, and would include intermittent train movements on the viaduct, travelling across the view. These elements would be visible in the mid to background of these views, and seen in the context of Old Windsor Road. Due to the local visual sensitivity of this location and a noticeable reduction in visual amenity, there would be a **minor adverse** impact on views during operation and Stage 2 construction.

Broad, panoramic views across the valley are available from Turkey Nest Recreation Park in Beaumont Hills. From this location, the viaduct would be seen in the background of the view, running from north to south across the view. At this distance, of approximately 1km, and viewed within the context of the Old Windsor and Windsor Roads, and the T-way, there would be no perceived reduction or improvement in the amenity of these views. Although this is a location of regional visual sensitivity, the visual impact is considered to be **negligible** during operation and Stage 2 construction.

Figure 16.18 Viaduct near Merriville T-way stop – before development

Figure 16.19 Viaduct near Merriville T-way stop – after development (showing general form and scale of development only)

Mungerie House is a small heritage listed cottage, including a visitor centre, and is set within attractive gardens. Although access to the house is now from the rear, it faces and is traditionally approached from Windsor Road. Some trees would be removed, however the remaining vegetation would provide filtered views to the viaduct and supporting structures. Intermittent train movements would be noticeable running across the view. The viaduct, although filtered by the intervening trees would be visually prominent. Due to the considerable reduction in visual amenity from a location of regional visual sensitivity, there would be a **high adverse** visual impact at this location during operation and Stage 2 construction.

Before and after views of the site from the front garden of Mungerie House, are shown in **Figure 16.20** and **Figure 16.21**.

Views from Residential Areas

Views to the viaduct from the residential areas between Old Windsor and Windsor Roads, to the east of the site and beyond the Macarthur Creek, would be filtered by creek side vegetation. From this location it is likely that there would not be a perceived reduction or improvement in visual amenity from a location of neighbourhood visual sensitivity. Views from this area would experience a **negligible** visual impact during operation and Stage 2 construction.

From some apartments between Kilbenny Street and Windsor Road, views would be elevated and therefore the viaduct would be viewed along much of its length. Due to the proximity and elevated angle of view there would be a considerable change in the amenity of views from this location of neighbourhood visual sensitivity, and therefore a **minor adverse** visual impact during operation and Stage 2 construction.

Residential properties in the vicinity of Sanctuary Drive would experience a range of views to the viaduct. From those areas directly adjacent to the alignment, and looking toward the intersection of Sanctuary Drive and Windsor Road, there would be a considerable visual change as the viaduct crosses the landscaped entry statement, and runs across the view. Further away from the alignment, vegetation and built form would filter and intervene, resulting in no perceived reduction or improvement in visual amenity. As this is an area of local visual sensitivity at

the entry, and neighbourhood visual sensitivity to the west, it is considered that there would be **moderate adverse** impact in the vicinity of the intersection, reducing to **negligible** visual impact as the distance increases. These impacts would be experienced during both operation and Stage 2 construction.

Residents of Beaumont Hills are afforded broad panoramic views across the western Cumberland Plain, with the Blue Mountains beyond. The viaduct may be visible from this location, running across the view in the background. However, it is considered that this would not result in a perceived reduction or improvement in the amenity of the view and therefore there would be a **negligible** visual impact during operation and Stage 2 construction.

The residential areas of Kellyville Ridge, a less prominent ridge than that of Beaumont Hills, have in some locations broad elevated views to the east across the viaduct and to Beaumont Hills beyond. It is expected that the viaduct would be visible running across the view, in the middle ground, but filtered by intervening vegetation and buildings. There would be no perceived reduction or improvement in the amenity of views from this location of neighbourhood visual sensitivity and therefore **negligible** visual impact during operation and Stage 2 construction.

Figure 16.20 Viaduct from Mungerie House – before development

Figure 16.21 Viaduct from Mungerie House – after development (showing general form and scale of development only)

Residential areas east of Elizabeth Macarthur Creek and off Samantha Riley Drive, would have views to the viaduct filtered and screened by vegetation located along the creek. Therefore it is unlikely that the viaduct would be visible for the majority of its length. There would be no perceived reduction or improvement in visual amenity from this location of neighbourhood visual sensitivity, resulting in a **negligible** visual impact during operation and Stage 2 construction.

Residential properties west of Old Windsor Road, in Stanhope Gardens, may have some views to the viaduct, as the landform is relatively flat. If visible, the viaduct would be viewed over Old Windsor Road and through intervening built form and vegetation. Due to the neighbourhood visual sensitivity of these views and noticeable reduction in visual amenity, there would be a **negligible** visual impact to views from Stanhope Gardens during operation and Stage 2 construction.

Views from Commercial Areas and Community Facilities

The viaduct would be visible from the John XXIII Catholic School and Church, at a distance of between 100m and 400m. The site is elevated, and has views across the plains to the east, with some intervening vegetation, built form and boundary fences. Views would include the viaduct and supporting structures with intermittent train movement across the view. The viaduct would be viewed in the context of Old Windsor Road and the T-way both being visible in the middle ground. Due to the local visual sensitivity of these views, and considerable reduction in their amenity, it is expected that there would be a **moderate adverse** visual impact from the Church and school during operation and Stage 2 construction.

The Merriville Road commercial area including the 'Ettamogah Pub' would include views toward the site as the viaduct travels across the view. Intermittent train movements running along the viaduct would also be visible. The viaduct would be in the foreground of the view. Views from this location are considered to be of neighbourhood visual sensitivity, and there would be a considerable reduction in the amenity of this view, thus visual impact is expected to be **minor adverse** during operation and Stage 2 construction.

The viaduct would be visible in views from the Lawn Cemetery and Crematorium. Due to the elevated location of the cemetery, the site would be visible in the middle to background, within broad panoramic views. This view is characterised by an urbanised landscape with the Rouse Hill Town Centre and emerging residential communities comprising much of the panorama. The viaduct would run across the view creating a noticeable reduction to the amenity of this viewpoint from a location of local visual sensitivity, thus resulting in a **minor adverse** visual impact during operation and Stage 2 construction.

Views at night

The visual setting of this area is considered to be an **E3: Medium district brightness** area, and generally includes lighting associated with Windsor Road, the T-way, commercial areas, illuminated windows of surrounding residential areas, and lit local roads. This setting includes sky glow caused by this urban setting.

The viaduct would not be lit at night; however lit windows from moving trains would be visible moving along the viaduct. As a result, it is expected that there would be no perceived reduction or improvement in visual amenity, resulting in a **negligible** visual impact.

16.6.4 Rouse Hill Station

Visual Sensitivity

Views from surrounding residential areas are generally considered to be of **neighbourhood** visual sensitivity as the study area includes mainly local roads, rural and residential properties in an area undergoing changes to a more dense urban residential development form. Windsor Road is the most significant roadway and is considered to be **local** sensitivity. Views from the Lawn Cemetery and Crematorium are also considered to be of **local** visual sensitivity due to the nature of the land use. Rouse Hill House and Farm, located at a distance of approximately 2.1km from the site, is considered to be of regional visual sensitivity and would therefore be considered in this assessment despite its distance from the site.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Laying rail track.
- Erecting power lines on viaduct.
- Construction of Station building, Services buildings, ancillary buildings, viaduct, access roads and shade structures.
- Construction of landscape works along Windsor Road.

The following elements and activities are likely to be visible during operation:

- Station entry building located under viaduct structure and station platform.
- Station platform located on viaduct structure approximately 18m high from entry level and running parallel with Windsor Road. Station platform 165m long.
- Station services facility under viaduct structure adjacent to White Hart Drive.
- Realignment of Tempus Street around pedestrian plaza space and existing community garden.
- Pedestrian plaza underneath station platform and viaduct structure, extending across T-way and along Tempus Street.
- Pedestrian bridge over Old Windsor Road.
- Bus zones as part of T-way configuration, Bus shelters at T-way station, kiss-and-ride, and taxi zones along Tempus Street.
- Landscape buffer 5-10m wide between T-way and Windsor Road.

Views from Major Routes

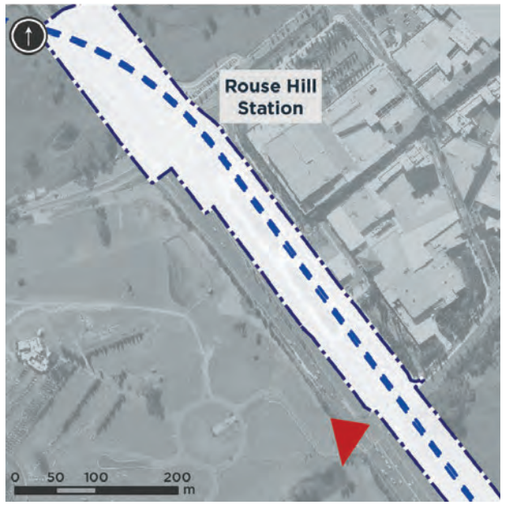
In views from Windsor Road, travelling north and south the Rouse Hill Shopping Centre is visually prominent set behind a narrow landscape area. From this location views would be changed as the viaduct and station would be visible between the town centre and roadway, aligned generally parallel with Windsor Road. The Station building and viaduct would partially screen views to the Town Centre and be visually prominent in the view with the T-way visible under the structure.

Views of the Station plaza spaces, service buildings and lower areas of the viaduct would be filtered by roadside planting. Trains would be visible moving across the viaduct. The visual prominence of the Town Centre would be reduced from this approach. The elevated and large scale of the station and viaduct in this area would not contrast with the existing town centre buildings in terms of form and scale. There would be a **minor adverse** impact on views from Windsor Road due to a noticeable reduction in the visual amenity from a location of local visual sensitivity. This impact would be experienced during both operation and Stage 2 construction.

Before and after views of the site from Windsor Road at the entry to the Lawn Cemetery and Crematorium, are shown in **Figure 16.22** and **Figure 16.23**.

Figure 16.22 Rouse Hill Station from Windsor Road – before development

Figure 16.23 Rouse Hill Station from Windsor Road – after development (showing general form and scale of development only)



There would be a change in the visual character for vehicles travelling along Rouse Hill Drive and White Hart Drive, as the viaduct crosses over these two roadways. Rouse Hill Drive and White Hart Drive are local access roads that extend around Rouse Hill Town Centre and form part of its approach. Therefore, views to the viaduct structure would only be seen when approaching Windsor Road. The viaduct, station platform, station building, services building, potential precinct activation building and shelter structures would be seen from these local access roads from the signalised intersections on Windsor Road. The trains would also be visible for short durations as they arrive and depart from the station. From Rouse Hill Drive and White Hart Drive there is likely to be a **negligible** impact during operation and Stage 2 construction due to there being a noticeable reduction in visual amenity from a location of neighbourhood visual sensitivity.

Views from Public Open Space and Viewpoints

Views from the Lawn Cemetery and Crematorium would include the site, due to the elevated and open nature of this location. It is likely that the station building, service building, station platform and viaduct would be visible, with some vegetation along Windsor Road providing filtering to the lower portions of the new infrastructure. The viaduct would be seen running across the view, influencing a considerable portion of the panorama. The trains would also be visible moving across the view as they arrive and depart from Rouse Hill Station. These elements would be viewed in the middle ground at a distance of approximately 200m. This view is characterised by an urbanised landscape with the Rouse Hill Town Centre and emerging residential communities comprising much of the panorama. Due to the local sensitivity of this location and noticeable reduction in the amenity of these views there would be a **minor adverse** visual impact during operation and Stage 2 construction.

The Rouse Hill House and Farm is a Historic Houses Trust property. The setting of the house and grounds, and views from this elevated site, are an important value of the property. In particular, views from the house are oriented west toward the Blue Mountains; however, the design of the gardens orients viewers to the south and towards the proposed project alignment at a distance of 2.1km. Views from Rouse Hill House and Farm do not currently include the Rouse Hill Town Centre, which is largely due to intervening vegetation and landform. The Rouse Hill Station is also unlikely to be visible. It is expected that there would be a **negligible** visual impact to views from Rouse Hill House and Farm due to no perceived reduction or improvement in a view of regional visual sensitivity during operation and Stage 2 construction.

Views from Residential Areas

To the south east of the site between White Hart Drive and Sanctuary Drive, on land sloping toward the former Kellyville Golf Course and the Outlook Nature Reserve, a residential community is progressively being developed. The Rouse Hill Station and associated buildings could be somewhat visible from this area, however, intervening vegetation and buildings within the Rouse Hill Town Centre would result in no perceived change in the visual amenity of the view. As these views are of neighbourhood sensitivity, there is likely to be an overall **negligible** visual impact during operation and Stage 2 construction.

Views from the Rouse Hill Town Centre and other Commercial Areas

Rouse Hill Town Centre is located directly to the east of the alignment. Public spaces including a shaded gathering plaza and community garden would be located directly adjacent to the site, whilst the east west running main streets would have views terminating at the site. Views from these areas would include the station building, plazas service building, potential precinct activation building, and viaduct. Rouse Hill Station and the viaduct would sit above the existing T-way. It is considered that this change would be in character with the town centre and therefore a noticeable improvement in visual amenity from a location of local visual sensitivity. Overall, this would result in a **minor beneficial** impact on views from Rouse Hill Town Centre during operation and Stage 2 construction.

Views at Night

The visual setting of this area is considered to be an **E4: High district brightness area**, and generally includes lighting associated with Windsor Road, Rouse Hill Town Centre, from surrounding commercial complexes, local roads and the illuminated windows of nearby residential properties. This setting includes sky glow caused by this highly urbanised area.

The lighting associated with the project would be mainly within the site and associated train movements. Lighting on the site would be directed and use cut-off fittings therefore limiting any perceptible contribution to localised skyglow effects, as well as limiting any light trespass onto neighbouring properties. It is expected that there would be no perceived reduction or improvement in visual amenity at night, due to the high volume of lighting in this highly urbanised area. Therefore there would be a **negligible** visual impact.

16.7 Visual Impacts, Rouse Hill to Tallawong Road

16.7.1 Windsor Road Viaduct to Cudgegong Road

Visual Sensitivity

Views from surrounding residential areas are generally considered to be of **neighbourhood** visual sensitivity as the study area includes mainly local roads, rural residential properties in an area undergoing change to a more dense urban residential development form. Schofield Road is the main connector road through this area, and once the Second Ponds residential development is complete, this road would be heavily trafficked and is therefore considered to be of **local** sensitivity. Views from the Castlebrook Cemetery and Crematorium are considered to be of **local** sensitivity due to the nature of the activity, elevated location, landscape character and openness of the aspect. Views from Rouse Hill House and Farm are considered to be of **regional** level visual sensitivity, due to the significant historic value of this estate, elevated location and landscape character.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Laying rail track.
- Erecting power lines on viaduct.
- Construction of viaduct crossover where Schofields Road meets Windsor Road.
- Construction of viaduct and rail on-grade alignment running parallel with Schofields Road, set back approximately 200m.
- Construction of service road.

The following elements and activities are likely to be visible during operation:

- Viaduct crossover where Schofields Road meets Windsor Road.
- Cut and fill batters between Windsor Road and Cudgegong Road.
- Service Road off Schofields Road.
- Viaduct over Second Ponds Creek.
- Revegetation of alignment corridor.
- Electricity lines above the viaduct and on-grade alignment to power trains.
- Trains moving along the viaduct.

Views from Major Routes

In views from Windsor Road, travelling north and south, the viaduct would cross overhead on the viaduct and then decline from this location to return to grade, running away from the view and parallel to Schofields Road. Therefore, views would include the viaduct structure and moving trains at an elevated location. It is expected that there would be a **moderate adverse** impact to views from Windsor Road due to a considerable reduction in visual amenity of a view from a location of local visual sensitivity during operation and Stage 2 construction.

There would be a change in the visual character for vehicles travelling along Rouse Hill Drive at the intersection with Windsor Road as the viaduct crosses over and above this intersection. Views to the viaduct structure would only be seen when approaching Windsor Road. The viaduct would be seen approaching and crossing the view at an angle, with trains visible moving along the viaduct. From Rouse Hill Drive there is likely to be a **minor adverse** impact on visual amenity during operation and Stage 2 construction, due to there being a considerable reduction in visual amenity from a location of neighbourhood visual sensitivity.

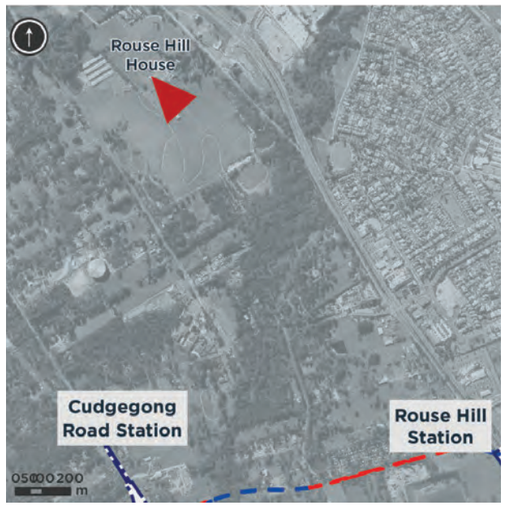
In most views from Schofields Road it is unlikely that the project would be visible as the alignment runs approximately 200m to the north and existing intervening vegetation is expected to filter and obscure views to the project. From Schofields Road there is likely to be a **negligible** impact on visual amenity during operation and Stage 2 construction due to no perceived reduction or improvement in visual amenity from a location of local visual sensitivity.

Views from Public Open Space and Viewpoints

Views from the Lawn Cemetery and Crematorium would include the site, due to the elevated and open nature of this location. It is likely that the viaduct crossing Windsor Road, and some cut and fill batters would be visible as the alignment parallels Schofields Road. The trains would also be visible for short durations as they travel along the viaduct crossing Windsor Road. These elements would be viewed in the middle ground of the view at a distance of approximately 200m, and within a mixed visual context of rural and natural landscapes, as well as the densely developed Rouse Hill Town Centre. Due to the local visual sensitivity of this location and noticeable reduction in the amenity of these views there would be a **minor adverse** visual impact.

Rouse Hill House and Farm is situated on an elevated site approximately 1.9 kilometres north of the intersection of Schofields Road and Windsor Road. It has been established that views from Rouse Hill House and Farm do not currently include this intersection. This is largely due to intervening local landform and vegetation. It is possible however, that the viaduct crossover and alignment may be visible filtered through intervening vegetation, due to the levels and height of the structure and landform. It is also possible that the removal of vegetation along this alignment may be visible as the upper canopy of this vegetation is visible. During construction, it is possible that the construction machinery required to erect the viaduct crossover would be seen from parts of the property, as cranes and other tall equipment protrude above surrounding vegetation. Any visible elements are however likely to form an extremely small part of the overall view, given the distance between Rouse Hill House and the proposal. Due to there being no perceived change in the amenity of these views, it is expected that there would be a **negligible** visual impact on views from Rouse Hill House and Farm during operation and Stage 2 construction. **Figure 16.24** shows the effect of intervening terrain and vegetation on views from the grounds of Rouse Hill House. In this figure, elements of the project that are potentially visible based on terrain only ae shown in yellow, while those that would be obscured by terrain are shown in blue. Of note is that the majority of the yellow coloured elements would be obscured by intervening vegetation.

Figure 16.24 View from the grounds of Rouse Hill House



Views from Commercial Areas

The historic Mean Fiddler pub is located to the north of the site on Windsor Road. Views to the site would be limited from this location; however the viaduct crossing Windsor Road may be visible from the footpath on Windsor Road in the vicinity of the pub. There would be a noticeable reduction in the amenity of views from a location of local visual sensitivity, and therefore there would be a **minor adverse** visual impact during operation and Stage 2 construction.

Views from Residential Areas

The project alignment runs through an area of mainly rural residential development to the north of Schofield Road. A denser cluster of residential properties are located off Terry Road, on Corral Drive, Harold Road, Graham Drive, Roger Boulevard and Newport Drive. The proposed alignment is located approximately 20m from these properties, is located in cut, and would require the removal of existing vegetation. During construction, properties would have views to the viaduct over Second Ponds Creek and earthworks associated with the alignment. During operation, there may be filtered views to the alignment and viaduct through existing vegetation within these properties and new vegetation within landscape areas would further filter views. Trains may also be visible from these properties. Overall, it is considered that there would be a **minor adverse** visual impact due to the noticeable reduction in visual amenity from a location of neighbourhood sensitivity. This impact would be experienced during operation and Stage 2 construction.

Views at Night

The visual setting of this area is considered to be an **E4: High district brightness area**, in the vicinity of Windsor Road, as it includes lighting associated with Windsor Road, Rouse Hill Town Centre, from surrounding commercial complexes, local roads and the illuminated windows of nearby residential properties. This setting includes sky glow caused by this highly urbanised area. In the areas north of Schofields Road the visual setting is considered to be **E2: Low district brightness area**, as it includes mainly lighting associated with rural residential properties and local roads.

The lighting associated with the project would be mainly generated by train movements. It is expected that there would be no perceived reduction or improvement in visual amenity at night, due to the limited amount of lighting likely to be visible. Therefore there would be a **negligible** visual impact.

16.7.2 Cudgegong Road Station

Visual Sensitivity

Views from surrounding residential areas are generally considered to be of **neighbourhood visual sensitivity** as the study area includes mainly local roads and rural residential properties in an area undergoing change to a more dense urban residential character.

Visible Components of the Proposal

The following elements and activities are likely to be visible during Stage 2 construction:

- Laying rail track.
- Erecting power lines on viaduct.
- Construction of bridges and retaining structures where the alignment crosses Cudgegong and Tallawong Roads.
- Construction of station building and platforms.
- Construction of on-grade park-and-ride areas.
- Clearing of vegetation within the project boundary.

The following elements and activities are likely to be visible during operation:

- Station building is 6m high at entry level and sits in 8m cut, with plaza space at ground level.
- Station services building and precinct activation building adjacent to station building approximately 6m high.
- New two-lane south spine road extending from Cudgegong Road through to Tallawong Road; two-lane north spine road extending from Cudgegong Road, over the rail alignment and connecting to south spine road; and two-lane access road extending from south spine road to on-grade park-and-ride areas.
- Bus and taxi zones, and kiss-and-ride along north spine road.
- 1010 on-grade park-and-ride spaces provided south of south spine road.
- Streetscape planting along Cudgegong Road, Tallawong Road and the access roads.
- Signalised intersection where south spine road meets Cudgegong and Tallawong Roads.
- New bridge over rail alignment with 3m high safety screens on Cudgegong and Tallawong Roads.
- Future development area.

Views from Major Routes

Schofields Road runs roughly parallel to the alignment of the station and there would be views glimpsed through existing properties toward the site. In the foreground, views would include upgraded intersections with Cudgegong and Tallawong Roads which would be realigned. In the middle to background, on-grade car parking areas and internal access roads, pedestrian and road bridges would be visible.

The station buildings would be visible set back approximately 200m from Schofields Road and within an area of cut. Intervening landform and proposed landscape and buffer planting areas would filter views to the project. It is expected that views from Schofields Road would experience **minor adverse** visual impact during operation and Stage 2 construction due to the local sensitivity of the route and noticeable reduction in visual amenity.

Views from Cudgegong Road would be altered as the road is realigned so that it runs to the west of the current alignment. Views would include the upgraded roadway, rising to a bridge that crosses the rail alignment which is in cut in this location. The Railway corridor would run generally across the view, and to the west. Cudgegong Road Station would be in the middle ground of the view, with the pedestrian plaza and upper levels visible, filtered by roadside planting along the new south spine road.

Overall the station would be 'nestled' into the landform and proposed planting would filter views. It is expected that views from Cudgegong Road would experience a **minor adverse** visual impact during operation and Stage 2 construction due to the considerable reduction in visual amenity from a location of neighbourhood visual sensitivity.

Views from Tallawong Road would be altered as the road is realigned so that it runs to the west of the current alignment. Views would include the upgraded roadway rising to a bridge that crosses over the rail alignment which would sit in cut at this location. The railway corridor would run generally across the view in cut. To the east of the road would be large on-grade car parking areas, filtered somewhat by roadside vegetation.

From the new Tallawong Road bridge, elevated and open views west over the stabling facility would be seen. Views east along the rail corridor would include the rail line and moving trains located in cut, and with open and direct views along the tracks to the station in the middle to background of views. There would be a **minor adverse** visual impact during operation and Stage 2 construction due to the considerable reduction in visual amenity from a location of neighbourhood visual sensitivity.

Views from Public Open Space and Viewpoints

Rouse Hill House and Farm is situated on an elevated site approximately 1.6km from Schofields Road in this location. Views from Rouse Hill House and Farm do not currently include Schofields Road, largely due to intervening landform and vegetation. It is unlikely that Cudgegong Road Station would be visible from this location, therefore it is expected that there would be a **negligible** visual impact on views from Rouse Hill House and Farm during operation and Stage 2 construction.

Views from Residential Areas

In this area the project alignment runs through an area of mainly rural residential development. A number of residential properties on Cudgegong, Terry and Schofields Roads may have views to the NWRL filtered through surrounding vegetation. These views would change according to the proximity to the station, with those closest to the site potentially experiencing a considerable reduction in amenity and those further from the site experiencing a noticeable reduction in amenity. Therefore, from a location of neighbourhood sensitivity, there would be a **negligible** to **minor adverse** visual impact during operation and Stage 2 construction.

Some 100-250m to the south of the site and Schofields Road is The Ponds residential development. This development sits on low lying land in the north and then rises in the southeast toward Kellyville Ridge. Elevated areas would have views to the upgraded intersections of Cudgegong and Tallawong Roads on Schofields Road. These elements would be visible in the middle ground of views. There would be a **negligible** visual impact during operation and Stage 2 construction, as there would be no perceived reduction or improvement to a view of neighbourhood sensitivity.

Views at Night

The visual setting of this area is considered to be an **E2: Low district brightness** area, and generally includes lighting associated with local streets and illuminated windows of surrounding rural residential properties.

The station building, car parking areas and new local streets would introduce additional light into an area with existing low level light sources from rural properties and filtered by rural landscapes and vegetation. During operation, there would be a considerable increase in lighting including lighting associated with the station building and platforms, service facility, car parking areas and pedestrian connections to and from these areas. It is expected that the change in visual amenity at night would result in a **moderate adverse** visual impact during operation and Stage 2 construction, due to the noticeable reduction in visual amenity.

16.7.3 Tallawong Stabling Facility

Visual Sensitivity

Generally, views in this area are considered to be of **local** and **neighbourhood** visual sensitivity as the study area includes mainly local roads, rural residential and residential land uses.

Visible Components of the Proposal

The following elements and activities are likely to be visible:

- Workshop and depot building 10m high located towards the south west corner of the site, on the corner of Schofields and new access roads.
- Bulk supply and adjacent building 8m high located approximately 50m north of Schofields Rd.
- New access road extending from Tallawong Road to the workshop, depot, bulk supply and adjacent building.
- On-grade car parking spaces provided adjacent to the workshop, depot, bulk supply and adjacent building.
- Future development site located in the south west corner of the site, situated on the corner of Schofields and Tallawong Roads.
- 5m fill embankment in the south west corner of the site and extending up along the new access road.
- Maintenance access road extending from Tallawong Road in the north eastern corner of the site, running west along the stabling yard and finishing at the workshop / depot building.
- Perimeter fencing surrounding the site

During evening hours the site would be sufficiently lit to allow for safe use of the stabling yards at night. This would include lighting of the; stabling yard buildings, car parking areas, and main pedestrian routes to and from these facilities.

Views from Major Routes

Schofields Road runs parallel to the Tallawong Stabling Facility and forms the southern boundary of the site. During construction, views from this location would include site hoarding and the upper portions of the shed construction. During operation, the existing rural residential properties and roadside vegetation would be replaced with large scale sheds. The largest of these buildings is approximately 10m high and 230m long. Views to the site would be filtered through proposed roadside vegetation and buildings set back approximately 50m from the road. However, these sheds are located on embankments, rising to up to five metres above the adjacent road level, and increasing the visibility and prominence of these structures. There would be a **high adverse** visual impact to views from this location due to a considerable reduction in visual amenity from a location of local visual sensitivity.

Views from Residential Areas

To the north, the site is surrounded by rural residential properties located at varying distances from the site. There would be a number of residential properties on Tallawong Road, in the vicinity of the intersection with Macquarie Road, which may have views to the site. Views from these properties would include the stabling yards seen through perimeter security fencing. The large shed buildings located adjacent to Schofields Road would be visible beyond the stabling yard. Along the northern edge of the site, the stabling yards would be in cut, screening some lower parts of the yard.

The surrounding landscape is also located on gently undulating terrain, which may also reduce the visibility of the site from more distant locations. However, the scale of the yards with sheds seen beyond, would be visually dominant within the landscape and contrast with the character of the surrounding landscape.

During construction, this site would be surrounded by hoarding and construction vehicles would be seen using Tallawong Road. From these locations there are likely to be **minor adverse** impacts, due to a considerable reduction in visual amenity from locations of neighbourhood visual sensitivity.

Approximately 100m to the southeast of the site is The Ponds residential community. This development sits on low lying land in the north and then rises in the southeast toward Kellyville Ridge. The site is likely to be visible from both low lying and elevated areas of this development. During construction, the lower lying areas of The Ponds community would view hoarding, additional traffic on Schofields Road, site clearing and construction activities which rise above the hoarding. Views to these elements would be filtered through intervening vegetation and built form.

During operation, these views would include elevated sheds and trains stabled beyond. These elements would be visible in the middle ground and would have a scale and character in contrast to the surrounding residential and rural residential context. Intervening built form and vegetation in the foreground, may provide some filtering of these views. From this location there would be a **negligible** visual impact during operation and Stage 2 construction, due to the noticeable reduction in the amenity of a view from a location of neighbourhood sensitivity.

During construction, areas of The Ponds residential community on elevated land would view hoarding, additional traffic on Schofields Road; and construction activities seen beyond the site boundary due to this elevated vantage point. During operation, these views would include elevated sheds and trains stabled beyond. These elements would be visible in the background and would have a scale and character in contrast to the surrounding residential and rural residential context. The distance (approximately 1.5-2km) from the site would somewhat diminish the scale of the site in the view. From this location there would be a **negligible** visual impact during operation and Stage 2 construction, due to the noticeable reduction in the amenity of a view from a location of neighbourhood sensitivity.

Views at night

The visual setting of this area is considered to be an **E2: Low district brightness** area, and generally includes lighting associated with local streets and illuminated windows of surrounding rural residential properties.

The project would introduce additional light into an area visually dominated by a relatively dark landscape. During operation and Stage 2 construction, the project would require lighting for security purposes. Lighting would be directed and use cut-off fittings, limiting light trespass onto neighbouring properties. However, due to the amount of lighting required for this large facility, it is likely to increase localised skyglow effects. It is expected that the change in visual amenity at night would result in a **moderate adverse** visual impact, due to the noticeable reduction in visual amenity.

Summary of Visual Effects

The following table summarises the range of visual impacts identified from each site location.

Table 16.6 Summary of Visual Effects

	Visual Impact During Stage 2 Construction	Visual Impact During Operation	Visual Impact at Night
Epping Services	Negligible to Moderate Adverse	Negligible to Moderate Adverse	Negligible
Cheltenham Services	Negligible to Moderate Adverse	Negligible to Minor Adverse	Minor Adverse
Cherrybrook Station	Negligible to Minor Adverse	Negligible to Moderate Adverse	Minor Adverse to Moderate Adverse
Castle Hill Station	Minor Adverse to Moderate Adverse	Minor Adverse to Moderate Adverse	Minor Adverse
Showground Station	Minor Adverse to High Adverse	Minor Adverse to High Adverse	Moderate Adverse
Norwest Station	Negligible to Minor Adverse	Negligible to Minor Adverse	Negligible to Minor Adverse
Bella Vista Station	Negligible to Minor Adverse	Negligible to Minor Adverse	Negligible
Balmoral Road & Memorial Ave	Negligible to Moderate Adverse	Negligible to Moderate Adverse	Minor Adverse
Memorial Avenue to Kellyville Station	Negligible to Moderate Adverse	Negligible to Moderate Adverse	Moderate Adverse
Samantha Riley Drive to Windsor Road & Old Windsor Road to White Hart Drive	Negligible to High Adverse	Negligible to High Adverse	Negligible
Rouse Hill Station	Negligible to Minor Adverse	Minor Beneficial to Minor Adverse	Negligible
Windsor Road Viaduct to Cudgegong Road	Negligible to Minor Adverse	Negligible to Minor Adverse	Negligible
Cudgegong Road Station	Negligible to Moderate Adverse	Negligible to Moderate Adverse	Moderate Adverse
Tallawong Stabling Yard	Negligible to High Adverse	Negligible to High Adverse	Moderate Adverse

16.8 Mitigation measures

16.8.1 Operation

An Operational Environmental Management Plan (OEMP) will be developed detailing the processes to manage environmental impacts during the operation of the project.

Mitigation measures in **Table 16.7** have been developed to avoid, reduce and manage identified potential operational impacts.

Table 16.7 Mitigation measures Operation

No.	Mitigation Measures	
OpV1	High quality landscape and urban treatments would be used in and around stations.	Stations.
OpV2	Cut–off and directed lighting would be used to ensure glare and light spill on surrounding existing and future residents are minimised.	All
OpV3	The colour and materials of service facility buildings would be selected to blend into adjacent bushland setting.	Service facilities
OpV4	Landform would be used to conceal buildings where reasonable and feasible	Stations and service facilities
OpV5	Street tree planting would be used to visually soften roads and car parking areas.	All
OpV6	Large specimen trees would be incorporated into the plaza at Castle Hill to create an immediate softening effect.	Castle Hill Station.
OpV7	The viaduct between Rouse Hill and Cudgegong Station would be treated to maximise visual integration with surrounding landscape in views from Rouse Hill House. This may include the use of dark colours, landform mounding and buffer planting.	Viaduct
OpV8	Where noise walls are proposed, potential visual impacts would be reduced through high quality urban design treatments developed in consultation with adjacent property owners.	All
OpV9	Earth mounding would be used as appropriate to improve the effectiveness of buffer planting areas where space permits and as appropriate, particularly where significant vegetation would be lost.	All
OpV10	The design and ongoing maintenance of the project would adopt CPTED principles, including the maintenance of unobstructed views into and outside of underpasses, effective drainage and ventilation, wide corridors and appropriate lighting.	All

16.8.2 Construction

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 16.8**.

Table 16.8 Mitigation measures Construction

No.	Mitigation measure	Applicable sites*
V1	Existing vegetation around the perimeter of the construction sites would be retained where feasible and reasonable to act as a visual screen.	1 – 17
V2	Cut-off and directed lighting would be used to ensure glare and light trespass are minimised.	1 – 17
V3	Where feasible and reasonable the elements within construction sites would be located to minimise visual impact, eg setting particular equipment/ structures back from the site boundaries to minimise their visual impact.	1 – 17
V4	Regular maintenance of site hoarding and perimeter site areas would be undertaken, including the prompt removal of graffiti.	1 – 17
V5	Visual mitigation would be implemented as soon as feasible and reasonable, and remain for the duration of the construction period.	1 – 17
V6	Monitoring of the effectiveness of mitigation measures would be undertaken by the relevant construction contractor. This would primarily include regular visual inspection of the condition of the various measures.	1 – 17
V7	The colour and materials of acoustic sheds at selected sites would be selected to blend into adjacent bushland or rural setting.	1 – 4 and 8
V8	The design of acoustic sheds as visual features would be considered where there is limited opportunity to make them recede.	5 and 8
V9	Designing hoarding as a feature would be considered at appropriate locations. This may include artworks or project information. These would be installed as early as feasible and reasonable in the construction process.	1, 4, 6 – 8 and 14
V10	Hoardings would be designed to visually recede in more rural or bushland settings.	3 – 5, 9 – 13 and 15 – 17

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 17

CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS

17 CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS

17.1 Introduction

Greenhouse gases (GHGs), such as carbon dioxide, are emitted into the Earth's atmosphere as a result of natural processes (eg forest fires) and human activities (eg burning of fossil fuels to generate electricity). GHGs absorb and re-radiate heat from the sun.

Since the industrial revolution there has been an increase in the amount of GHGs emitted which has increased the concentration of GHG emissions in the atmosphere. This has led to an increase in the Earth's average temperature (surface temperature) and has caused climate change (or global warming) to occur.

The recent State of the Climate 2012 report (CSIRO and Bureau of Meteorology, 2012) confirms the long term warming trend over Australia's land and oceans, showing that in Australia, each decade has been warmer than the previous since the 1950s. Other observed trends include an increase in record hot days, a decrease in record cold days, ocean warming, sea-level rise and increases in global GHG concentrations. Due to long lag times associated with climate processes and feedbacks, even if GHG emissions are significantly reduced the warming trend will continue for centuries (Intergovernmental Panel on Climate Change (IPCC), 2007).

The predicted future effects of climate change for the environment and for human life are numerous and varied. The main effect is an increasing global average temperature. From this flow a variety of resulting impacts, such as rising sea levels, increased extreme weather and extreme weather events.

With strong evidence from scientists and government in relation to climate change and its likely impacts on infrastructure, it is no longer prudent to manage infrastructure on the basis of past climatic conditions. Climate change is now widely accepted as being a tangible risk to infrastructure. The two key responses to climate change are:

- Climate change adaptation
- Adapting to the physical impacts (for example more frequent and longer heatwaves) of climate change
- Climate change mitigation
- Reducing the amount of GHG emissions emitted into the atmosphere.

This chapter is structured into two sections relating to climate change adaptation (the climate change risk assessment) and climate change mitigation (the GHG assessment).

17.2 Director-General's Requirements, Conditions of Approval and Statement of Commitment

Table 17.1 sets out the Director General's Requirements (DGRs), Conditions of Approval (CoA) and Statement of Commitments (SoC) that relate to climate change and/or GHG emissions and where in the EIS these have been addressed. The DGRs for EIS 2 do not include specific climate change or GHG related requirements. Unless otherwise stated, references are to chapters of EIS 2 in relation to the construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL project.

Table 17.1 Conditions of Approval and Statement of Commitments

DGRs SSIA 2 Reference	Description	Addressed
None	N/A	N/A
DGR SSIA 1 Reference	**Description**	**Addressed**
Air Quality and Emissions	A Scope 1 greenhouse gas assessment (as defined by the Greenhouse Gas Protocol).	EIS 1 Chapter 17 EIS 2 Chapter 17
CoA Reference	**Description**	**Addressed**
-	CoA require compliance with DGRs and SoC	N/A
SoC Reference	**Description**	**Addressed**
1	Core sustainability principles would be developed for the design and construction of the project covering the following themes: ▪ Energy ▪ Greenhouse emissions ▪ Water ▪ Community and stakeholder involvement ▪ Biodiversity ▪ Resource recycling/minimisation To develop the principles a benchmarking exercise would be undertaken to enable sustainability goals and objectives to be determined, which would provide clear result areas and targets under each theme	EIS 2 Chapter 4

17.3 Climate Change Risk Assessment

Risks to the project associated with climate change need to be understood and mitigated where necessary, to avoid impacts on customers, service reliability, safety, and project capital and operating costs. To adapt to climate change, it is necessary to understand how our climate is changing and identify the risks associated with the change.

The climate change risk assessment identifies those areas of the construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL project that may be most at risk from potential changes, and proposes mitigation measures (adaptation options) that could be implemented to respond to these challenges.

Climate change resilience is a key objective of the project's sustainability strategy which has been used to guide the project planning, implementation and design. In accordance with the NWRL *Environment and Sustainability Policy and Sustainability Strategy* a climate change risk assessment of the direct and indirect risks associated with the project has been completed. This section provides summary information on the climate change context, methodology and results of the climate change risk assessment which was undertaken. Climate change adaptation options which can be implemented to reduce the consequences or likelihood of the risks identified have also been developed and are presented in Sections 17.3.4 and 17.3.5.

The objectives of the risk assessment were to:

- Identify the potential impacts of climate change on the project
- Assess the level of climate related risks for the project
- Identify climate change risks adaptation measures.
- Legislative and Policy Context

An increasing number of legislative and policy mechanisms include considerations and requirements relating to climate change. The following provides a summary of these legislative and policy mechanisms:

The NWRL Environment and Sustainability Policy includes an objective to *'Be resilient to climate change impacts'*.

The Draft NSW Long Term Transport Master Plan (September 2012) promotes the need to ensure that transport infrastructure is *'… able to withstand the predicted impacts of a changing climate'*.

The NSW State Plan (NSW 2021) includes a target (number 28) to *'Ensure NSW is ready to deal with major emergencies and natural disasters'*.

17.3.1 Methodology

The risk assessment was conducted in accordance with:

- The risk management approach set out in AS/NZS ISO 31000:2009 Risk management – Principles and guidelines and ISO/IEC 31010:2009 Risk management – Risk assessment techniques. Both build upon AS/NZ 4360:2004 Risk management and its application to climate change risks.
- The DRAFT Australian Standard (DR AS 5334) Climate change adaptation for settlements and infrastructure.

An initial climate change risk assessment on the NWRL project was undertaken by TfNSW focused on project design. This climate change risk assessment developed for the stations, rail infrastructure and systems addresses planning, construction and operational risks.

It should be noted that a climate change risk assessment relating to the major civil construction works stage of the project has been undertaken as a separate task which informed EIS 1.

The following key steps were undertaken to complete the risk assessment:

a. Determine the climate change context – undertaken in accordance with DR AS 5334:
   i. Define the GHG emissions scenarios.
   ii. Define future time slices.
   iii. Define the climate variables.
   iv. Selection of climate data.
   v. Determine other associated impact studies required (including flood modelling).
   vi. Obtain past meteorological record.
b. Identify the climate risks and assess the likelihood and consequence of each risk.
c. Identify adaptation responses.

Scientists have modelled the climate system and projected climatic changes likely to occur under various future GHG emissions scenarios. GHG emission scenarios represent estimations of future quantities of GHGs that may be released into the atmosphere. They are based on assumptions about future demographics and the implementation and efficiency of energy policies.

The scenarios which were used in the risk assessment are A1B (moderate emissions) and A1FI (high emissions) as set out in the Special Report on Emissions Scenarios (SRES) of the IPCC (2007). It should be noted that the observed global temperature, GHG emissions and sea level rise recorded since 1990 are currently tracking the high emissions A1FI scenario. A description of the A1B and A1FI scenarios is provided in **Table 17.2** below.

Table 17.2 Description of Special Report on Emission Scenarios (SRES) Scenarios

SRES Scenario	Description of Scenario	
A1FI	Rapid economic growth, a global population that peaks mid 21st century and rapid introduction of new technologies	Intensive reliance on fossil fuel energy resources
A1B		Balance across all energy sources

Due to the expected design life of assets such as tunnels, bridges and drainage infrastructure (60 to 100 years), the time periods which were selected for the assessment are 2030 and 2070. Climate change projections for 2050 and 2100 have also been used where information was available. The climate models used to project future climate conditions are not an effective tool to determine near term changes such as within the next 10 years (during the expected construction period). The use of observed climate change over the past 30 years versus the long term average (past 100 years) provides a better representation of the change in climate that has already occurred and is expected to continue over the next 10 years.

The climatic variables identified as potentially generating risks for NWRL are annual average rainfall, extreme rainfall, drought, extreme temperature, extreme wind, storms (cyclones, hail, dust & lightning), groundwater, ground stability and fire danger index.

An initial screening of climate sensitivity of the project was undertaken which indicated that changes to sea level rise, storm surge, annual average temperature, evaporation, humidity, solar radiation and average wind speed are likely to have minimal impact to the NWRL and therefore were excluded from the assessment.

17.3.2 Observed and Future Climate

The Australian climate is likely to experience a greater frequency and severity of extreme weather events due to climate change. As a result, it is especially important to understand the 'most likely' and 'worst case' implications of climate change on high-value infrastructure in major Australian cities such as Sydney. According to CSIRO research, the Sydney area is likely to become warmer, with more hot days and fewer cold nights. Detailed projections are presented below, and can be summarised as follows:

By 2030 – approximately 0.9°C (0.6 – 1.3°C range) increase in temperature, with increasing frequency of hot days and warm nights. Average rainfall may range from a 9% decrease to a 3% increase, with increased likelihood and intensity of extreme rainfall.

By 2070 – approximately 3.0°C (2.1 – 4.3°C range) increase in temperature, with increasing frequency of hot days and warm nights. Winter and spring rainfall patterns may range from a 25% decrease to a 10% increase, with increased likelihood and intensity of extreme rainfall.

By 2100 – up to 6.4°C increase in temperature, with increasing frequency of hot days and warm nights. Winter and spring rainfall patterns to vary widely, with increased likelihood and intensity of extreme rainfall.

Table 17.3 and **Table 17.4** ummarises temperature, rainfall and extreme events climate change projections for 2030 and 2070, the two dates most commonly used as reference points. Some of the temperature projections apply to CSIRO projections for Richmond, as these are the most relevant climate projections available for the project area. This is a limitation for this climate assessment as the eastern portion of the rail alignment (i.e. Epping) has a different temperature range to Richmond.

Table 17.3 Climate change projections for Western Sydney – temperature, rainfall and extreme events

Variable	Average Long Term	Units	2030 (A1B)	2070 (A1FI)
Maximum temperature days	14.6	average days over 35°C per year	18.4 (15.7 – 21.2)	34.9 (19.1 – 52.8)
	2.1	average days over 40°C per year	3.2 (2.4 – 4.1)	8 (3.0 – 14.3)
Maximum temperature heatwaves	1.2	times per year 35°C exceeded for 3 to 5 successive days	1.6 (1.3 – 1.9)	4.7 (1.6 – 8.2)
	0.1	times per year 40°C exceeded for 3 to 5 successive days	0.1 (0.1 – 0.1)	0.6 (0.1 – 1.2)
Rainfall – average annual	1094mm	% change	-3% (-9 to +3%)	-8% (-25 to +10%)
Extreme rainfall (indicative change in 40 year 1 day rainfall total)		% change 40 year – 1 day	+5% (-3% to +12%)	+2% (-7% to +10%)
Rainfall – intensity		100 year– 2 hr % change	-10% (-15% to +5%)	+10% (+5% to +15%)
Rainfall – intensity		5 year– 2 hr % change	0% (-5% to +5%)	+10% (+5% to +15%)

The climate change projections for hail, for 2050 are summarised in **Table 17.4**.

Table 17.4 Hail climate change projections for Sydney

Hail Size	Average recurrence intervals of hail storm events	
	Long Term Average	Projected Change (2050*)
4cm hail or greater	1.4 years	1.2 years
6cm hail or greater	8 years	5 years
8cm hail or greater	28 years	19 years
10cm hail or greater	51 years	28 years

Note: * Based on 2050 medium emissions scenario (relative to 1991).

The climate change projections for additional climate variables – cyclone and fire risk include:

- Cyclone frequency is projected to decrease, however the intensity is projected to increase and there will be greater southern migration of cyclones.
- The number of fire risk days is projected to increase from 9 (long term average) to 9-11 fire days in 2020 and 10-15 fire days in 2050.

17.3.3 Impacts

For the scope of the construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL, a range of climate change risks were identified. The risks identified were rated as either low, medium, high and extreme. The appropriate risk rating level was determined by:

- Determining the consequences of each risk occurring
- Determining the likelihood of each risk occurring
- Considering the existing controls expected to be applied through design and construction
- Determining the risk rating (residual risk)

In summary, the climate risk assessment process undertaken for the year 2030 identified:

- No *extreme* risks (also referred to as an 'unacceptable' risk).
- No *high* risks (also referred to as an 'undesirable' risk).
- Fifteen *medium* risk ratings (also referred to as a 'tolerable' risk).
- One *low* risk (also referred to as an 'acceptable' risk).

In summary, the climate risk assessment process undertaken for the year 2070 identified:

- No extreme risks.
- One high risk.
- Fifteen medium risk ratings.
- No *low* risks.

The risks identified are summarised in **Table 17.5**.

Table 17.5 Climate risks for NWRL Stations, Rail Infrastructure and Systems for 2030 and 2070.

Risk Title	Risk Description	Residual Risk Rating for year 2030	Residual Risk Rating for year 2070
Risks relating to temperature increases			
Track buckling	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to rail track movement/cracking/ buckling.	Medium (tolerable)	Medium (tolerable)
Impacts on thermal comfort of passengers	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to increased difficulty (incl. maintenance) to adequately ventilate and cool stations and tunnels impacting customers comfort.	Medium (tolerable)	Medium (tolerable)

Risk Title	Risk Description	Residual Risk Rating for year 2030	Residual Risk Rating for year 2070
Increased ventilation and cooling cost	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to increased cost (incl. maintenance) to ventilate and cool stations, trains and tunnels.	Medium (tolerable)	Medium (tolerable)
Air conditioning units on trains failing	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to increased failure of air conditioning equipment on trains resulting in reduced rolling stock capacity and impacting customer health. By 2070 the number of high temperature days and duration of heat wave events would be significant and increases the potential for fatalities due to heat stress.	Medium (tolerable)	High (undesirable)
Air conditioning of critical equipment failing	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to increased failure of air conditioning equipment on critical communications and control equipment resulting in reduced network capacity and increasing potential for major safety incidents.	Medium (tolerable)	Medium (tolerable)
Interruptions to mains power	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to more frequent interruptions to mains power supply.	Medium (tolerable)	Medium (tolerable)
Failure of signalling and communication equipment and reduced functionality of electrical systems	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to failure of signalling and communication equipment and reduced functionality of electrical systems.	Medium (tolerable)	Medium (tolerable)
Heat-related sag in overhead powerlines	Increased frequency, severity and duration of extreme temperatures (days exceeding 35 °C) leading to heat-related sag in overhead powerlines potentially causing loss of power and reduced network capacity.	Medium (tolerable)	Medium (tolerable)

Risk Title	Risk Description	Residual Risk Rating for year 2030	Residual Risk Rating for year 2070
Risks relating to increased rainfall intensity			
Ground stability issues, risk of landslides and embankment / slope failure	Climate change causes increased frequency and severity of extreme rainfall events leading to flooding or saturation of embankments and ground conditions.	Medium (tolerable)	Medium (tolerable)
Extreme rainfall causing malfunctioning of power supplies and communications.	Increased frequency and severity of extreme rainfall events leading to more frequent malfunctioning of power supplies, communications and associated circuitry. Impacts on radio signal propagation.	Medium (tolerable)	Medium (tolerable)
Extreme rainfall causing flooding of rail infrastructure and stations	Increased extreme rainfall in 2030 is acceptable however extreme rainfall by 2070 has the potential interrupt service and cause damage to infrastructure and stations.	Low (acceptable)	Medium (tolerable)
Risks associated with reduced annual rainfall			
Soil movements and cracking of embankments and tunnel walls	Reductions in average annual rainfall leading to cracking and movement of concrete trackform and failure of embankments.	Medium (tolerable)	Medium (tolerable)
Risks associated with increased storms, hail and wind			
Storm, hail and wind causing damage to exposed infrastructure (structural, electrical and communications) and customers	Increased frequency and severity of extreme storm, hail and wind events leading to debris, fallen trees and branches impacting infrastructure (structural, electrical and communications) and customers.	Medium (tolerable)	Medium (tolerable)
Storm, hail and wind impacts to train services	Increased frequency and severity of extreme storm, hail and wind events leading to operational service disruptions and delays.	Medium (tolerable)	Medium (tolerable)
Risks relating to increased frequency of bushfire			
Bushfire damage to aboveground infrastructure, health and safety impacts on customers	Increased frequency, severity and duration of bushfires damaging aboveground infrastructure and generating health and safety impacts on customers.	Medium (tolerable)	Medium (tolerable)
Other risks			
Increased solar radiation leading to accelerated degradation of external materials	Increased annual average UV radiation leading to accelerated degradation of external materials on station entrances at surface.	Medium (tolerable)	Medium (tolerable)

The changing climatic conditions would likely impact the region and broader infrastructure networks having implications for the operation of NWRL. These climatic risks include:

- Extended loss of mains power supply to rail network beyond capacity of emergency back-up power generation.
- Extended interruption to road access impacting bus and car connection to NWRL stations and transit catchment.
- Extended interruption to rail network connecting to the NWRL.
- Restricted water supply to NWRL sites due to extended drought conditions.

These risks could be generated by large scale type events impacting Greater Sydney or several states stemming from:

- Bushfire.
- Flood (extreme rainfall).
- Storm (hail, dust, wind).
- Drought.
- Heatwaves.

17.3.4 Adaptation Responses

Typical adaptation to respond to the climate risks associated with the Stations, Rail Infrastructure and Systems are outlined in **Table 17.6**. Both design and operational procedures are important in responding to climate risks, which are subject to review and optimisation by a future operator. TfNSW would be responsible for adaptation responses.

Table 17.6 Typical Adaptation Responses

Risk Title	Adaptation Responses
Track buckling	RailCorp Engineering Standard Track (ESC200) specifies a rail temperature range from –10°C to 75°C and a neutral temperature of 35°C. This correlates to an operating air temperature range of -10°C to 45°C. Much of the track is within tunnels, so protected from extreme temperatures. The exposed area is limited to the viaduct and at-grade sections. Tracks in exposed areas would have concrete sleepers which are less vulnerable to heat-related movement. Derailment protection is included in the viaduct design. Rail track movement would be controlled by undertaking annual pre-summer reviews to identify areas requiring special monitoring or maintenance and developing maintenance strategies. Heat patrols would be conducted to inspect track on very hot days. The areas most vulnerable to heat related impacts (e.g. crossovers in open cut sections) would be the subject of regular inspection and maintenance. Speed management may be implemented on very hot days (i.e. over 43 °C for track with concrete sleepers).
Impacts on thermal comfort of passengers	Use of vegetation in the station precinct would help combat the urban heat island effect, and contribute passive cooling in the station precinct. Station canopy design would also consider protection of passengers from extreme weather effects beyond high temperature days such as extreme rainfall, wind etc.
Increased ventilation and cooling cost	Use of water cooled A/C systems for staff air conditioned spaces at stations and stabling to offer increased adaptive capacity. Designing tunnel ventilation systems and equipment for optimum energy efficiency across the range of temperatures predicted for the system's design life.
Air conditioning units on trains failing **Air conditioning of critical equipment failing** **Interruptions to mains power**	The complete NWRL electrical system is designed around diversity and redundancy, and emergency backup provision is a feature of the circuit design across all voltages. Future rolling stock with air conditioning units to adequately handle increased higher temperature and duration events would be specified in the procurement of new rolling stock particularly in response to this high risk in 2070. Redundant power supplies are designed to cater for the full system capacity. As an additional redundancy measure, batteries and Uninterruptable Power Supplies are included to provide sufficient time to divert power supplies and co-ordinate emergency responses. Maintenance inspection cycle would identify equipment which is not performing efficiently or is becoming degraded. All critical electrical equipment would be protected in evaporatively-cooled conditions (and double-skinned). Substation equipment would typically be designed to work in ambient temperatures up to 50°C.

Risk Title	Adaptation Responses
Failure of signalling and communication equipment and reduced functionality of electrical systems	All signalling power rooms, signalling and communications equipment rooms would be air conditioned (either rooms within stations or tunnel or trackside in air conditioned brick buildings). Trackside, signalling equipment would be protected in signalling cases (double skinned with a roof and natural ventilation). Outdoor equipment (cameras, speakers, phones) would be designed to operate in hot conditions. Communications equipment in substations would not be ventilated, but would be designed to work in hot conditions.
Heat-related sag in overhead powerlines	Overhead wiring designs would be designed for ambient temperatures up to 60oC. A normal maintenance cycle would identify any potential accelerated degradation of overhead wires, which could be addressed if and when it occurs.
Ground stability issues, risk of landslides and embankment / slope failure	Embankments and slopes would be investigated at the detailed design stage to take account of climate change – related increases in rainfall intensity. A regular inspection cycle would identify potential issues relating to instability. Further detailed design, would take account of extreme weather events and 'worst-case scenario' risks for geotechnical elements.
Extreme rainfall causing malfunctioning of power supplies and traction problems	Electrical cabling may be buried underground and / or within conduits / troughing to reduce vulnerability. Cables would be well protected, insulated and have fail-safe mechanisms built in to ensure no safety issues. The electrical circuitry has been designed to operate autonomously, such that one failure would not mean the failure of entire systems. If track circuits fail, they will fail safe. The signalling distances being used for NWRL are very conservative to account for the worst possible adhesion conditions (which is appropriate to account for wet rail after heavy rain). Routine inspections of cable routes would be undertaken to identify and rectify flooded cable conduits to minimise the likelihood of water-related malfunction. Radio systems would be designed with a rain fade margin that is sufficiently conservative to cope with projected increased rainfall intensity.
Soil movements and cracking of embankments and tunnel walls	Potential risks of seasonal variations may require remedial measures at some locations. This would be specified to be addressed in the detailed design.

Risk Title	Adaptation Responses
Extreme rainfall causing flooding of rail infrastructure and stations	Adopted design flood levels are to include an appropriate allowance for increased rainfall intensities due to climate change in accordance with current best practice and NSW Floodplain Risk Management Guideline – Practical Considerations of Climate Change: ▪ Generally the rail infrastructure, including track, stabling yard, underside of viaduct and bridges, above ground stations, substations and other facilities are designed based on a 100 year average recurrence interval (ARI) event (i.e. a flood which will occur once every 100 years), plus an additional 10% increase in rainfall intensity to provide a nominal allowance for potential impacts due to climate change. The 10% margin reflects industry good practice. ▪ The levels for tunnel portals and entries have been set based on a probable maximum flood (PMF) risk to safeguard them and prevent risk of catastrophic failure. This is the absolute worst case scenario and therefore accounts for any additional climate change impacts. ▪ Drainage of 'at grade' track sections, bridges and viaducts is designed to a 50 year ARI storm event, including a 10% increase in rainfall intensity to account for climate change.
Storm damage to exposed infrastructure (structural, electrical and communications) and customers	Weather protection has been included in concept design of station precincts. Appropriate setback for trees and other vegetation would ensure vegetative debris would not disrupt services, whilst maintaining visual aesthetics and soil stability. The wind loading of each structural element, including station canopies, would be evaluated at the detailed design stage and extreme weather events considered. Areas of shelter would be provided in the station precincts (e.g. bus shelters) to provide additional protection to customers from extreme weather.
Impacts on rolling stock on the viaduct	Derailment protection would be included in the design of the viaduct.
Bushfire damage to aboveground infrastructure, health and safety impacts on customers	Project assets directly exposed to bushfire risk are minimised as much of the project is underground. More vulnerable areas are near Cherrybrook Station (Cumberland State Forest), and viaduct sections, elevated stations and the stabling yard. Buildings and structures would be designed to be fire resistant in accordance with standards.
Increased solar radiation leading to accelerated degradation of external materials	Resilience to degradation associated with solar radiation would be considered in materials selection.

17.3.5 Climate Change Risk Assessment Conclusions

In 2070 the increase in high temperature days and duration of heatwaves is projected to be significant. As a result in 2070 air conditioning failure due to heat waves impacting health is rated as a *high* risk ('unacceptable'). The adaptive response to this risk would be future rolling stock with air conditioning units capable of adequately handling the increased higher temperature and duration events. The rolling stock air conditioning requirements would be specified in the procurement of new rolling stock/upgrade of rolling stock (however it should be noted that this requirement would not be needed for some time).

In 2030 and 2070 there are 15 *medium* rated ('tolerable') climate change risks related to the NWRL stations, rail infrastructure and systems that should be addressed in the design, construction and operation of the project. Each stage in the project should consider the most up to date climate change projections and design guidelines such as new climate change projections for Greater Sydney region being released by the NSW Office of Environment and Heritage in late 2012. The climate risks require ongoing review and response by designers and constructors.

The flood risks to infrastructure should also be reviewed even though this is currently considered to have a *low* (acceptable) residual risk at 2030 and a *medium* ('tolerable') residual risk at 2070. The current controls/adaptation responses use an additional +10% increase in rainfall intensity to provide a nominal allowance for potential impacts due to climate change. However, given the climate projections for this region of Sydney, this allowance may require review beyond 2030.

17.4 Greenhouse Gas Assessment

GHG emissions are reported as tonnes of carbon dioxide equivalent (tCO_2-e) and categorised into three different scopes (either scope 1, 2 or 3) in accordance with the Greenhouse Gas Protocol (WRI & WBCSD 2004), IPCC and Australian Government GHG accounting/classification systems.

Emissions are categorised into three different scopes to help delineate between direct emissions from sources that are owned or controlled by a project and upstream indirect emissions that are a consequence of project activities but occur at sources owned or controlled by another entity. The three GHG scopes include:

- Scope 1 emissions, also called "direct emissions". These emissions are generated directly by a project, eg emissions generated by the use of diesel fuel by construction plant/ equipment.
- Scope 2 emissions, also referred to as "indirect emissions". Scope 2 emissions are generated outside of a project's boundaries to provide energy to the project, eg the use of purchased electricity from the grid.
- Scope 3 emissions, are all indirect emissions (not included in scope 2) due to upstream or downstream activities. For example indirect upstream emissions associated with the extraction, production and transport of purchased construction materials.

The objectives of the GHG assessment were to:

- Identify the sources of GHG emissions associated with construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL.
- Quantify the GHG emissions associated with each GHG source.
- Present the Scope 1, 2 and 3 GHG emissions.
- Identify opportunities (mitigation measures) which may be implemented to reduce the GHG emissions associated with construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL.

17.4.1 Legislative and Policy Context

An increasing number of legislative and policy mechanisms include considerations and requirements relating to reducing GHG emissions including the NWRL Environment and Sustainability Policy (refer to section 4.3). The following provides a summary of these legislative and policy mechanisms:

- The TfNSW Corporate Plan 2012-2017 (Connections, 2012) promotes the need to ensure that the transport system *'…meets present social and economic needs without compromising the quality of life for future generations. An important part of this is minimising the impact of transport on our natural environment now and into the future.'* The Plan also places a strong emphasis on energy management and the need to respond to climate change.
- The NSW Government's Sustainability Policy sets targets to improve the efficiency of the NSW public sector's use of water, energy and transport. The policy includes a target for Agencies to continue to purchase a minimum of 6% GreenPower, with the exception of Area Health Services. The policy also commits NSW Government agencies to become carbon neutral by 2020.
- The Federal Government has committed to reducing GHG emissions and the Clean Energy Plan (Securing a clean energy future: the Australian Government's climate change plan, 2011) includes the following targets:
  - 5% emission reduction from 2000 levels by 2020, irrespective of commitments made by other countries.
  - 15% or 25% emission reduction from 2000 levels by 2020, if commitments are made by other countries.
  - 80% emission reduction from 2000 levels by 2050.
- The Carbon Price Mechanism (CPM) set out in the Clean Energy Act 2011 is the central national climate change mitigation instrument which puts a price on scope 1 GHG emissions and provides a financial incentive for reducing GHG emissions.
- The CPM is underpinned by the National Greenhouse and Energy Reporting Act 2007 (NGER). NGER is the national framework for reporting and disseminating information on GHG emissions, energy use and energy production associated with the activities of Australian corporations.
- The Energy Efficiency Opportunities Act 2006 (EEO Act) requires users (corporations or corporate groups) of more than 0.5 petajoules of energy per year to assess their energy use, identify cost-effective energy efficiency opportunities, and report publicly on the outcomes.

17.5 Methodology

The assessment was conducted according to the general principles outlined in:

- The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition), World Resources Institute (WRI) and World Business Council for Sustainable Business Development (WBCSD) (2004).
- National Greenhouse Accounts (NGA) Factors, Australian Department of Climate Change and Energy Efficiency (2012).
- IPCC Guidelines for National Greenhouse Gas Inventories (2006).

To calculate the GHG emissions associated with the project, the following four steps were undertaken:

1. GHGs relevant to construction of the NWRL stations, rail infrastructure and systems and operation of the NWRL were identified.
2. The GHG assessment boundary was determined.
3. The emission sources / reduction sinks were classified according to scope and quantified.
4. The quantity of GHG emissions was calculated.

The GHG assessment boundary defines the scope of GHG emissions and activities included in the GHG assessment. The principle of relevance is an important consideration in development of the boundary. This relates to selection of an appropriate boundary that considers (WRI & WBCSD 2004):

- The intended use of the GHG assessment results
- The needs of decision makers
- The project activities that generate GHG emissions
- Project operational boundaries relating to the project activities that incur GHG emissions.
- The GHG emission sources which were included in the assessment boundary and their relevant GHG scope are listed in **Table 17.7**.

Table 17.7 GHG Assessment Boundary – Stations, Rail Infrastructure and Systems

Project Stage	Emission Source	Activity	Emission Scope		
			1	2	3
Construction of stations, rail infrastructure and systems	Fuel – used for transport purposes	Transport of construction equipment to site			•
		Transport of materials to/from site			•
		Staff travel to and from construction site in project owned/operated site vehicles	•		•
	Fuel – used onsite	Operation of site vehicles for moving people and materials around site	•		•
		Operation of mobile construction equipment	•		•
		Operation of stationary construction equipment	•		•
	Electricity - used onsite	For powering site infrastructure including office complexes, lighting, stores, water treatment plants, gantry cranes, workshops, compressors, sundry pumps, lifts and hoists		•	•
	Materials	Train manufacture and delivery			•
	Materials	Use of construction materials			•
Maintenance	Fuel – used onsite	Track maintenance activities	•		
	Materials	Use of materials			•
	Electricity – used on site	For powering train maintenance activities		•	•
	Waste	Created and disposed associated with train maintenance			•
Operation	Electricity	For powering train traction, stations, the stabling yard, tunnels (lighting and ventilation) and services facilities		•	•
	Sulphur Hexafluoride gas (SF6)	SF6 gas losses from Gas Insulated Switchgear and Ring Main Unit Switchgear within substations	•		
	Hydrofluorocarbon (HFC)	HFC gas losses from air conditioning systems in the rolling stock and stations	•		

The potential avoided GHG emission associated with passenger mode shift, from private car use onto rail, have also been included in the GHG assessment. These avoided GHG emission would be Scope 3 emissions.

Direct scope 1 GHG emissions are generated directly by the project, by an emission source or activity owned or operated by the project. The project is considered to have operational control over a GHG emission source or activity if that emission source or activity is subject to the full authority of project introduced and implemented operational (such as health and safety) policies (WRI & WBCSD 2004). It is assumed that project would have operational control of the following sources of GHG emissions (ie scope 1 GHG emissions):

- Operation of project owned/operated site vehicles for moving people and materials (including staff travel)
- Operation of stationary and mobile construction equipment
- SF6 gas losses from Gas Insulated Switchgear and Ring Main Unit Switchgear within substations.
- HFC gas losses from air conditioning systems in the rolling stock and stations.

The following lists emission sources and sinks which have been excluded from the GHG inventory boundary and provides a brief explanation why:

- Fuel used by construction workers travelling to/from the site in privately owned vehicles or by public transport – the GHG emissions associated with workers travelling to/from site would be a small percentage of the total project emissions. The project has limited operational control of how workers travel to/from site.
- Emissions associated with the transport, placement and decomposition of construction waste – In accordance with the TCA GHG Inventory Guide for Construction Projects (2010), construction waste emissions are considered negligible as this waste is inert and does not decompose in a landfill and generate GHG emissions (specifically methane). It is assumed that the green waste would not be disposed of to landfill and decompose in anaerobic conditions.

- Emissions associated with the international freight of rolling stock, as at this stage of the project, it is not known where the rolling stock would be sourced from.
- Emissions associated with providing power supply to the construction sites. High voltage power supply would be required to be supplied to a number of the construction sites in order to facilitate the construction of the NWRL. NWRL Principal Contractors would determine final power supply sources and routes to the construction sites.
- Emissions sinks associated with vegetation planted as part of the biodiversity offset strategy. The ecological offset is a requirement of State and Commonwealth legislation and therefore does not meet the additionality requirements of the Carbon Credits (Carbon Farming Initiative) (CFI) Act 2011 and cannot be counted as a carbon offset. To earn carbon credits under the CFI Act 2011, abatement must be additional to what is required to be carried out by or under a law of the Commonwealth, a State or a Territory (CFI Act 2011 Division 6 Part 41(1b)).

17.5.1 Impacts

It is estimated that construction of the NWRL stations, rail infrastructure and systems would generate approximately (note all numbers have been rounded up):

- 260,180 tCO_2-e of direct scope 1 GHG emissions;
- 50,360 tCO_2-e of indirect scope 2 GHG emissions; and
- 339,523 tCO_2-e of indirect upstream scope 3 GHG emissions
- 650,063 tCO_2-e of total scope 1, 2 and 3 GHG emissions.

It is estimated that at the commencement of operations (year 2021), annual operation and maintenance of the NWRL project would generate approximately (note all numbers have been rounded up):

- 1,172 tCO_2e of direct scope 1 GHG emissions;
- 51,509 tCO_2e of indirect scope 2 GHG emissions; and
- 11,857 tCO_2e of indirect upstream/downstream scope 3 GHG emissions
- 64,538 tCO_2-e of total scope 1, 2 and 3 GHG emissions.

To put the project's emissions in context, Australia's national GHG emissions for the year to March 2012 totalled 546.8 million tCO_2e (DCCEE, *Quarterly Update of Australia's National Greenhouse Gas Inventory: March Quarter 2012,* 2012). The electricity sector accounted for 35% of Australia's national inventory, for the year to March 2012, contributing 193.1 million tCO_2e, from the generation of electricity by the combustion of fuels, mainly coal and natural gas. The use of electricity by electric rail is included in this electricity sector GHG emission estimate. The latest available estimates of annual GHG emissions for Australia's States and Territories (DCCEE, *Australia's National Greenhouse Gas Accounts: State and Territory Greenhouse Gas Inventories, 2009-10,* April 2012) show the annual NSW State GHG emissions to total 152.5 million tCO_2e.

The estimated GHG emissions associated with each of the key emission sources generated by the construction of the NWRL stations, rail infrastructure and systems and annual operation and maintenance of the NWRL are given in **Table 17.8** and **Table 17.9** respectively.

Table 17.8 Estimated GHG Emissions - Construction of the NWRL Stations, Rail Infrastructure and Systems

Emission Source/Activity	GHG Emissions: Scopes (t CO_2-e)			Total	% of Total Emissions
	1	2	3		
Fuel use - transport of construction equipment	38.6	0.0	2.9	41.5	0.0
Fuel use – on site operation of project owned/operated site vehicles	1,316.2	0.0	99.9	1,416.1	0.2
Fuel use - Staff commute in site vehicles	500.2	0.0	38.0	538.2	0.1
Fuel use - mobile construction equipment	193,816.3	0.0	14,714.6	208,530.9	32.1
Fuel use - stationary construction equipment	64,508.7	0.0	4,919.4	69,428.1	10.7
Electricity - site infrastructure	0.0	50,360.2	10,300.9	60,661.1	9.3
Materials and Energy - train manufacturing and delivery	0.0	0.0	15,109.2	15,109.2	2.3
Materials - steel	0.0	0.0	130,298.0	130,298.0	20.0
Materials - concrete	0.0	0.0	164,040.0	164,040.0	25.2
Total	260,180.0	50,360.2	339,522.9	650,063.1	
% Total	40	8	52		

Table 17.9 Estimated GHG Emissions - Annual Operational and Maintenance (at 2021)

Emission Source/Activity	GHG Emissions: Scopes (t CO2-e)			Total	% Total Emissions
	1	2	3		
Energy – track maintenance activities	81.4	0.0	0.0	81.4	0.13
Maintenance materials EIS2 infrastructure elements - concrete	0.0	0.0	164.0	164.0	0.25
Maintenance materials EIS2 infrastructure elements - steel	0.0	0.0	260.6	260.6	0.40
Maintenance materials EIS1 infrastructure elements - concrete	0.0	0.0	248.9	248.9	0.39
Maintenance materials EIS1 infrastructure elements - steel	0.0	0.0	119.1	119.1	0.18
Materials - train maintenance	0.0	0.0	30.9	30.9	0.05
Electricity - train maintenance	0.0	4,994.7	1,021.6	6,016.3	9.32
Waste - train maintenance	0.0	0.0	497.9	497.9	0.77
Electricity – traction, stations, the stabling yard, tunnels and services facilities	0.0	46,514.3	9,514.3	56,028.6	86.81
SF6 losses	41.4	0.0	0.0	41.4	0.06
HFC Losses (R410C)	788.0	0.0	0.0	788.0	1.22
HFC Losses (R410A)	223.4	0.0	0.0	223.4	0.35
HFC Losses (R134A)	37.6	0.0	0.0	37.6	0.06
Total	1,171.8	51,509.0	11,857.3	64,538.1	100
% Total	1.8	79.8	18.4		

The figures in **Table 17.8** and **Table 17.9** are estimates based on the current design and may change as the detailed design of the NWRL project progresses. Hence the estimated GHG emissions and reductions results provided are an estimate only, and subject to the accuracy of the estimated electricity use, construction material / resource quantities and current project design stage and all other project assumptions.

The electricity used to power the trains, stations and their supporting infrastructure (including maintenance) represents the greatest source of total (scope 1, 2 and 3) operational GHG emissions.

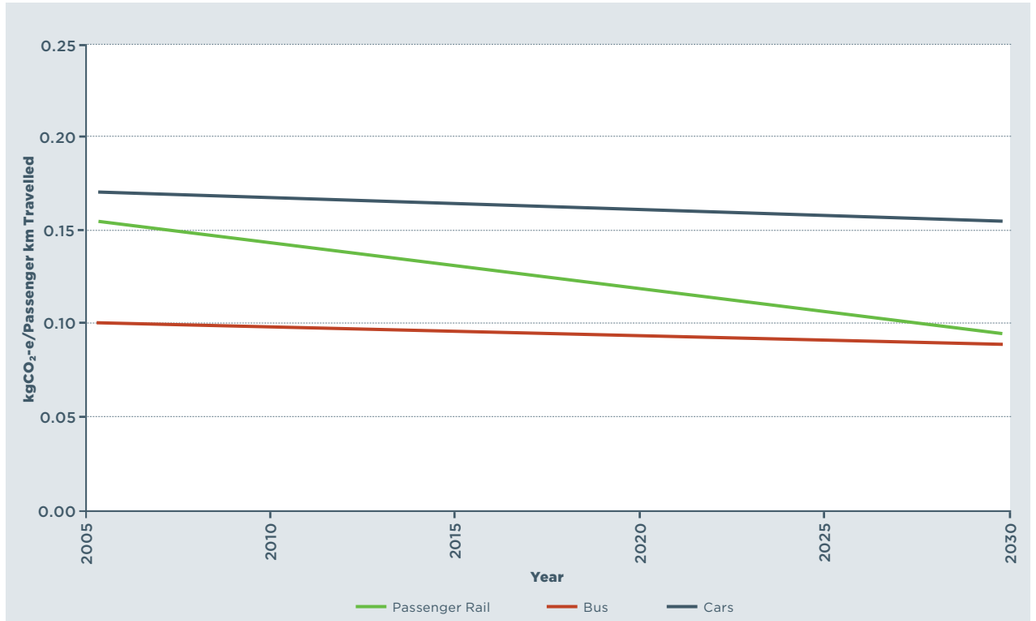
The GHG emissions associated with operational electricity use have been estimated using current emission factors for the consumption of purchased electricity from the New South Wales electricity grid and estimates of the NWRL electricity usage in the year 2021. Annual GHG emissions associated with electricity use are likely to decrease over time as the carbon intensity of grid sourced electricity decreases with the development of more renewable energy projects, driven by Government policies such as the Renewable Energy Target (RET) scheme and the Carbon Price Mechanism (CPM).

The strategies for reducing project GHG emissions have focused on the key GHG emission sources including the use of electricity to power trains and stations.

Construction, operation and maintenance of the NWRL project would generate GHG emissions, however once the NWRL is in operation, across the wider Sydney transport network, the NWRL project has the potential to reduce GHG emissions by providing a low GHG intensive alternative to car travel.

Figure 17.1 shows the projected GHG emission intensities of cars, buses and passenger rail to 2030 based on Australian national averages. The figure shows the GHG emission intensity of rail transport to decrease over time, as the carbon intensity of grid sourced electricity decreases with the development of more renewable energy projects, largely driven by Government policies such as the RET and CPM. Additionally, the GHG emission intensity of car and bus transport is anticipated to decrease, due to improved vehicle efficiencies.

Figure 17.1 National average carbon emissions per passenger kilometre over time for cars, bus and rail (Source: TfNSW, 2012, Sustainability Benefits Report)



Based on mode shift projections across Sydney's network wide transport system and the projected carbon intensities of rail, bus and car travel at the year 2021, the operation of the NWRL project would result in an annual reduction of transport related GHG emissions of 6,860 tCO_2-e/yr. This annual GHG emission reduction is due to the projected network-wide shift in passenger journeys from private vehicle to rail and associated energy and GHG emission savings. Notwithstanding the emissions reductions there remains a significant operational footprint as summarised in **Table 17.9.**

17.5.2 Mitigating GHG Emissions

GHG Mitigation through Design

Aspects of the NWRL stations, rail infrastructure and systems that would reduce GHG emissions are presented below according to their GHG emission category and design element.

Station Operations – Refrigerants

The station operations would include the use of refrigerants R410A, R134A and R407A, which have a low Global Warming Potential in comparison to other refrigerants currently available in Australia and suitable for use in underground and enclosed environments.

Stations and Stabling Facility Operation – Electricity

Measures that would reduce the quantity of electricity consumed per unit of operation, at the stations, stabling yard and maintenance facility include:

Day-lighting at stations (where daylight penetrates to platform level) minimises the requirement for artificial lighting. At underground stations, skylights can be used.

- Raising the alignment has resulted in energy savings associated with lighting, ventilation and vertical transportation. It is estimated that elevated stations consume approximately half of the energy used in the operation of an at-grade/ underground station.
- Natural ventilation has been provided at aboveground stations.
- Demand operated ventilation has been incorporated into the design of cut and cover stations, open cut stations and the stabling yard facilities building. The system operates based on temperature and carbon dioxide levels, to ensure that it only operates when needed.
- Water cooled chillers, considered to be twice as efficient as the air-cooled alternative, have been incorporated to provide cooling to staff areas, critical equipment and environmental shelters.
- Waste heat can be recovered from critical equipment areas for use in space heating in winter.
- Energy efficient heating, ventilation, and air conditioning equipment has been designed for, which exceeds requirements under Part J of the Building Code of Australia. The cooling equipment is 60% more efficient than the minimum requirements of Part J5.4 of the National Construction Code 2011.
- High efficiency motors (with variable speed drives for all fan and pump applications).
- Night Flushing for cooling of the stations and tunnel lining.
- Inclusion of demand controlled and timed lighting.
- Inclusion of energy efficient light fittings, signals and communication equipment.
- Draught relief in all underground stations, to allow heat to escape from the tunnels.
- Inclusion of digitally controlled demand operated tunnel ventilation equipment, which is designed to operate only when required.

Stations/Stabling Facility/Viaduct/Rail infrastructure and systems construction and maintenance – Materials

Measures that would reduce the quantity of materials for the NWRL stations, rail infrastructure and systems include:

- Prioritised use of pre-cast elements in the stations. The use of pre-cast concrete results in less waste material and energy expended in construction in comparison to concrete cast in-situ.
- Design refinements and optimisation to minimise the absolute quantities of steel and concrete used on the project, such as by optimisation of member spacing in stations.
- Use of post-tensioned concrete which has been shown to use less materials and have a lower embodied energy than reinforced concrete.
- Use of robust self-finished materials in stations, to avoid the use of paints and adhesives and to reduce the quantity of materials required for maintenance and replacement.

Rail Infrastructure and Systems Operation – Electricity

Measures that would reduce electricity use during operations include:

- Optimisation of the vertical alignment to minimise traction power demand, where feasible and reasonable, within significant physical and property constraints.
- Incorporation of slight track humps at stations to assist with train braking and acceleration.
- The traction system has been designed for receptivity to regenerative braking It is estimated that 100% of the energy used in braking between Epping and Castle Hill Stations would be returned to the overhead wiring system and utilised.

17.5.3 Renewable Energy

An assessment into the opportunities, costs and benefits for onsite renewable and low carbon intensity energy generation on the project has been undertaken. This assessment identified solar photovoltaics (PV) as the most feasible renewable/low carbon intensity energy generation technology for application at stations and the stabling facility. There is potential for PV systems to be installed on the roofs and canopies of station, services facility, stabling facility buildings and for the electricity generated to be directed to the station, stabling facility electricity supply.

The feasibility of opportunities for PV varies according to canopy design and orientation, station typology, building orientation and the potential for overshadowing by surrounding features. The installation of potentially feasible PV systems at NWRL stations and the stabling facility could generate between 200,000 – 300,000 kWh/year of electricity (assuming 260W PV panels, at optimum orientation and tilt angle) (TfNSW NWRL Sustainability Report 14 June 2012).

In order to achieve the NWRL Sustainability Policy Objectives to (1) improve the shift towards lower carbon transport, (2) reduce the operational, construction and embodied carbon emissions associated with the project and (3) identify low carbon energy generation and procurement options, a feasible project target could be to source five per cent of operational electricity demand from onsite renewable or low carbon sources at the stabling facility, stations or car parks.

17.5.4 Carbon Offset Options

There are a range of options available to avoid or reduce the GHG emissions associated with the operational electricity use of the project. The use of carbon offsets to counterbalance the emissions associated with electricity consumption is a common practice in Australia and internationally. In order to achieve the NWRL Sustainability Policy Objectives to (1) improve the shift towards lower carbon transport and (2) identify low carbon energy generation and procurement options, a feasible project target could be to offset 100 per cent of the electricity needs for the operational phase of the project. TfNSW are exploring options to achieve this.

Options for offsetting the GHG emissions associated with operational electricity use include investment in wind or solar generation projects, purchasing GreenPower from an accredited GreenPower provider and purchasing accredited biosequestration offsets created under the Federal Government's Carbon Farming Initiative, or a combination of these.