4. Review of receiving environment

This chapter provides a description of the receiving environment (i.e. the existing social, cultural, and biophysical environment likely to be impacted by the project, and the planned future development of the area surrounding the project. It provides additional information to that provided in the Concept Plan Environmental Assessment (EA) (Parsons Brinckerhoff 2006a), which has arisen through further and more detailed studies of the project. It is not the intention of this EA to re-document all of the information previously provided. Instead the chapter focuses on new information on the existing environment, although a summary of information from the Concept Plan EA is provided where appropriate.

This chapter concludes with a discussion on the likely future environment of the project and surrounding area. It confirms the project corridor and surrounding area would be subject to significant growth in the future which would be guided by the *Draft South West Subregional Strategy* (NSW Government 2007) and precinct planning.

4.1 Strategic overview

The project traverses parts of the Campbelltown, Liverpool and Camden local government areas (LGAs) located in Sydney's south-west region. This region of south-west Sydney is a fast growing area that has made substantial economic progress in recent decades.

The south-west region of the Sydney metropolitan area, had a rapidly growing population between 1991 and 2004, and this growth is expected to continue over the next 30 years (confirmed by Transport and Population Data Centre, TPDC, 2006). Further, the region has one of the highest rates of private vehicle ownership and use in Sydney. Residents in the south-west of Sydney have the longest commute (on average), and travel longer distances (on average) each weekday than residents residing in other parts of Sydney.

The primary communities (those directly affected by the project and located within the zone of environmental impact) along the project corridor are listed in Table 4-1, along with a brief community profile.

Table 4-1 Primary communities along the project

Community	LGA	Profile
Parts of Glenfield	Campbelltown	Older, established suburb on the eastern side of Glenfield Station (20-30 year old houses) characterised by private businesses next to the station. Predominantly residential, with special uses, such as Hurlstone Agricultural High School and James Meehan Estate, adjacent to the western side of the project corridor.
Bardia Village	Campbelltown	An older more established area, the village is part of the Ingleburn Military Precinct, but is no longer used for military purposes with only a few remaining residents. The land is currently intended to be transferred to NSW Government ownership for development by Landcom; however, the land is still Commonwealth owned.
Edmondson Park	Liverpool	Characterised by rural-residential development and the former Ingleburn Army Camp in the southern part of the release area. However, residential development is commencing with Ingleburn Gardens being the first residential development in the area.

Community	LGA	Profile
Denham Court	Liverpool and Campbelltown	Characterised by large houses on large parcels of land. The suburb has one of the highest property values within the LGA (Australian Property Monitors 2006).
Horningsea Park	Liverpool	A relatively new residential area that mostly comprises young families. The recent opening of the two local schools has strengthened local community ties.
Leppington	Liverpool, Camden and Campbelltown	Predominantly private rural-residential dwellings with some market gardens. Residences mainly comprise large houses on large parcels of land. The 2001 Census data indicates that a large proportion of these are occupied by couples without children. The market gardens have an above average percentage of the population from non-English speaking backgrounds (mainly Chinese, Vietnamese and Maltese).
Rossmore	Liverpool and Camden	Characterised by low density housing within a predominantly rural/semi-rural setting. The population has an above average percentage of the population that are couples without children.

4.2 Land use

The existing land use in the vicinity of the project has not changed significantly since the Concept Plan EA was prepared in 2006. The corridor passes through the following land uses:

- rural-residential
- special uses
- residential
- retail
- public open space and recreation
- other open spaces (including vacant land).

These land uses are illustrated in Figure 4-1.

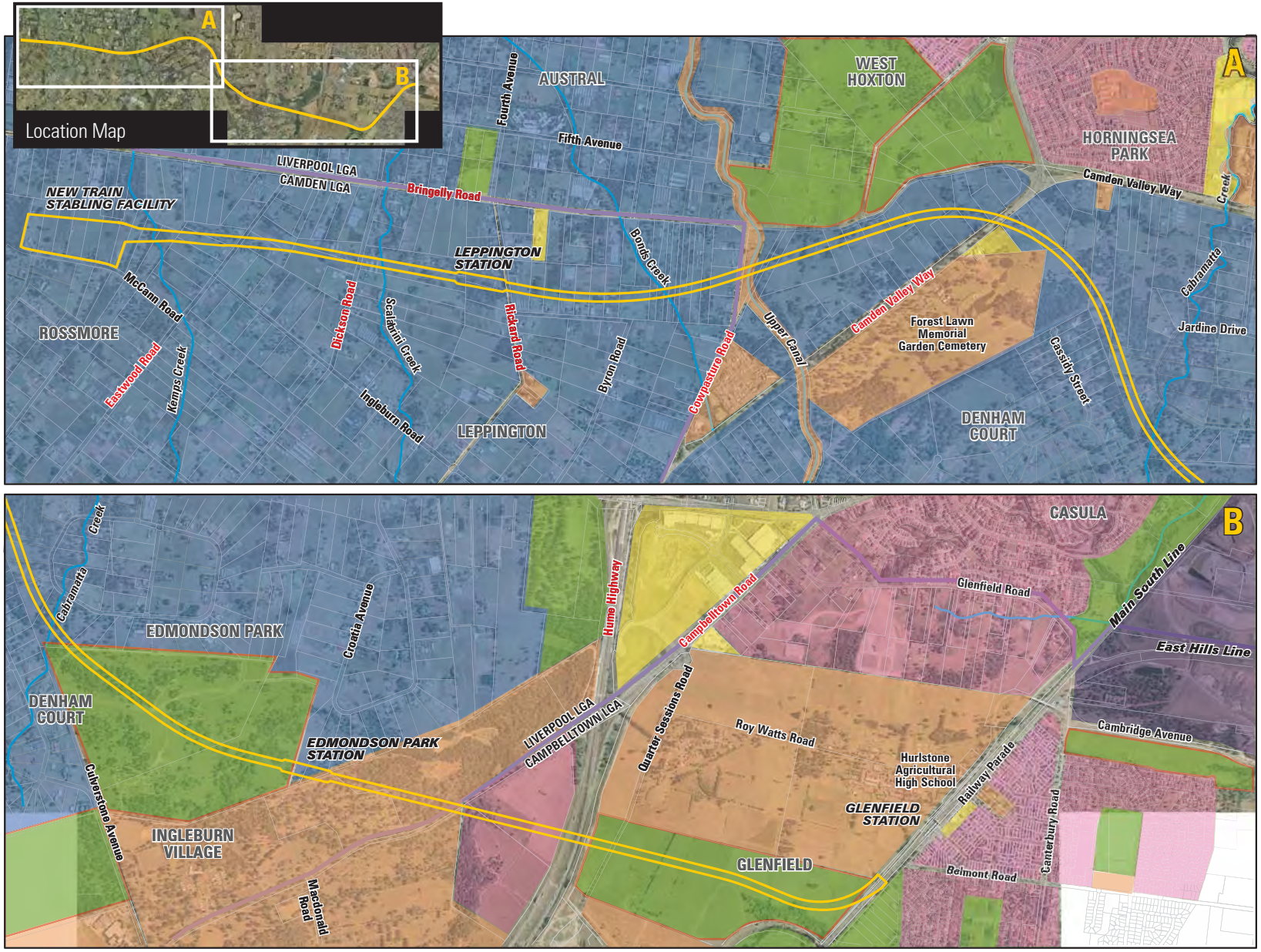


Figure 4-1 Land uses in the vicinity of the proposed SWRL

4.3 Traffic and transport

4.3.1 Road network

The existing road traffic network were documented in detail in Volume 2 of the Concept Plan EA. Background traffic levels and the existing road network have not changed significantly since preparation of the Concept Plan EA in 2006 and, as such, no additional baseline analysis was undertaken for this EA. Key findings from the Concept Plan EA are outlined below.

Sydney Orbital Network

The Sydney Orbital Network is a motorway network that connects key strategic regions within Sydney, including the Sydney CBD, Sydney international and domestic airports, Port Botany and the North West/South West Growth Centres (NWGC/SWGC). The project area would be linked to the Sydney Orbital Network via connections with the Hume Highway at Casula and Camden Valley Way. The Hume Highway also provides regional access between Sydney, the Southern Highlands, Goulburn and Canberra, as well as a road transport and freight corridor to Melbourne.

Road network improvements

To cater for population and employment growth in south-west Sydney, the following road upgrades have been completed or have commenced planning:

- M7 Motorway (NSW Roads and Traffic Authority (RTA)) ─ six-lane, 2-way dual carriageway was completed in 2005.
- Cowpasture Road (RTA) ─ upgraded to four lanes between The Horsley Drive and North Liverpool Road, and between Hoxton Park Road and Main Street (including an interchange with the M7).
- Camden Valley Way (RTA) ─ upgraded to provide four lanes between the M5 and Bernera Road (including an upgrade of the Camden Valley Way/ Bernera Road/ Croatia Road intersection to a signalised intersection). A $104 million four-year program of upgrades to Camden Valley Way was announced by the NSW Government in 2008, which includes the sections between Bernera Road and Bringelly Road, and Camden Valley Way between Cobbitty Road and Narellan Road. RTA investigations are intended to be carried out for the section of Camden Valley Way where it crosses the SWRL. With respect to the section of Camden Valley Way between Cobbitty Road and Cowpasture Road, RTA's community update of October 2009 contained a concept design for the upgrading of this section from two lanes to four lanes, though there is no Government commitment to a timetable for the works.
- Cowpasture Road (RTA) ─ the following upgrades are planned and scheduled for completion in mid 2011 (Roads and Traffic Authority 2008):
  - twin bridges over Hinchinbrook Creek
  - new traffic signals at the intersection of Cowpasture Road and Green Valley Road
  - an upgrade to four lanes between Main Street and Camden Valley Way, and North Liverpool Road and Hinchinbrook Creek.

- Bringelly Road (Liverpool City Council) – a number of upgrades have been proposed including the section from Cowpasture Road to Fourth Avenue, the section from Fourth Avenue to North Avenue, and the section from North Avenue to The Northern Road. Bringelly Road is proposed to be widened to two lanes in each direction between Eastwood Road and Cowpasture Road. The widening of this road would include upgrades to the intersections of Bringelly Road with Kings Street, Eastwood Road, Richard Road and Cowpasture Road. Although these upgrades are described within the Growth Centres Special Infrastructure Contribution Practice Note (November 2008), there is no present Government commitment to a specific timetable for delivery.

The major road network within the south-west region will be upgraded to cater for future growth within the region (refer Section 4.10).

4.3.2 Public transport and pedestrian/cyclist provisions

Existing services and pedestrian/cyclist provisions

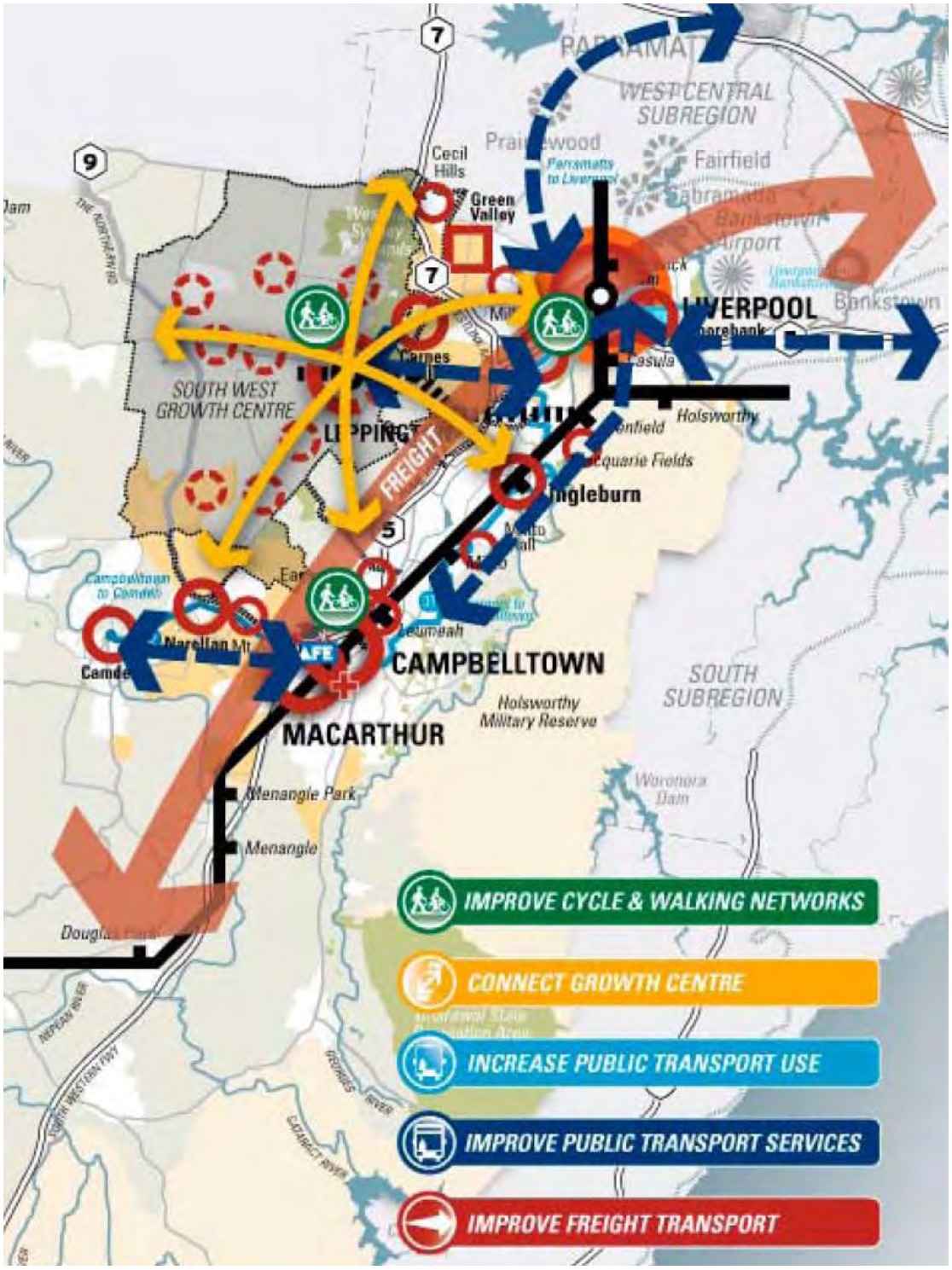
Some bus services are available in the SWGC but have limited frequency.

Footpaths and cycleways are virtually non-existent outside of residential areas, and facilities within residential areas are relatively sparse.

Planned service improvements

The planned bus routes to service the proposed Edmondson Park and Leppington stations are discussed in Sections 8.3.3 and 8.4.3. Proposed pedestrian and cycle access around the project is discussed in Sections 8.3.5 and 8.4.5.

The draft *South West Subregional Strategy* (Department of Planning 2007) set out the general strategy for transport in the SWGC (refer Figure 4-2). The strategy identified the need for transport linkages, consisting of the South West Rail Link (SWRL) and an extension of the Strategic Bus Corridors.



Source: Department of Planning 2007

Figure 4-2 Strategic transport linkages

Metropolitan Transport Plan 2010

On 21 February 2010, the NSW Government released the *Metropolitan Transport Plan – Connecting the City of Cities* for the Greater Sydney Metropolitan Region. The SWRL was a key part of this plan, which also identified Leppington as a major centre. Figure 4-3 shows a map of the projects that are scheduled to proceed as part of the 10 year plan.

Source: NSW Government 2010a

Figure 4-3 Metropolitan Transport Plan 2020 map

The plan includes completion of the overall SWRL project by 2016 as part of a plan to increase public transport capacity to help manage population and employment growth. In particular, the plan recognises the need for more efficient public transport serving of key centres including Parramatta and Liverpool. The plan also confirms that both Leppington and Edmondson Park stations would have new commuter car parks.

South West Sector Bus Servicing Plan

The NSW Government's bus network plan for the SWGC (*South-West Sector Bus Servicing Plan, February 2009*) is consistent with the *South West Subregional Strategy* and *Metropolitan Transport Plan* and identifies a long-term bus network as well as interim staging strategies for the short term.

Figure 4-4 shows the short-term bus network proposed to be implemented within the next five years, while Figure 4-5 shows the long-term network at full operation (assumed to be 2031 in the Servicing Plan).

At the time the Bus Servicing Plan was finalised, the SWRL was proposed to be staged and, therefore, the planned bus network does not include the SWRL; although the plan does serve proposed activity centres at Edmondson Park and Leppington and would require only minor adjustment to accommodate the SWRL.

At early stages of the SWRL operation, the short-term bus network (which does not provide links between the Oran Park and Turner Road precincts and the proposed SWRL stations) would need to be modified to introduce some longer-term planned routes to connect these precincts to Leppington Station.

The proposed long-term bus network consists of regional routes, district routes and peak hour service routes with some 26 routes (19 of which would terminate at Leppington Station and three of which would also serve Edmondson Park Station). These routes would provide a high quality, high frequency bus network, comprising strategic routes, as well as district and local services.

Source: NSW Government 2009

Figure 4-4 Expected short-term (i.e. within five years) bus routes

Source: NSW Government 2009

Figure 4-5 Expected longer-term bus routes by 2031[1]

[1] Route D6 is listed in the Legend as "Liverpool to Campbelltown" it is intended to be Leppington to Campbelltown.

4.4 Noise and vibration

An assessment of the ambient noise environment along the project corridor was undertaken by noise consultants Heggies Australia Pty Ltd (Heggies) in April 2006 and reported in the Concept Plan EA (Parsons Brinckerhoff 2006a).

The assessment found that the existing noise environment varies along the proposed SWRL corridor. The absence of any significant commercial or industrial development results in very low night-time ambient noise levels.

There are unlikely to have been any significant changes in ambient noise levels since this time and, therefore, no new ambient noise assessment has been undertaken. Key findings from the Concept Plan EA are outlined below.

4.4.1 Noise monitoring

Ambient noise monitoring was undertaken at five representative locations, illustrated in Figure 4-6. The noise loggers (type EL215 and EL316) recorded noise levels continuously in consecutive 15 minute intervals. Table 4-2 summarises the processed L_{A90} and L_{Aeq} noise levels. The L_{A90} levels represent the 'background noise levels', which are the average minimum noise level during the daytime, evening and night-time periods. The existing L_{Aeq} levels represent the typical 'energy-averaged' noise levels during the daytime, evening and night-time periods.

Table 4-2 Ambient noise levels at unattended noise monitoring locations

Monitoring location	Daytime[1] noise level (dBa)		Evening[1] noise level (dBa)		Night-time[1] noise level (dBa)	
	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
615 Bringelly Road, Rossmore	43	58	38	57	30	55
198 McCann Road, Rossmore	34	66	33	59	30	54
25 Cassidy Street, Denham Court	36	47	37	43	33	42
135 Croatia Avenue, Edmondson Park	38	49	42	48	37	45
18 Newtown Road, Glenfield	41	61	42	59	37	56

Note 1: DECCW's preferred definition of daytime, evening and night-time hours: Daytime refers to standard daytime construction hours, namely 7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 am on Saturday. Evening refers to the period 6.00 pm to 10.00 pm. Night-time refers to the period 10.00 pm to 7.00 am.

The full results of the unattended noise monitoring are presented graphically in Appendix B of Technical Paper 1 (Noise and Vibration Assessment) in Volume 2a.

4.4.2 Noise sensitive receiver locations

Ten receiver groups (residential dwellings etc) were identified within the vicinity of the project, using information on building occupancy types (residential, commercial, educational, etc), and proposed land use documented in:

- Campbelltown City Council's *Campbelltown (Urban Area) Local Environmental Plan 2002*
- Liverpool City Council's *Edmondson Park Precinct Development Control Plan 2008*
- NSW Department of Planning's (DoP's) *South West Growth Centre Structure Plan*.

These receiver groups are shown in Figure 4-6 and summarised in Table 4-3. The general pattern of existing sensitive receivers located within the vicinity of the project includes:

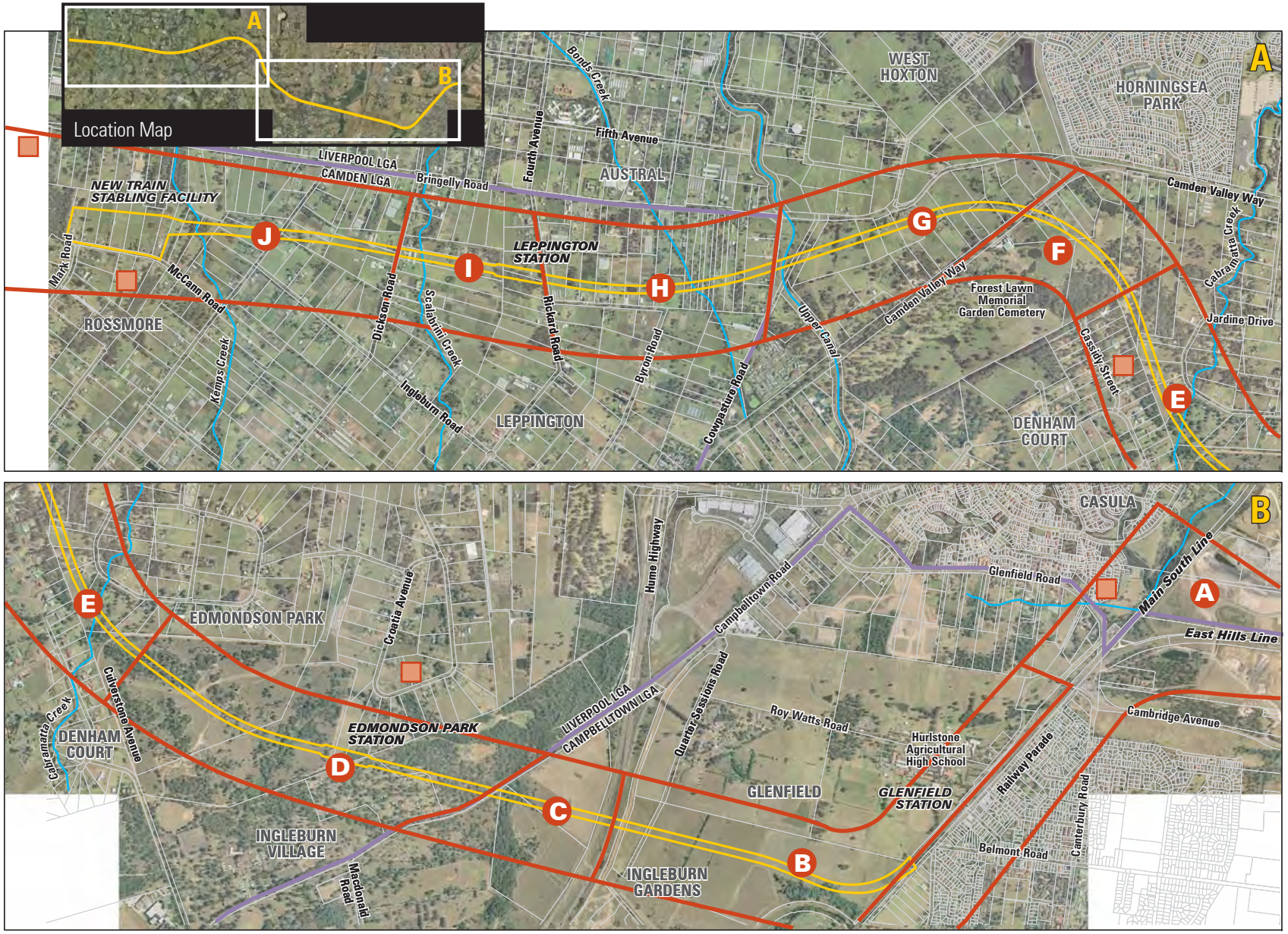
- residential land and Glenfield Primary School located to the east of the rail corridor within the Glenfield town centre (refer receiver group A in Table 4-3)
- Hurlstone Agricultural Collage and Glenfield Special School located to the north of the proposed Glenfield Southern Flyover (refer receiver group B in Table 4-3)
- Macquarie Field House and Macquarie Links International Golf Club located to the south of the project within the vicinity of the Hume Highway (refer receiver group B in Table 4-3)
- Ingleburn Gardens Estate located to the south of the project within the vicinity of the Hume Highway (refer receiver group C in Table 4-3)
- residential receivers located along the southern boundary of the project corridor within the Ingleburn Army Camp (refer receiver group D in Table 4-3)
- rural-residential properties within the vicinity of Culverston Avenue, Denham Court (refer receiver group E in Table 4-3)
- a caravan park located south of the project corridor within the vicinity of Cowpasture Road (refer receiver group G in Table 4-3).

It should be noted that the future environment surrounding the project will be extensively modified by the development associated with the SWGC (refer Section 4.10). The project would pass through a number of precincts in the SWGC that are planned for major development in the future. Precincts of the SWGC are at various planning stages so it is difficult to determine the exact nature and distribution of future land uses. It is estimated that 110,000 new homes will be built in south-west Sydney's 'greenfield' areas and another 7,500 homes will be built at Edmondson Park. This is forecast to house approximately 300,000 people.

Edmondson Park is likely to be developed first, as the area is already largely planned and has been rezoned. Some parts of this development are likely to be in place by the time the project is constructed. The Leppington North precinct was released for development by NSW Department of Planning (DoP) in late 2009, meaning that precinct planning will be progressed through 2010. The timing of its development is as yet unconfirmed, but it would be likely to follow the project construction.

The existing and anticipated future noise environments at each receiver group are summarised in Table 4-3.

The noise and vibration assessment undertaken by Heggies (refer Technical Paper 1 of Volume 2a) did not identify any additional sensitive receiver areas since the Concept Plan EA.



A. East of Main South Line (Canal to Cambridge Avenue) and west of Main South Line (Glenfield Road overbridge to Slessor Road)
B. Between Glenfield Road, Main South Line and Hume Highway
C. Hume Highway to Campbelltown Road
D. Campbelltown Road to Culverston Avenue
E. Culverston Avenue (Denham Court)
F. Culverston Avenue to Camden Valley Way
G. Camden Valley Way to Cowpasture Road
H. Cowpasture Road to Rickard Road
I. Rickard Road to Dickson Road
J. Dickson Road to Mark Road

Figure 4-6
Ambient noise monitoring locations and receiver zones

Table 4-3 Existing and future noise environment and sensitivity along the corridor

Receiver group[1]	Location	Description	
		Existing	Future proposed
A	East of Main South Line (Canal to Cambridge Avenue) and West of Main South Line (Glenfield Road Overbridge to Slessor Road)	The corridor is primarily bounded by residential land. A small area of light commercial property is situated adjacent Glenfield Station. Glenfield Primary School is also located in this area.	Developed areas unlikely to change in the short term; however, the undeveloped land on the western side of the Main South Line is likely to include some residential development.
B	Between Glenfield Road, Main South Line, and Hume Highway Chainage 42.39 to 43.9 kilometres	The corridor is bounded by rural land, with Hurlstone Agricultural College and Glenfield Special School to the North. Heritage listed Macquarie Field House is located to the south of the corridor, as is Macquarie Links International Golf Club. The Hume Highway and Main South Railway would be the dominant noise sources.	Residential development may occur in the area (James Meehan Estate).
C	Hume Highway to Campbelltown Road Chainage 44.1 to 44.6 kilometres	Ingleburn Gardens Estate is currently under development. Development including residential, aged care facility and a school is approved by Council for this area. Campbelltown Road and the Hume Highway would be the dominant noise sources.	The areas flanking the rail corridor are zoned as “2(c) Higher Density Residential” under the *Edmondson Park Precinct Development Control Plan 2008*.
D	Campbelltown Road to Culverston Avenue Chainage 44.7 to 47.2 kilometres	Mostly part of previous Ingleburn Army Camp. Predominantly undeveloped, apart from some residential buildings along the southern boundary of the proposed rail corridor. Generally quiet area. Noise environment would be controlled by distant road traffic noise.	This area is covered by the *Edmondson Park Precinct, Liverpool Local Environmental Plan 2007* and *Development Control Plan 2008*. The zoning maps indicate mainly nature reserves and town centre areas on the southern (Down) side of the proposed railway corridor and the eastern half of the area on the northern (Up) side of corridor. The western half of the northern (Up) boundary is bordered by a medium density residential zone.

Receiver group[1]	Location	Description	
		Existing	Future proposed
E	Culverston Avenue (Denham Court) Chainage 47.2 to 47.7 kilometres	The proposed rail corridor is bounded by rural-residential properties (i.e. single dwellings on blocks of typically 1 hectare). Quiet residential area.	The character and housing density of this area is likely to remain relatively unchanged. To capture the long-term effects, however, this area on the eastern side of the rail line has been modelled as a general (low density) residential zone, as indicated in the *Liverpool Local Environmental Plan 2007*.
F	Culverston Avenue to Camden Valley Way Chainage 47.7 to 48.4 kilometres	The proposed rail corridor is generally bounded by rural land. Includes some low density dwellings in Denham Court and the northern part of the Forest Lawn Memorial Garden Cemetery. Generally quiet area. Noise environment would be controlled by road traffic noise from Camden Valley Way.	Based on the *Liverpool Local Environmental Plan 2007*, development to the east of the rail corridor is expected to be general (low density) residential.
G	Camden Valley Way to Sydney Water Canal and Cowpasture Road Chainage 48.5 to 49.7 kilometres	Caravan park, exposed to noise from Camden Valley Way and Cowpasture Road. Most of the area is rural-residential and small scale agriculture.	This area south of Bringelly Road was identified as part of the Western Sydney Parklands in the concept EA. This is no longer the case and further land uses in this area are uncertain.
H	Cowpasture Road to Rickard Road Chainage 49.8 to 50.9 kilometres	The proposed rail corridor is bounded by rural land, exposed to noise from local traffic and Bringelly Road.	Based on the *South West Growth Centre Structure Plan*, development in this area is expected to contain a range of residential density types.
I	Rickard Road to Dickson Road Chainage 50.9 to 51.7 kilometres	Predominantly rural land. Generally quiet area. Noise environment would be controlled by distant road traffic noise.	Based on the *South West Growth Centre Structure Plan*, development in this area is expected to be a mix of town centre (commercial, services etc) and high density residential.
J	Dickson Road to Mark Road Chainage 51.7 to 53.38 kilometres	The proposed rail corridor is bounded by rural land with some market gardens. Generally quiet area. Noise environment would be controlled by road traffic noise from Cowpasture Road.	Based on the *South West Growth Centre Structure Plan*, development in this area is expected to be medium density residential between Dickson Road and Kemps Creek, and general (low density) residential between Kemps Creek and Mark Road.

Note 1: Reference areas A through to J are shown in Figure 4-6.

4.5 Water quality and hydrology

This section summarises the existing hydrological environment as described in Technical Paper 3 (Hydrology) in Volume 2b.

The project alignment crosses or intersects the catchment of 16 waterways as shown in Figure 6-1 (Chapter 6). Table 4-4 summarises each of the waterway crossings considered in this assessment.

Table 4-4 Existing and future hydrological environment

Crossing	Chainage in kilometres	Catchment	Proposed development		Existing vegetation	Department of Environment Climate Change and Water (DECCW) stream classification[1]
			Upstream	Downstream		
1	42.93	Bunbury Curran Creek	James Meehan Estate	Existing railway line	Highly modified catchment, weeds, no defined creek	3
2	43.80	Bunbury Curran Creek	Existing School	Existing Macquarie Links Estate	Highly modified catchment, no defined creek	Not classified
3	44.53	Maxwells Creek	Public Recreation Area	Nature reserve	Defined creek, dense vegetation	2
4	45.13	Maxwells Creek	Edmondson Park town centre	Public recreation area	Drainage depression rather than creek, highly modified catchment	2
5	45.43	Maxwells Creek	Edmondson Park town centre	Public recreation area	Highly modified catchment, no defined creek	Not classified
6	45.70	Maxwells Creek	Nature reserve	Public recreation area	Defined creek, dense vegetation, standing water	2
7a	46.93	Cabramatta Creek	Existing and proposed rural residential	Public recreation area	Modified catchment, defined creek, dense vegetation, standing water	1
7b	47.19	Cabramatta Creek	Existing rural residential	Future residential	Drainage depression, modified/urbanised catchment	Not classified
8	47.90	Cabramatta Creek	Existing cemetery	Public recreation area	Drainage depression rather than a creek, highly modified catchment	2
9	48.17	Cabramatta Creek	Existing cemetery	Public recreation area	Drainage depression rather than a creek, highly modified catchment with ponds	2
10a	48.44	Cabramatta Creek	Future urban use	Public recreation area	Drainage depression rather than a creek, highly modified catchment, ponded water upstream	2
10b	49.43	Bonds Creek	Future urban use	Public recreation area	Drainage depression	Not classified
11	50.12	Bonds Creek	Leppington Urban Release Precinct	Leppington North Urban Release Precinct	Defined creek, weed and bank collapse, modified catchment, standing water	1

Crossing	Chainage in kilometres	Catchment	Proposed development		Existing vegetation	Department of Environment Climate Change and Water (DECCW) stream classification[1]
			Upstream	Downstream		
12	51.34	Scalabrini Creek	Leppington Urban Release Precinct	Leppington North Urban Release Precinct	Drainage depression rather than a creek, highly modified catchment	Not classified
13	51.58	Scalabrini Creek	Leppington Urban Release Precinct	Leppington North Urban Release Precinct	Defined creek, weeds and bank collapse, modified catchment	2
14	52.74	Kemps Creek	Rossmore/Leppington Urban Release Precinct	Rossmore/Leppington North Urban Release Precinct	Modified catchment, defined channel, dense vegetation, standing water	1

Note 1: Category 1: 40 metre wide core riparian zone (measured from top of bank) plus 10 metre buffer either side of watercourse.

Category 2: 20 metre wide core riparian zone (measured from top of bank) plus 10 metre buffer either side of watercourse.

Category 3: 10 metre wide core riparian zone (measured from top of bank).

Category 4: No defined riparian habitat.

The catchment areas upstream of the project alignment are reasonably varied in respect to their size and the degree of existing and proposed urbanisation. The catchment areas range in size from around 3 hectares up to areas of approximately 750 hectares. A number of the existing catchments are reasonably natural, while others have existing rural-residential development. Further development has been proposed in a large portion of the areas upstream of the project alignment, including the proposed provision of 110,000 dwellings in the broader area, which is expected to significantly alter the nature of the catchments.

The sixteen (16) identified waterways are prone to flooding, particularly in the area around the proposed Edmondson Park Station (Crossings 4, 5 and 6), where the potential flood risk is high in regard to events that exceed the design standard as detailed in Technical Paper 3 (refer Volume 2b). This issue is discussed in more detail in Chapter 11.

4.6 Flora and fauna

This section summarises the existing biodiversity within the vicinity of the project, based on the findings of Technical Paper 2 in Volume 2a.

The biodiversity assessment completed for this EA has been undertaken to address the relevant state and Commonwealth statutory requirements in relation to the assessment of biodiversity and the matters outlined in Transport Infrastructure Development Corporation's (TIDC) Statement of Commitments and the Minister's Conditions of Approval for the Concept Plan (refer Appendix C and D).

Field surveys were completed in July 2006 as part of the concept approval process (Parsons Brinckerhoff 2006b), and in October 2006 and between March and June 2008. The description of the existing environment and conclusions of this report are based on a combination of field surveys and desktop review. Due to the delay in the final report, database searches were updated.

4.6.1 Vegetation communities

The project traverses numerous lots with a variety of land uses, including rural-residential properties (5 acre lots) with market gardens and/or light intensity grazing; land owned by the NSW Government (Landcom) that is zoned for future residential development (Edmondson Park); housing and land owned by the Department of Defence (currently intended to be transferred to NSW Government ownership for development by Landcom); roads; and an existing railway corridor (at Glenfield). The remnant vegetation and fauna habitats within the project area have, therefore, been exposed to a range of past impacts and levels of disturbance and are located within an area of significant proposed development.

Three native vegetation communities have been mapped (NSW National Parks and Wildlife Service 2002a) in the project area (see Figure 4-7). These are:

- Shale Plains Woodland
- Shale Hills Woodland
- Alluvial Woodland.

Shale Hills Woodland was the most abundant vegetation community in the project area and the condition ranged from poor to good, comprising areas of 'core habitat', 'support for core habitat', and 'other remnant vegetation' conservation significance classes (NSW National Parks and Wildlife Service 2002b). The Shale Hills Woodland was identified to correspond with the threatened ecological community of Cumberland Plain Woodland, which is listed as critically endangered under the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

All Shale Plains Woodland sites in the project area had evidence of historical clearing (partial or complete) and most sites were dominated by regrowth. Important patches of the vegetation community were identified within the Ingleburn Defence lands and Edmondson Park. Although no threatened species of plant was recorded at these locations, the diversity of native species was high, including locally rare species (e.g. *Bossiaea prostrate*) and habitat for the Cumberland Plain Land Snail (state listed endangered species). The Shale Plains Woodland was identified to correspond with the threatened ecological community of Cumberland Plain Woodland, which is listed as critically endangered under the TSC Act and EPBC Act.

Shale Hills Woodland is closely associated with Shale Plains Woodland and the communities may integrate; however, Shale Hills Woodland occurs at higher elevations and on steeper slopes than Shale Plains Woodland. Shale Hills Woodland occurred in fragmented patches between Camden Valley Way and Cowpastures Road. The condition of the community in these patches was generally poor.

Alluvial Woodland occurs in association with drainage lines traversing Wianamatta Shale soils and is a diverse vegetation community that can be dominated by a range of different species (NSW National Parks and Wildlife Service 2002a). Alluvial Woodland occurred in association with six drainage lines in the project area. The condition of the Alluvial Woodland at these locations ranged from moderate to poor and comprised areas of 'core habitat', 'support for core habitat' and 'other remnant vegetation' (NSW National Parks and Wildlife Service 2002b). The Alluvial Woodland was identified to correspond with the threatened ecological community of River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, which is listed as endangered under the TSC Act.

The remaining areas in the vicinity of the project are mapped as 'no native vegetation overstorey' (NSW National Parks and Wildlife Service 2002a). These areas comprise a range of land uses and conditions that lack a native vegetation overstorey, including areas of derived grassland (exotic and native dominated).

Areas of no native vegetation overstorey include patches of derived native dominated grassland in the Edmondson Park Release Area. Areas of native dominated grassland are formed (derived) when the trees and shrub stratum is removed (cleared) in a manner that allows a native dominated ground cover to persist. Derived grasslands are not distinguished by broad scale vegetation mapping (NSW National Parks and Wildlife Service 2002a), as they cannot be distinguished from exotic dominated grasslands (paddocks) through aerial photograph interpretation. These areas can regenerate into more complex woodland if given the opportunity.

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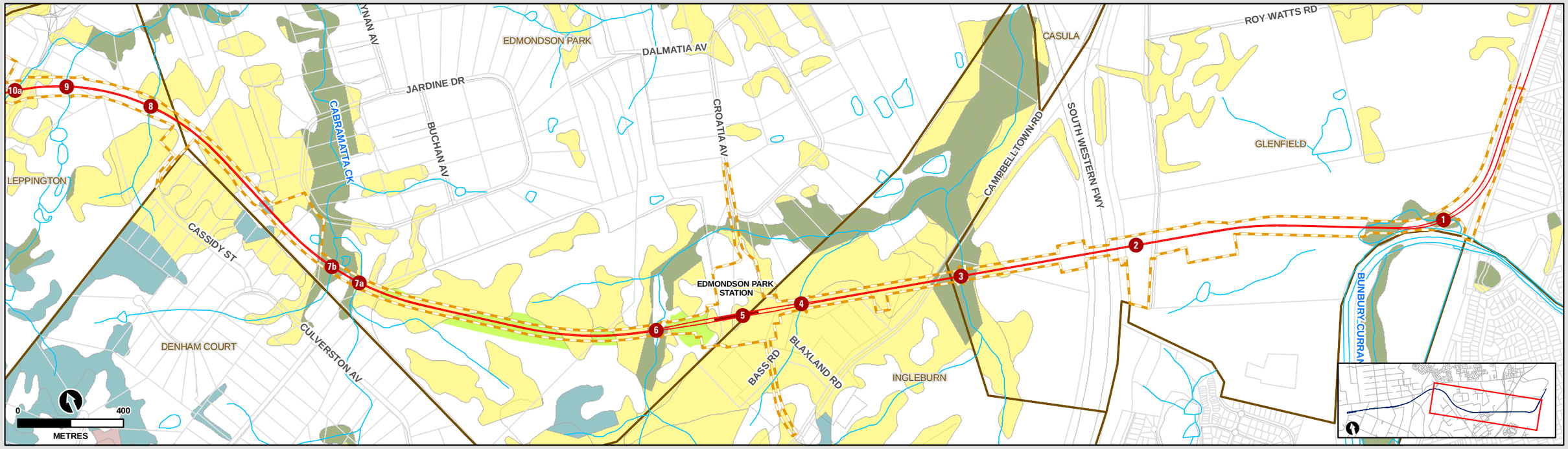

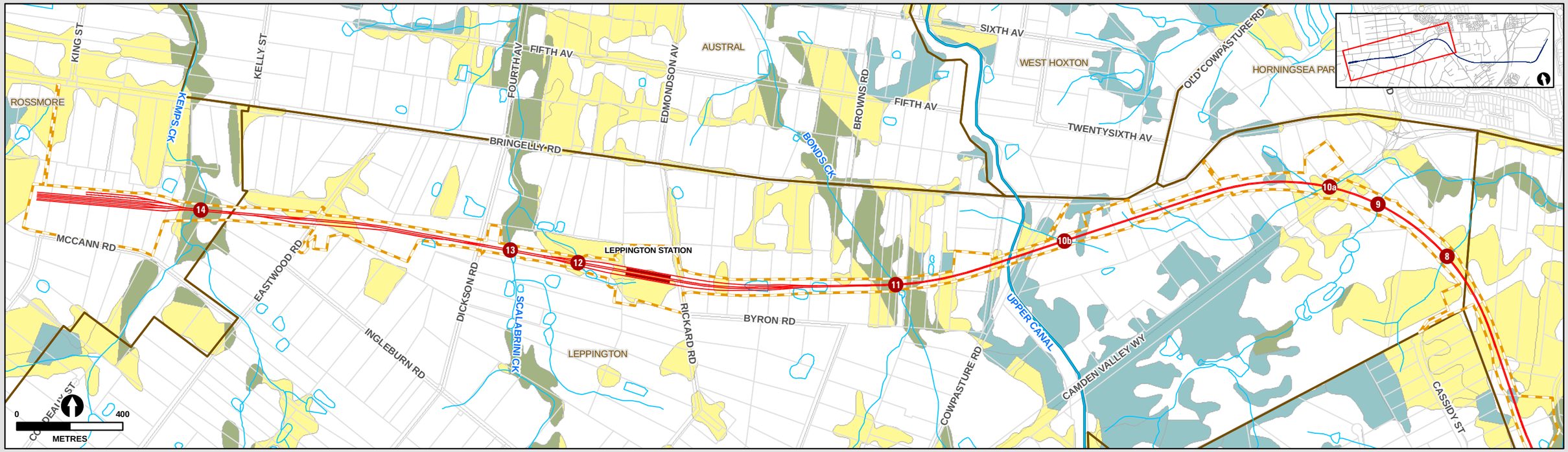

Waterway crossing
Cadastre
Suburbs
Drainage
Proposed track
Clearing Footprint*

Cumberland Plain Woodland [1]
Shale Hills Woodland
Shale Plains Woodland

Sydney Coastal River-flat Forest [1]
Alluvial Woodland

Derived native grasslands

1 - NSW National Parks and Wildlife Service (2002) *Native Vegetation of the Cumberland Plain.* NSW, NPWS, Hurstville

***Note:** Clearing footprint includes likely stockpiles and construction compounds*

Figure 4-7 Vegetation communities

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4.6.2 Species of plant

A total of 282 species of plant, representing 80 families, were recorded within the project area of which 113 (40%) were native (refer to Appendix B of Technical Paper 2). The number of species of plant recorded in each community, and the percentage of these that are native species, is summarised in Table 4-5.

Table 4-5 Number of species of plant recorded in the project area

Community	Total number of species	Number of native species (% of total)	Number of introduced species	Number of sample sites
Shale Hills Woodland	125	63 (50%)	62	5
Shale Plains Woodland	198	129 (65%)	69	19
Alluvial Woodland	120	69 (58%)	51	6
No native canopy overstorey / unclassified vegetation	168	93 (55%)	75	4
All communities	**282**	**113 (40%)**	**169**	**34**

Fifteen species of plant recorded in the project area are listed under the *Noxious Weeds Act 1993* for the Camden Council, Campbelltown City Council or Liverpool City Council control areas and six are also listed as Weeds of National Significance (Thorp and Lynch 2000) (refer Table 4-6).

Table 4-6 Weeds recorded in the project area

Family name	Botanical name	Common name	NW Act control category[1]	WONS[2]
Amaranthaceae	*Alternanthera philoxeroides*	Alligator Weed	3	Y
Asparagaceae	*Myrsiphyllum asparagoides*	Bridal creeper	5	Y
Asteraceae	*Xanthium spinosum*	Bathurst Burr	4	
Cactaceae	*Opuntia* sp.	Prickly Pear	4	
Crassulaceae	*Bryophyllum tubiflorum*	Mother-of-millions	3	
Oleaceae	*Ligustrum lucidum*	Large-leaved Privet	4	
	Ligustrum sinense	Small-leaved Privet	4	
Oxalidaceae	*Oxalis* sp.		5	
Poaceae	*Sorghum halepense*	Johnson Grass	4	
	Nassella neesiana	Chilean needle grass	4	Y
Rosaceae	*Rubus fruiticosus*	Blackberry complex	4	Y
Salicaceae	*Salix* sp.	Willow	5	Y
Solanaceae	*Cestrum parqui*	Green Cestrum	3	
	Lycium ferocissimum	African Boxthorn	4	
Verbenaceae	*Lantana camara*	Lantana	5	Y

Notes: 1. *Noxious Weeds Act 1993*: Class 3: The plant must be fully and continuously suppressed and destroyed. Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Class 5: The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

2. Weeds of National Significance (Thorp and Lynch 2000).

4.6.3 Fauna habitats

The suitability, size and configuration of fauna habitat types correlated broadly with the structure, floristics, connectivity and condition of the vegetation communities described above (refer Table 4-7).

Table 4-7 Fauna habitats and their associated vegetation communities in the project area

Fauna habitat type	Vegetation community or location
Woodlands	▪ Shale Hills Woodland ▪ Shale Plains Woodland ▪ Alluvial Woodland
Derived grasslands	▪ no Native Canopy Overstorey / Unclassified vegetation
Developed areas	▪ no Native Canopy Overstorey / Unclassified vegetation
Riparian and other aquatic habitat	▪ drainage lines within Alluvial woodland ▪ minor drainage lines in Shale Hills Woodland and Shale Plains Woodland ▪ drainage lines and other waterbodies in areas of No Native Canopy Overstorey / Unclassified vegetation

Woodland fauna habitats consisted of the patches of remnant woodland vegetation communities, including Shale Hills Woodland, Shale Plains Woodland and Alluvial Woodland. These woodland fauna habitats were interspersed with cleared areas of land including derived grasslands and developed areas. Woodland habitats provide a range of fauna microhabitat resources including:

- an abundance of blossoms that are important feeding resources for nectivorous birds, arboreal mammals and the threatened Grey-headed Flying-fox
- hollows in major eucalypts that are important roosting and nesting sites for fauna including native birds, mammals (microbats, arboreal and scansorial), reptiles and frogs (The majority of the woodlands in the project area were, however, dominated by Eucalyptus regrowth that possessed few or no hollows. Mature eucalypts with hollows were, however, recorded at James Meehan Estate (at the Glenfield Southern Flyover site), the Ingleburn Defence Site and within the Landcom lands at Edmondson Park)
- dense understorey and shrub vegetation, fallen timber, bark and leaf litter and dense ground cover which provide cover and protection of ground dwelling animals and the threatened Cumberland Plain Land Snail.

Derived grasslands are those areas where the native woodland vegetation has been cleared and that are now dominated by a range of native and/or exotic grass and herb species. Derived grasslands provide a range of fauna habitat elements that are limited or absent in woodland habitats including:

- high floral diversity (native and exotic) and an abundance of grasses, which provide a reliable and abundant source of seed throughout the seasons for species of bird that forage in open areas
- an absence of trees, which provides good visibility for aerial hunting by raptors and preferred foraging habitat for some species of microbat that forage over cleared areas or along woodland edges.

Riparian habitats provide optimal habitat for a range of vertebrate (particularly amphibians and reptiles) and invertebrate species. Riparian and aquatic habitats were associated with 11 of the 16 drainage lines and stormwater crossings and seven man-made waterbodies (farm dams) in the project area. Riparian habitats along the main drainage lines in the project area (Bunbury Curran Creek, tributaries of Maxwells Creek, Cabramatta Creek, Bonds Creek and Kemps Creek) were generally in moderate condition. Bunbury Curran Creek, one of the tributaries of Maxwells Creek, Scalabrini Creek and Kemps Creek also have potential to provide minimal fish habitat (permanent creeks with clearly defined bed and banks and semi-permanent to permanent waters in pools, Fairfull & Witheridge 2003). The remaining drainage lines and farm dams in the project area provide unlikely fish habitat as they are ephemeral, only flow in response to localised rainfall and generally lack semi-permanent pools.

Farm dams in the project area also provided additional aquatic habitat, particularly for frogs and water birds. However, these were generally in poor habitat condition with limited to no emergent aquatic vegetation and poor terrestrial vegetative buffers. These dams are likely to support common species of frog only, as supported by the findings of the fauna surveys (refer Section 4.6.3 of Technical Paper 2).

Developed areas included existing infrastructure, housing and market gardens that have removed woodland or derived grassland habitat types. These areas generally do not provide habitat for native animals, except those species adapted to urbanised environments like parklands, bridges, roads, culverts and buildings. The fauna habitats of the highly modified areas were in poor condition.

4.6.4 Species of animal

A total of 95 species of animal were recorded in the project area during surveys carried out for this assessment, comprising 84 native species and 11 introduced species (refer Appendix C of Technical Paper 2). The most abundant and diverse group was birds, followed by mammals, reptiles and frogs (refer Figure 4-5 of Technical Paper 2). Invertebrate surveys were targeted at the Cumberland Plain Land Snail and, therefore, the results of this assessment are by no means representative of the total invertebrate diversity in the project area.

4.6.5 State listed biodiversity and other significant features

Threatened ecological communities

Two threatened ecological communities listed under the TSC Act were identified in the project area (refer Table 4-8). These ecological communities correspond with the broad scale mapping of vegetation communities in the project area (NSW National Parks and Wildlife Service 2002a, refer Figure 4-8).

Table 4-8 Threatened ecological communities

Threatened ecological community	Corresponding vegetation communities	Conservation status[1]
Cumberland Plain Woodland	Shale Plains Woodland Shale Hills Woodland	Critically endangered
River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Alluvial woodland	Endangered

Note 1: Conservation status as listed under the TSC Act

Endangered populations

Two endangered populations are listed within the LGAs traversed by the project (Liverpool, Campbelltown and Camden), these are:

- *Dillwynia tenuifolia* at Kemps Creek suburb in the Liverpool LGA
- *Marsdenia viridiflora* subsp. *viridiflora* in the Camden and Campbelltown, LGAs.

Neither of these endangered populations was recorded in the project area.

Threatened species of plant

A total of 41 threatened species of plant listed under the TSC Act are known or predicted to occur in the locality. No threatened species of plant was detected during the surveys done for this assessment.

Potential habitat was detected for three threatened species of plant during surveys undertaken for the Concept Plan EA: *Acacia pubescens*, *Pimelea spicata* and *Pultenaea pedunculata*. Targeted searches were subsequently undertaken in patches of potential habitat. None were detected. As such, these species are considered unlikely to occur.

Threatened species of animal

A total of 48 threatened species of animal listed under the TSC Act are known or predicted to occur in the locality, comprising 14 mammals, 25 birds, two reptiles, six frogs and one invertebrate. Six threatened species of animal were recorded in the project area, with a further species not recorded but with the potential to occur based on suitable habitat (refer Table 4-9 and Figure 4-8).

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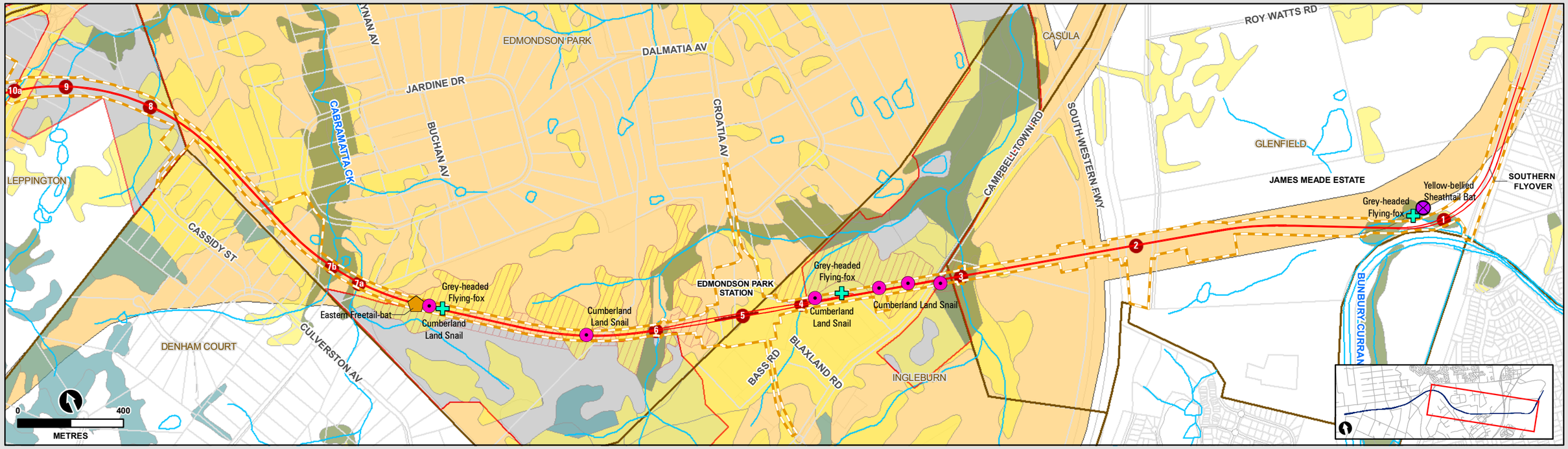

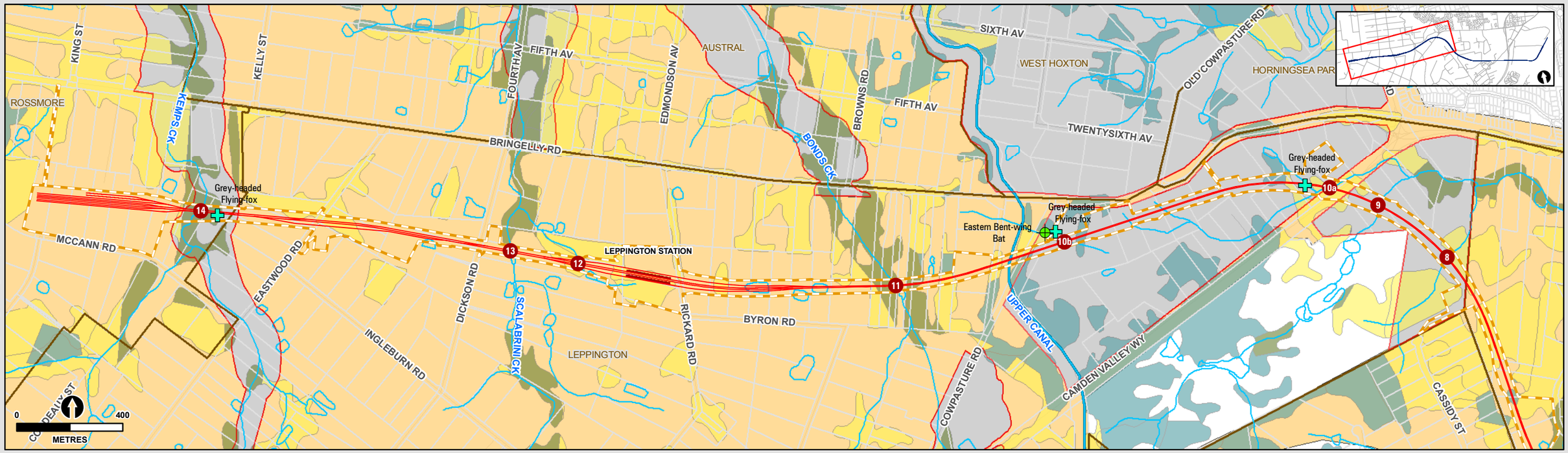

Waterway crossing
Cadastre
Suburbs
Drainage
Proposed track
Clearing footprint*

Non-certified areas
Certified areas
Cumberland Plain Land Snail habitat

Cumberland Plain Woodland
Shale Hills Woodland
Shale Plains Woodland

Sydney Coastal River-flat Forest
Alluvial Woodland

Threatened species recorded
Cumberland Plain Land Snail *(Meridolum corneovirens)*
Eastern Bent-wing Bat *(Miniopterus schreibersii oceanensis)*
Eastern Freetail-bat *(Mormopterus norfolkensis)*
Grey-headed Flying-fox *(Pteropus poliocephalus)*
Yellow-bellied Sheathtail Bat *(Saccolaimus flaviventris)*

***Note:** Clearing footprint includes likely stockpiles and construction compounds*

Figure 4-8 Threatened biodiversity recorded in the study area

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Table 4-9 Threatened species of animal recorded or likely to occur in the project area

Name	Conservation status [1]	Recorded
Cumberland Plain Land Snail (*Meridolum corneovirens*)	E	Yes
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	Yes
Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	V	Yes
Eastern Freetail-bat (*Mormopterus norfolkensis*)	V	Yes
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	V	Yes
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V	Yes
Eastern False Pipistrelle *(Falsistrellus tasmaniensis)*	V	No

Note 1: Conservation status as listed under the TSC Act. E = endangered. V = vulnerable.

Threatened species of fish

Two threatened species of fish and one invertebrate listed under the *Fisheries Management Act 1994* are known or predicted to occur in the locality: Trout Cod (*Maccullochella macquariensis*), Macquarie Perch *(Macquaria australasica)* and Adam's Emerald Dragonfly (*Archaeophya adamsi*). No suitable habitat was identified for the threatened species listed under the *Fisheries Management Act 1994.*

Critical habitat

Critical habitat is the whole or any part or parts of an area or areas of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is critical to the survival of the species, population or ecological community.

No declared critical habitat listed under the TSC Act occurs within the project area or locality.

4.6.6 Commonwealth listed biodiversity and other significant features

Three threatened ecological communities listed under the EPBC Act were identified or predicted to occur in the study area (refer Table 4-10). Cumberland Plain Woodland was the only ecological community listed under the EPBC Act identified in the study area, corresponding with the Shale Plains Woodland and Shale Hills Woodland vegetation communities (refer Figure 4-8).

Table 4-10 Summary of threatened ecological communities that are Matters of National Environmental Significance

Name	Conservation Status[1]	Recorded in study area
Cumberland Plain Woodland (Shale Plains Woodland)	CE	yes
Shale/Sandstone Transition Forest	E	no
Turpentine-Ironbark Forest in the Sydney Basin Bioregion	CE	no

Note 1: E = Endangered, CE = Critically Endangered (EPBC Act).

In the locality 12 threatened species of plant and 20 threatened species of animal listed under the EPBC Act have potential habitat (refer Table 5-5 and Appendices D and E in Technical Paper 2). Of these species, only one was recorded (Grey-headed Flying-fox). No other threatened species listed under the EPBC Act was considered likely to occur in the study area.

Migratory species

Migratory species are protected under international agreements to which Australia is a signatory. These include the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA), the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals.

Based on the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) Protected Matters Search Tool (refer Appendix E of Technical Paper 2) 13 migratory species were predicted to occur.

While migratory species of bird may potentially use the area (refer Appendix E of Technical Paper 2), the site would not be classed as an 'important habitat' as defined under the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment and Heritage 2006), in that the site does not contain:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- habitat utilised by a migratory species which is at the limit of the species range
- habitat within an area where the species is declining.

As such, it is unlikely that development within the project area would significantly affect migratory species.

4.7 Aboriginal heritage

A full Aboriginal archaeological and cultural heritage assessment was undertaken for the purpose of this EA by Australian Museum Business Services (AMBS). AMBS undertook a field survey during March, April and July 2008, focusing on areas previously identified as having archaeological potential in the Concept Plan EA assessment. The survey also looked at sites that were not able to be surveyed during the Concept Plan EA. The results of the field survey are discussed in Section 12.3.2.

The full Aboriginal archaeological and cultural heritage assessment is provided in Technical Paper 6 (Aboriginal Heritage) in Volume 2b. The existing Aboriginal heritage environment is summarised in this section, while the assessment findings and proposed mitigation measures are summarised in Chapter 12.

4.7.1 Aboriginal stakeholders

The following stakeholder groups were identified in the heritage assessment undertaken for the Concept Plan EA:

- Cubbitch Barta Native Title Claimants Aboriginal Corporation
- Darug Aboriginal Cultural Heritage Assessments
- Darug Custodian Aboriginal Corporation
- Darug Tribal Aboriginal Corporation
- Tharawal Local Aboriginal Land Council
- Northern Illawarra Aboriginal Collective.

No additional stakeholders were identified in the current assessment.

4.7.2 Aboriginal cultural heritage listings/recorded sites

A search of the appropriate heritage registers in 2006 for the Concept Plan EA identified 42 sites within a 5 by 10 kilometre corridor. A new Aboriginal Heritage Information Management System (AHIMS) search for the current project approval EA was undertaken with a 8 by 17.5 kilometre area centred on the study area (refer Table 4-11). The Concept Plan EA also recorded six sites and one possible scarred tree that are not registered on the AHIMS, but are within the area for which the AHIMS search was undertaken. AMBS (2003) also located six sites not registered on the AHIMS, while Dallas (1999) found four isolated finds. The frequencies of Aboriginal site types within three kilometres of the project area are listed in Table 4-11.

Overall, there are ten sites located in the vicinity of the project alignment: SW1 to SW4, SWST1, ISF1, MFH#2, EPCS4, EPCS7 and EPCS10 (refer Figure 4-9 and Table 4-12).

Table 4-11 Frequency of Aboriginal site types within a 8 by 17.5 kilometre centred on the study area

Site type	Number	Frequency (%)
Isolated find	88	43
Stone artefact scatter	84	42
Scarred tree (two possible)	13	6.5
Potential Archaeological Deposit (PAD)	8	4
Shelter with art	4	2
Axe grinding groove	2	1
Shelter with deposit	1	0.5
Shelter with art and deposit	1	0.5
Isolated find, scarred tree	1	0.5
Total	**202**	**100**

Table 4-12 AHIMS sites within 50 metres of the study area

Site	Site Type	Approximate Distance from Study Area
SW1	Isolated find	Within SWRL footprint
SW2	Stone artefact scatter	Within 23m of potential site compound
SW3	Isolated find	Within SWRL footprint
SW4	Isolated find	Within 40m of SWRL footprint
SWST1	Possible scarred tree	Within 24m of SWRL footprint
ISF1	Isolated find	Within potential site compound area
MFH#2	Stone artefact scatter	Area of associated PAD within SWRL footprint; surface expression of artefacts within 18m of SWRL footprint
EPCS4	Stone artefact scatter	Within SWRL footprint
EPCS7	Isolated find	Within 10m of SWRL footprint
EPCS10	Stone artefact scatter	Within 50m of SWRL footprint

4.7.3 Areas of Aboriginal archaeological sensitivity

Eleven areas of archaeological sensitivity were identified during the field survey (refer Table 4-14). Archaeological sensitivity is defined as areas in which sites are known to occur, or which have the potential to contain undetected buried Aboriginal archaeological deposits. Definitions of levels of archaeological sensitivity are provided in Table 4-13.

A summary of the identified archaeologically sensitive areas, and items that are likely to be found within these areas, is provided in Table 4-14.

Table 4-13 Definition of levels of archaeological sensitivity

Sensitivity level	Definition
No sensitivity	Artefacts very unlikely to occur. May include constructed or fully developed/excavated landscapes.
Low	Artefacts unlikely to be found in similar environmental/landscape contexts, but may occur/have been found in very low densities.
Moderate	Artefacts in detectable densities known to occur in the area, or in similar environmental/landscape contexts within the region.
High	Artefacts known to occur in high densities in the area, or are consistently identified in similar environmental/landscape contexts, and are highly likely to be detected and disturbed during ground disturbance works and archaeological excavations.