Table 13: Vegetation communities mapped in the study area

VEGETATION COMMUNITY	BIOMETRIC VEGETATION TYPE	ABBREVIATION USED	TSC ACT STATUS	EPBC ACT STATUS	VEGETATION CONDITION	TOTAL AMOUNT IN STUDY AREA (HA)
Blue Gum High Forest	Sydney Blue Gum – Blackbutt – Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin	BGHF	CEEC	CEEC	Good	1.16
					Poor	1.04
				N/A	Poor	0.1
Sydney Turpentine-Ironbark Forest	Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin	STIF	EEC	CEEC	Good	0.43
					Poor	1.83
				N/A	Good	0.43
				N/A	Moderate	0.07
				N/A	Poor	2.03
Shale/Sandstone Transition Forest	Red Bloodwood - scribbly gum healthy woodland on sandstone plateaux, Sydney Basin	SSTF	EEC	EEC	Poor	2.05
Cumberland Plain Woodland	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	CPW	CEEC	CEEC	Moderate	5.16
			CEEC	N/A	Good	0.63
			CEEC	N/A	Moderate	5.47
			CEEC	N/A	Poor	12.37
River Flat Eucalypt Forest	Forest Red Gum - Rough-barked	RFEF	EEC	N/A	Moderate	6.35

VEGETATION COMMUNITY	BIOMETRIC VEGETATION TYPE	ABBREVIATION USED	TSC ACT STATUS	EPBC ACT STATUS	VEGETATION CONDITION	TOTAL AMOUNT IN STUDY AREA (HA)
	Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin				Poor	4.43
Coastal Shale – Sandstone Forest	Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateaux, Sydney Basin	CSSF	N/A	N/A	Good	3.59
					Moderate	0.22
					Poor	3.46
					TOTAL NATIVE VEGETATION	**50.82**
Planted/Exotic	Cleared	P/E	N/A	N/A		104.66
					GRAND TOTAL	**155.48**

CEEC: Critically Endangered Ecological Community EEC: Endangered Ecological Community

Notes 1. Some vegetation meets TSC classification only, whilst some meets TSC and EPBC

2. Total hectares of vegetation type are for the study area (as opposed to impacted) are not double counted or include Area 20 vegetation

3.1.2 Native Species Recorded

A total of 397 species from 118 plant families were recorded from across the study area (Appendix J). Of the 397 species recorded, 156 (39%) were exotic weeds and 25 (6%) were introduced plantings. The families which have the greatest representation within the study area include the Poaceae (50 species), Myrtaceae (38 species), Asteraceae (26 species), and Faboideae (19 species).

3.1.3 Threatened Species

One threatened flora species, *Epacris purpurascens* var. *purpurascens* was recorded within the study area during the field surveys. A total of six (6) *Epacris purpurascens* var. *purpurascens* were located on a shale slope on the eastern edge of Cheltenham oval, which is approximately 80 m to the east of the proposed construction footprint (see Section M.4.1, Appendix M)

It is noted that *Epacris pulchella* was detected at two locations within the Cheltenham site study area. This species is not listed as threatened, but has been noted on the map (Section M.4.1, Appendix M) as it is similar in appearance to the threatened *Epacris purpurascens* var. *purpurascens.*

It is also noted that Hornsby Council staff have previously identified *Epacris purpurascens* var. *purpurascens* within, or in close proximity to, the construction footprint near Kirkham Road at the Cheltenham Services Facility site. Despite surveying this area, at the time of writing it is not been possible to confirm the location and identification of the reported *Epacris purpurascens* var. *Purpurascens.* This report assumes it is present on site but also proposes pre-clearance surveys to confirm this information (see section 5.1).

All other threatened flora species are considered unlikely to occur within the study area predominately due to the degraded nature of the existing remnant vegetation.

3.2 NOXIOUS WEEDS

Of the 156 exotic species recorded in the study area, 26 are declared noxious weeds within the Hornsby, The Hills, and Blacktown LGAs (DPI 2011). Noxious weed species recorded are included in **Table 14**.

Most of the sites surveyed had moderate to high levels of weed invasion due to disturbance from stormwater, vegetation clearance, and edge effects.

Table 14: Weeds declared noxious weeds in the Hornsby, The Hills, and Blacktown LGAs

SPECIES	COMMON NAME	CLASS	HORNSBY	THE HILLS	BLACKTOWN
Lycium ferocissimum	African Boxthorn	4		x	x
Olea europaea subsp. *cuspidata*	African Olive	4		x	x
Asparagus aethiopicus	Asparagus fern	4	x		
Cardiospermum grandiflorum	Balloon vine	4	x		
Xanthium spinosum	Bathurst Burr	4		x	

SPECIES	COMMON NAME	CLASS	HORNSBY	THE HILLS	BLACKTOWN
Rubus fruticosus aggregate species	^Blackberry	4	x	x	x
Chrysanthemoides monilifera subsp. *monilifera*	^Boneseed	4	x	x	x
Asparagus asparagoides	^Bridal creeper	4	x	x	x
Cinnamomum camphora	Camphor laurel	4	x		
Asparagus plumosus	Climbing asparagus fern	4	x		
Ageratina adenophora	Crofton weed	4		x	x
Cestrum parqui	Green cestrum	3	x	x	x
Lantana species	^Lantana	4	x	x	x
Ludwigia peruviana	^Peruvian Primrose	3		x	x
Anredera cordifolia	Madeira vine	4	x		
Bryophyllum species	Mother-of-millions	3		x	x
Ipomoea cairica	Morning glory (coastal)	4	x		
Ipomoea indica	Morning glory (purple)	4	x		
Ochna serrulata	Ochna	4	x	x	x
Echium species	Paterson's curse	4	x	x	x
Opuntia species	Prickly pear	4	x	x	x
Ligustrum lucidum	Privet (Broad-leaf)	4	x	x	x
Ligustrum sinense	Privet (Narrow-leaf)	4	x	x	X
Hypericum perforatum	St. John's wort	4	x	x	X
Tradescantia fluminensis	Trad	4	x		
Acetosa sagittata	Turkey rhubarb	4	x		

Noxious weed categories from DPI 2011. Weed categories are:

- Class 3 = The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.
- Class 4 = The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed.

^Denotes noxious weeds also declared Weeds of National Significance.

3.3 FAUNA

3.3.1 Species Recorded

Within the study area a total of 140 birds, 38 reptiles, 18 frogs, 11 flying mammal (bat) species, 16 non-flying mammal species (including ten introduced species), 2 snail species (including one introduced species), and 13 fish species (including three introduced species) have been recorded. These records are from both the field survey conducted as part of this study and from previous ecological impact assessments reviewed in preparing this report.

During the field survey migratory species (as listed under the EPBC Act) were recorded. These were *Ardea ibis* (Cattle Egret), which was recorded ten times, and *Gallinago hardwickii* (Latham's Snipe) which was recorded once (with two individuals together).

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

3.3.2 Cumberland Plain Land Snail

The Cumberland Plain Land Snail was not recorded from a total of 13 targeted search locations undertaken in potential habitat. Cumberland Plain Land Snail has been recorded in previous surveys on Tiles 10, 19 and 20. Thus, although not detected, this species was assumed to be present (section 2.6.1).

3.3.3 Amphibians

In 2008, an ecological assessment was carried out for the threatened species GGBF in the Riverstone East precinct as a requirement for BioCertification (ELA 2008). A confirmed sighting of GGBF was recorded at one site, and there was another unconfirmed sighting at a second site. The assessment recorded another six non-threatened frog species and found substantial areas of habitat for GGBF across the entire study area.

Nine frog species were recorded during the field survey conducted for the NWRL study. Three species, *Litoria fallax* (Dwarf Green Tree Frog), *Litoria peronii* (Brown Tree Frog) and *Crinia signifera* (Brown Toadlet) were commonly detected by auditory and/or visual survey; the remaining species were irregularly detected from intermittent calls, auditory survey or call playback. The threatened GGBF was not detected, despite a targeted survey including visitation to a nearby known reference site twice during the survey period. The results of the field survey are included in Appendix G.

3.3.4 Tree Hollow Survey

A total of 297 hollows were recorded in the field survey (refer to **Table 15**). Hollow size was recorded to assist with a determination on the fauna species potentially using the hollows for breeding or roosting habitat. The greatest number of hollows was recorded in large *Eucalyptus tereticornis* (Forest Red Gum) and *E. amplifolia* (Cabbage Gum) trees, which are the most common tree species in the Cumberland Plain Woodland and River Flat Eucalyptus Forest communities. A number of these trees also survive as individual senescent and decaying stag trees within exotic grassland areas.

It is noted that tree hollow surveys generally underestimate the number of hollows that are present/occur.

Table 15 Tree Hollows recorded in the field survey

VEGETATION COMMUNITY	TOTAL			
	TREES WITH HOLLOWS OF VARYING DIAMETER			
	<100MM	100 -300MM	>300MM	TOTAL
Blue Gum High Forest	1	1	0	2
Coastal Shale-Sandstone Forest	2	15	9	26
Cumberland Plain Woodland	32	10	4	46
River Flat Eucalypt Forest	15	14	6	35
Shale/Sandstone Transition Forest	18	13	1	32
Sydney Turpentine-Ironbark Forest	7	9	0	16
Planted/Exotic	31	41	15	87
Unmapped	17	28	8	53
	123	131	43	297

3.3.5 Fauna Habitat

Vegetation condition and the availability of habitat attributes varied across the study area. Vegetation within the eastern part of the study area was richer in species diversity and habitat complexity than the western part. Condition varied within each site and between sites. Fauna habitat is discussed in more detail for each site in the site profiles (**Appendix L**).

The eastern part of the study area, including the 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 alignment, including several endangered and critically endangered ecological communities. In contrast, extensive vegetation clearing, grazing and weed infestation has significantly degraded much of the native vegetation within the western alignment.

The following fauna habitats are of note:

- Habitat at Epping has been affected by small remnant patch size, adjacent urban areas, and weed species.
- The eastern part of the alignment although fragmented by urban development contained scattered urban trees and riparian corridors providing suitable connectivity between habitat patches only for highly mobile species.
- At the Cheltenham Service Facility 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 Devlin Creek.

- At the Cherrybrook Station native shrubs and groundcover species were poorly represented in areas of high weed infestation and mechanical disturbance. Weed infestation was severe within the poor condition patch of BGHF at the Cherrybrook Station site. Whilst the area of BGHF classified as good condition had weed species, native species were regenerating.
- The Hills Centre Station 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 mechanical disturbance. The Hills Centre Station area contained scattered *Eucalyptus racemosa* with several hollows of varying size and shape in each tree. Hollow-dependant avian species including, migratory species such as *Eurystomus orientalis* (Dollarbird) were observed nesting in hollows and foraging in tree canopy.
- For the north-western portion of the alignment (from Tile 14 – 18) large tracts of exotic perennial grasses, *Pennisetum clandestinum* and *Bromus sp* dominated, and native species richness was low. Clearing of vegetation, underscrubbing and grazing have degraded habitat. A few small pockets of moderate Cumberland Plain Woodland (CEEC) vegetation in moderate condition were retained in private lots. Some regenerating CPW canopy trees, *Eucalyptus tereticornis* and *E. crebra*, were present, which could provide foraging resources for winter migrant bird species. Occasional mature canopy trees were present with hollows.
- The north-western portion of the alignment 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 perennial 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.
- Ephemeral and permanent water bodies were well represented within the north-western portion of the alignment, including: minor creeks (Elizabeth Macarthur and Caddies Creek), secondary drainage lines (Charlies Creek), farm dams and constructed wetlands off Becky Place and Norwest Boulevard. Water bodies were generally in poor health with nutrient enrichment and absence of native vegetation cover; however reptile and amphibian and wading avian species were noted during field inspection. Exotic species such as *Ligustrum lucidum* (Large Leaved Privet) and *L. sinense* (Small Leaved Privet) were present along riparian corridors. Generally native resilience was low, particularly in areas of high weed infestation.

Additional details on riparian and aquatic habitats are provided in the NWRL riparian assessment report (ELA 2012b).

3.4 THREATENED AND MIGRATORY FLORA AND FAUNA SPECIES

3.4.1 Data and literature review

Table 16 identifies threatened and migratory species identified in datasets within 10km of the project area (see **Appendix A** for detailed list).

Table 16: Threatened and migratory fauna listed in data sets within 10 km radius of the study area

FAUNA GROUP	TSC ACT	TSC ACT POPULATION	EPBC ACT	EPBC ACT MIGRATORY
Fish			2	
Frogs	6		5	

FAUNA GROUP	TSC ACT	TSC ACT POPULATION	EPBC ACT	EPBC ACT MIGRATORY
Reptiles	2		1	
Birds	40	2	3	6 + 10 other EPBC listed migratory
Mammals (excluding bats)	7	1	5	
Bats	8		2	
Invertebrates	1			
Total	63	3	18	6

3.4.2 Threatened Flora and Fauna Known, Likely, or Potentially Occurring

Likelihood tables are presented in Appendix A for all threatened species.

One threatened flora species *Epacris purpurascens* var. *purpurascens* was recorded within the study area (but outside of the proposed construction footprint). Whilst potential habitat was present for a number of other threatened flora species, targeted searches of the study area during appropriate survey seasons did not record any other threatened flora. Therefore, it was considered unlikely that other threatened flora species occur in the study area.

Table 17 identifies those fauna species for which the study area is likely to provide habitat with impact assessments provided for these species in **Appendix M**.

No threatened fish or reptiles are considered likely to occur in the study area.

Table 17: Threatened Fauna Species likely, or with the potential, to occur in the Study Area

SCIENTIFIC NAME	COMMON NAME	TSC ACT *	EPBC ACT *	LIKELIHOOD OF OCCURRENCE
AMPHIBIANS				
Litoria aurea	Green and Golden Bell Frog	E	V	Potential. Not observed during field survey.
DIURNAL BIRDS				
Anthochaera phrygia	Regent Honeyeater	E	E & M	Potential. Highly mobile species that has been previously recorded within the study area (Wildlife Atlas records).
Callocephalon fimbriatum	Gang-gang Cockatoo	V, E2	-	Likely. Previously recorded within and near the study area.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Likely. Previously recorded near the study area.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	Potential. Recorded near to study area and marginal habitat present in the study area.
Daphoenositta chrysoptera	Varied Sittella	V	-	Potential. Recorded near the study area and marginal habitat present.
Lathamus discolor	Swift Parrot	E	E	Likely. Highly mobile species that has been previously recorded within the study area (Wildlife Atlas records).
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	Potential. Marginal habitat within the study area and Wildlife Atlas Record near the study area.
Neophema pulchella	Turquoise Parrot	V	-	Potential. Marginal habitat within the study area and Wildlife Atlas Record near the study area.
Petroica boodang	Scarlet Robin	V	-	Potential. Marginal habitat within the study area and Wildlife Atlas records near the study area.
Ptilinopus superbus	Superb Fruit-Dove	V	-	Potential. Marginal habitat present. Wildlife Atlas records near the study area.

SCIENTIFIC NAME	COMMON NAME	TSC ACT *	EPBC ACT *	LIKELIHOOD OF OCCURRENCE
NOCTURNAL BIRDS				
Ninox corneovirens	Barking Owl	V	-	Potential. Marginal habitat present in the study area. Wildlife Atlas records near the study area.
Ninox strenua	Powerful Owl	V	-	Likely. Potential habitat present in the study area. Wildlife atlas records near the study area.
MAMMALS (excluding bats)				
Dasyurus maculatus maculatus	Spotted-tailed Quoll (SE Mainland Population)	V	E	Potential. Marginal habitat present in the study area. One Wildlife Atlas record from 2001 near Castle Hill.
MAMMALS (bats)				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Potential. Marginal habitat present in the study area.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Likely. Marginal habitat present in the study area. Wildlife Atlas records near the study area.
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Likely. Known from the study area at Cheltenham.
Mormopterus norfolkensis	East Coast Freetail Bat	V	-	Likely. Marginal habitat present in the study area. Wildlife Atlas records near the study area.
Myotis macropus (formerly *M. adversus*)	Southern Myotis, Large-footed Myotis	V	-	Potential. Marginal habitat in the study area. Wildlife Atlas records near the study area.
Pteropus poliocephalus	Grey-headed Flying-Fox	V	V	Yes. Suitable habitat in the study area. Wildlife Atlas records near the study area.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Potential. Marginal habitat in the study area. Wildlife Atlas records near the study area.
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Potential. Marginal habitat in the study area. Wildlife Atlas records near the study area.
INVERTEBRATES				

SCIENTIFIC NAME	COMMON NAME	TSC ACT *	EPBC ACT *	LIKELIHOOD OF OCCURRENCE
Meridolum corneovirens	Cumberland Plain Land Snail	E	-	Potential. Marginal habitat in the study area. Wildlife Atlas records near the study area.
MIGRATORY BIRDS				
Apus pacificus	Fork-tailed Swift	-	M	Potential. Highly mobile species.
Hirundapus caudacutus	White-throated Needletail	-	M	Potential. Highly mobile species.
Monarcha melanopsis	Black-faced Monarch	-	M	Potential. Marginal habitat in the study area.
Myiagra cyanoleuca	Satin Flycatcher	-	M	Potential. Marginal habitat in the study area.
Rhipidura rufifrons	Rufous Fantail	-	M	Potential. Marginal habitat in the study area.
Ardea alba	Great Egret	-	M	Potential. Marginal habitat in the study area.
Ardea ibis	Cattle Egret	-	M	Yes. Ten birds identified within study area, though habitat in the study area is marginal.
Gallinago hardwickii	Latham's Snipe	-	M	Yes. Two birds identified within study area

* E = Endangered, E2 = Endangered Population, M = listed migratory species, V = Vulnerable

4 Identification of Impacts

This section of the assessment outlines the anticipated impacts from the Project on the ecological values of the study area. The direct and indirect impacts outlined below are considered the 'worst case' impact of the Project. It is envisaged that modifications identified prior to construction would require (at a minimum) to be included in the Environmental Management Framework, which could potentially reduce the impacts of the project.

Detailed impacts have been assessed in accordance with the SSI requirements and in accordance with the EP&A Act principle of improving or maintaining (IoM) biodiversity values (**Appendix M**). Relevant subsections below summarise impacts in relation to listed vegetation communities, flora, and fauna species. These sections separate out those impacts that occur within the NWGC under biocertification from those that occur to uncertified vegetation.

Indirect impacts have also been estimated based on the approach presented in 2.10.2. It is noted that these indirect impacts will not constitute loss of all habitat, rather additional degradation within an urban and already fragmented context. The project will indirectly impact on vegetation communities and flora and fauna species present in the study area, through habitat fragmentation, introducing additional artificial light, increasing noise levels, changing microclimates, and encouraging weed invasion. Indirect impacts were calculated for the areas of vegetation around the construction footprint.

Individual indirect impacts are discussed in stand-alone sections below but also considered in the calculations alongside direct impacts in the following sections. Information on how the Project relates to key threatening processes as well as consideration of SEPP 19 – Bushland in Urban Areas, is also presented in this section.

4.1 VEGETATION IMPACTS

A total of 30.87 ha of native vegetation would be directly impacted by the proposal and it is estimated 6.32 ha of native vegetation will be indirectly impacted (**Table 18**). Approximately 39% of this impact is within the NWGC. The condition of the vegetation impacted as follows:

- Good - 5.35 ha (17.33%)
- Moderate - 10.17 ha (32.95%) and
- Poor – 15.35 ha (49.72%),

Table 18 provides a detailed breakdown of impacts on vegetation communities in the Project area.

Table 18: Vegetation communities impacted by the North West Rail Link

VEGETATION COMMUNITY	TSC ACT STATUS	EPBC ACT STATUS	CONDITION	DIRECTLY IMPACTED (HA)			INDIRECTLY IMPACTED (HA)		
				WITHIN NWGC	OUTSIDE NWGC	TOTAL	WITHIN NWGC	OUTSIDE NWGC	TOTAL
Blue Gum High Forest	CEEC	CEEC*	Good	-	-	-	-	0.15	0.15
			Poor	-	0.91	0.91	-	0.01	0.01
		N/A	Poor	-	0.10	0.10	-	-	-
Coastal Shale-Sandstone Forest	N/A	N/A	Good	-	0.88	0.88	-	0.86	0.86
			Poor	-	0.45	0.45	-	0.3	0.3
Shale/Sandstone Transition Forest	EEC	EEC	Poor	-	0.78	0.78	-	0.38	0.38
Sydney Turpentine-Ironbark Forest	EEC	N/A	Good	-	0.01	0.01	-	0.09	0.09
		CEEC*	Poor	-	0.04	0.04	-	0.08	0.08
		N/A	Poor	-	0.27	0.27	-	0.26	0.26
Cumberland Plain Woodland	CEEC	CEEC*	Good	3.26	-	3.26	0.05	-	0.05
			Moderate	-	4.66	4.66	-	0.39	0.39
		N/A	Good	-	0.63	0.63	-	-	-
			Moderate	1.36	3.66	5.02	0.06	0.29	0.35
			Poor	6.6	4.93	11.53	0.96	0.64	1.60
River Flat Eucalypt Forest	EEC	N/A	Good	0.57	-	0.57	0.31	-	0.31
			Moderate	0.03	0.46	0.49	0.37	0.80	1.17
			Poor	0.34	0.93	1.27	0.01	0.31	0.32
Total Native Vegetation				**12.16**	**18.71**	**30.87**	**1.76**	**4.56**	**6.32**

Notes:

NWGC = NWGC.

* Not all TSC listed vegetation patches meet the EPBC Act definition for Blue Gum High Forest, Cumberland Plain Woodland, and Sydney Turpentine-Ironbark Forest.

4.1.1 NWGC

4.1.1.1 The Sydney 'Growth Centres SEPP' EP&A Act Certification

The *Sydney* 'Growth Centres SEPP' EP&A Act Certification has 'bio-certified' (s126G of the EP&A Act) Area 20 and Riverstone East in the western portion of the NWRL alignment. BioCertification negates the requirement for impact assessment under s.5A of the EP&A Act, thus turning off the requirements for seven part tests or species impact statements. Subsequent development applications within certified areas in the precinct will be considered biodiversity compliant developments and certified vegetation is effectively approved for removal.

Table 19 details the extent and types of vegetation community impacts within the NWGC. Within Area 20 and Riverstone East the Project footprint will result in the direct removal of up to 12.16 ha of native vegetation (**Table 19**). If potential indirect impacts are included (noting that the majority of vegetation is approved for removal) the total area of impacted vegetation is 13.92 ha, all of which comprises threatened ecological communities (Cumberland Plain Woodland 12.29 ha and River Flat Eucalypt Forest 1.63 ha). The certification does not hold for areas of 'non-certified' native vegetation but these areas are able to be utilised for essential infrastructure (pursuant to condition 11 of the Ministers conditions) provided such areas are equally compensated (additional offset or revegetation).

Table 19: Summary of impacts on native vegetation in the NWGC

VEGETATION COMMUNITY AND PRECINCT	TSC ACT	EPBC ACT	NATIVE VEGETATION IMPACTED (HA)				TOTAL (HA)
			DIRECT IMPACTS		INDIRECT IMPACTS		
			CERTIFIED	NON-CERTIFIED	CERTIFIED	NON-CERTIFIED	
Cumberland Plain Woodland – Area 20	CEEC	CEEC	3.26	-	0.05	-	3.31
	CEEC	-	5.60	0.08	0.85	0.04	6.57
Cumberland Plain Woodland – Riverstone East	CEEC	CEEC	-	-	-	-	-
	CEEC	-	2.28	-	0.13	-	2.41
Cumberland Plain Woodland Total			**11.14**	**0.08**	**1.03**	**0.04**	**12.29**
River Flat Eucalypt Forest – Area 20	EEC	Not listed	-	0.57	-	0.31	0.88
River Flat Eucalypt Forest – Riverstone East	EEC	Not listed	0.37	-	0.38	-	0.75
River Flat Eucalypt Forest Total			**0.37**	**0.57**	**0.38**	**0.31**	**1.63**
TOTAL			**11.51**	**0.65**	**1.41**	**0.35**	**13.92**

A total of 0.65 ha of mapped vegetation would be directly impacted by the construction footprint for the Project, and a further 0.35 ha of non-certified vegetation would be indirectly impacted by the Project.

From the perspective of assessment under the Biodiversity Certification Order it is the amount of

existing native vegetation (ENV) within non-certified land that needs to be considered. The amount of ENV (as identified by the Growth Centres Conservation Plan 2003) affected by the construction footprint within Riverstone East is 2.75 ha, all of which is certified; and within Area 20 a total of 8.26 ha of certified ENV, and a further 0.50 ha on non-certified ENV. The ENV areas as mapped by GCC 2007 and the areas of non-certified lands are provided in **Appendix Q**.

Impacts to native vegetation occurring within the certified lands have already been considered and offset as part of the NSW Biocertification process under the TSC Act. Standard mitigation measures would apply. Impacts on non-certified native vegetation within the NWGC must be compensated for at a ratio of 1:1 as per the GCC development code, or at a ratio of 3:1 for revegetation and/or restoration (see **Appendix N** – Offsetting Strategy).

4.1.1.2 EPBC Vegetation Communities

The Strategic Assessment endorsed by the Federal Environment Minister in December 2011 did not include specific classes of action exempt from further EPBC Act assessment. It is understood this process is occurring currently. Once the classes of action permitted under the endorsed strategic assessment are finalised, the impact of the rail alignment provided for within the NWGC would be exempt from further EPBC Act assessment so long as it complies with GCC development code requirements. A separate referral to SEWPaC to assess impacts on MNES specifically addresses these EPBC Act requirements.

4.1.2 Outside of NWGC

The construction footprint outside the NWGC will result in the direct removal of approximately 18.71 ha native vegetation and an estimated 4.56 ha will be affected via indirect impacts. **Table 20** shows the area of each native vegetation community directly and indirectly impacted, and the total estimated area of each community within its distribution.

Table 20: Summary of impacts on TSC Act listed native vegetation outside the NWGC

VEGETATION COMMUNITY	TSC ACT	EPBC ACT	AREA IMPACTED (HA)		TOTAL (HA)
			DIRECT IMPACTS	INDIRECT IMPACTS	
Blue Gum High Forest	CEEC	CEEC*	1.01	0.16	1.17
Sydney Turpentine-Ironbark Forest	EEC	CEEC**	0.32	0.43	0.75
Shale/Sandstone Transition Forest	EEC	EEC	0.78	0.38	1.16
Cumberland Plain Woodland	CEEC	CEEC*	13.88	1.32	15.20
River Flat Eucalypt Forest	EEC	N/A	1.39	1.11	2.50
Coastal Shale – Sandstone Forest	N/A	N/A	1.33	1.16	2.49

Total			**18.71**	**4.56**	**23.27**

Notes: *Not all TSC listed vegetation patches meet the EPBC Act definition for STIF and CPW
EPBC Act definition of STIF includes Blue Mountains Shale Cap Forest and Turpentine-Ironbark Forest. * Has been calculated from NPWS 2002b and DECCW 2009

Most of the impacted vegetation is threatened. This comprises a total of 20.78ha (17.38 ha directly impacted and 3.40 ha indirectly impacted) listed under the TSC Act and 7.40 ha (6.39 ha directly impacted and 1.01 ha indirectly impacted) listed under the EPBC Act.

The largest direct impact in any one threatened vegetation community will occur in Cumberland Plain Woodland (13.88 ha), which will constitute a loss of less than 0.13 % of its entire distribution. A direct loss of 1.39 ha will occur in the River Flat Forest vegetation community, which is less than 0.03% of its distribution.

Blue Gum High Forest will experience the greatest proportional loss in terms of the distribution of the vegetation community (in the order of 0.86%), with clearance of 1.01 ha and another 0.16 ha of indirectly impacted. The Blue Gum High Forest vegetation, however, was unlikely to have survived as a community into the immediate future without major restoration works, due to its extremely degraded condition. Regardless, it is recognised that individual canopy trees contribute to genetic diversity within the local population.

Proportional losses for the remaining two threatened vegetation communities are relatively low, with impacts on Sydney Turpentine-Ironbark Forest (0.32 ha) accounting for a 0.02% loss in distribution and impacts on Shale/Sandstone Transition Forest (0.78 ha) accounting for a 0.008% loss.

Celebration Drive to Balmoral Road (Tile 14) will experience the greatest loss of native vegetation with 6.62 ha (4.66 moderate condition and 1.96 poor condition) of Cumberland Plain Woodland directly impacted (cleared) and another 0.39 ha indirectly impacted.

The only site where Shale/Sandstone Transition Forest occurs is the Hills Centre Station (Tile 10) where 0.78 ha will be cleared and a further 0.38 ha indirectly impacted. Cherrybrook, (Tile 6) is the only site where Blue Gum High Forest occurs. A total of 1.01 ha of highly degraded vegetation will be cleared and up to another 0.16 ha of vegetation indirectly impacted.

Sydney Turpentine-Ironbark forest occurs at Epping (Tile 1), Cheltenham (Tiles 2 and 3) and the Hills Centre Station (Tile 8). Only 0.32 ha of this vegetation community will be directly impacted.

River Flat Eucalypt Forest is present at Burns Road to Samantha Riley Drive (Tiles 15 and 16), Samantha Riley Drive to Windsor Road (Tiles 16 and 17) and Windsor Road to Sanctuary Drive (Tile 17). Across these areas combined, a total of 2.33 ha of River Flat Forest will be directly impacted.

Mitigation measures will be implemented to further minimise impacts during construction, and VMPs will be prepared and implemented in retained vegetation areas with high biodiversity values.

The degree of loss and indirect impact on EPBC Act listed vegetation outside of the NWGC is the same as TSC Act vegetation outcomes for the Blue Gum High Forest and Shale/Sandstone Transition Forest vegetation communities. The loss for Sydney Turpentine-Ironbark Forest is less than for TSC Act vegetation, with 0.04 ha of direct loss and 0.08 ha of estimated indirect impact.

The loss for Cumberland Plain Woodland is less than for TSC Act vegetation, with 4.66 ha of direct loss and 0.39 ha of estimated indirect impact. This significant difference in areas impacted (EPBC

compared to TSC Act listings) is due to the definition of CPW under the EPBC and its incorporation of patch size and condition thresholds to classification.

4.2 THREATENED FLORA IMPACTS

One threatened flora species, *Epacris purpurascens* var. *purpurascens* occurs within the Cheltenham site study area, though outside of the proposed construction footprint for the Cheltenham Services Facility. Searches within the Cheltenham site located a related non-listed species, *Epacris pulchella*, but did not locate any other *Epacris purpurascens* var. *purpurascens.* An impact assessment in accordance with the TSC Act for *Epacris purpurascens* var. *purpurascens* has been undertaken (see **Appendix M)**. Some potential habitat may be disturbed within the construction footprint. Six (6) individuals are located approximately 80m east of the proposed construction footprint and are not expected to be impacted by the proposal.

Targeted searches within the NWRL study area did not record any other threatened flora species. Other threatened flora species are considered unlikely to occur, predominately due to their absence during optimum survey periods and due to the majority of vegetation being in a degraded condition or previously impacted by historical and residential land use practices.

No significant impacts on threatened flora species are anticipated as *Epacris purpurascens* var. *purpurascens* is located outside of the proposed construction footprint and other threatened flora are considered unlikely to occur within the study area.

However, due to uncertainty of the previous record within, or in close proximity to, the construction footprint for the Cheltenham Services Facility site (see section 3.1.3), additional pre-clearance surveys are recommended (see section 5.1).

4.3 THREATENED FAUNA IMPACTS

The study area provides a variety of habitat features for a range of threatened fauna species. The direct vegetation loss outlined in section 4.1 will result in the removal of known or potential habitat, including primary habitat (breeding/roosting sites with hollow bearing trees used as an indicator) and secondary habitat (foraging). The assumptions underpinning the identification of primary and secondary habitat for each threatened fauna species are detailed in **Appendix M**. Apart from direct impacts to fauna through loss of habitat, there will be indirect impacts, which are discussed in Section 4.4.

Twenty-three (23) threatened fauna species listed under the TSC Act have the potential to occur within the study area as shown in **Appendix A**. Table 22 below summarises the area (or number of tree hollows) of primary and secondary threatened fauna habitat directly and indirectly impacted by the Project. The table includes figures for Area 20 and Riverstone East in the Growth Centres (shown separately inside brackets). State significant impact assessments have been undertaken for these threatened species and are contained in **Appendix M**. The State significant assessments have been grouped where species occupy a similar ecological niche or display common habitat preferences. Impact assessments have been undertaken for the known, likely, or potentially occurring threatened species and are outlined in **Appendix M**.

4.3.1 EPBC Act listed fauna species

A total of six (6) threatened fauna species listed under the EPBC Act have the potential to be impacted by the Project directly through habitat loss, including loss of hollow bearing trees, or indirectly. These include: Green and Golden Bell Frog; Swift Parrot; Regent Honeyeater; Large-eared Pied Bat; Grey-headed Flying-fox; and Spotted-tailed Quoll. In addition a total of nine (9) migratory fauna (including the Regent Honeyeater) listed under the EPBC Act were identified as either occurring or having the potential to occur within the study area.

Estimated risks to habitat for each threatened fauna species as outlined in Table 22.

4.3.2 Hollow-dependent Fauna

Nine (9) threatened fauna species will be impacted to some degree by the direct loss of hollow-bearing trees. Table 21 details the number of hollow-bearing trees that will be lost within each vegetation community and has been used to estimate the amount of primary habitat lost for hollow dependent fauna species (shown in Table 22), based on their habitat preferences and size of hollow required for breeding (see Table 30 in **Appendix M**).

The hollow-dependent fauna consist of birds and bats that use tree hollows for breeding. There are only two (2) potential breeding hollow for Powerful and Barking Owl (which require large tree hollows) that will be removed. However, there will be 58 potential breeding hollows for tree-roosting microbats (which can breed in small tree hollows) that would be cleared, and 37 potential breeding hollows for Turquoise Parrot removed. Thirteen (13) potential breeding hollows for Glossy Black-cockatoo and 9 for Gang-gang Cockatoo will be cleared. Potential breeding habitat for Brown Treecreeper will not be directly impacted.

Table 21: Number and size of tree hollows directly impacted for each vegetation community

VEGETATION COMMUNITY	DIRECT IMPACT		
	TREES WITH HOLLOWS OF VARYING DIAMETER		
	<100MM	100 -300MM	>300MM
Blue Gum High Forest	1	1	0
Coastal Shale-Sandstone Forest	1	6	1
Cumberland Plain Woodland	27	6	1
River Flat Eucalypt Forest	4	1	2
Shale Sandstone Transition Forest	3	5	0
Sydney Turpentine Ironbark Forest	0	0	0
Planted/Exotic	16	21	7
Unmapped	6	3	0

* Isolated trees outside mapped vegetation community classifications.

Table 22 summarises the area (or number of tree hollows) of primary and secondary threatened fauna habitat directly and indirectly impacted by the Project. The table includes figures for Area 20 and Riverstone East in the Growth Centres separately (inside brackets). Detailed improve or maintain assessments are provided in **Appendix M**.

Apart tree-hollows, potential primary (breeding) habitat for four threatened fauna species including listed under EPBC Act were identified: the Cumberland Plain Land Snail (Cumberland Plain Land Snail), Green and Golden Bell Frog (GGBF), Scarlet Robin and Varied Sittella. The remaining nine (9) fauna species listed in Table 22 either do not breed within the study area due as having the potential to their migratory nature, or breeding habitat is absent from the study area. Primary habitat for Scarlet Robin and Varied Sittella is the same as secondary habitat and the direct loss is highest for both species within the NWGC. At a regional level, the loss of habitat is very small for both species.

4.3.3 Cumberland Plain Land Snail

The total loss of potential habitat for the Cumberland Plain Land Snail in a regional context is very small (0.10%) with most of this loss occurring within the NWGC. However, given the vulnerability of this species to fragmentation, habitat disturbance and a reduction in patch size, any loss of known habitat may result in local extinction of the species over time (Clark and Richardson 2002).

During recent surveys by Eco Logical Australia, the Cumberland Plain Land Snail was not recorded from a total of 13 targeted search locations undertaken in potential habitat. However, the species was has been previously recorded in past ecological surveys on Tiles 10, 19 and 20. Therefore, predicting impacts to this species is pre-cautionary and a worst case scenario. It is recommended that consideration is given to the potential to utilise timber from felled trees as logs in areas outside of the construction footprint to be managed via Vegetation Management Plans (VMPs).

4.3.4 Green and Golden Bell Frog (GGBF)

The GGBF was not recorded during targeted surveys during optimal survey periods and weather conditions. There is only a small amount of potential GGBF breeding habitat that would be impacted by the NWRL alignment. This habitat is considered marginal due to the presence of Mosquito Fish (*Gambusia holbrooki*).

Secondary habitat for the GGBF is defined as movement corridors with 3.25 ha calculated to be directly impacted, and 1.53 ha of this being within the NWGC. Foraging habitat for this species has not been estimated in this study. GGBF could forage across a broader area than just movement corridors, however there are significant limitations in making an adequate assessment of broader foraging habitat and consequently this type of habitat has not been included in 'secondary habitat' for this species.

Given the scattered distribution, and relative isolation between populations of GGBF, the area of regional habitat for GGBF was not able to be determined by this study and is not known from background research. The mapped movement corridors predict a tenuous (given development across the landscape and barriers including roads) connection between the semi-captive breeding population at Riverstone with First Ponds Creek and sections of along Caddies Creek and Elizabeth Macarthur Creek. Impacts to this 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. At this location, the presence of roads and other development already renders potential habitat values as low.

It is unlikely that the NWRL will significantly or directly impact on GGBF. Sedimentation and erosion controls and treatments of riparian areas will be important to limit downstream influences on all amphibian populations.

4.3.5 Loss of secondary habitat

Direct loss of secondary habitat is highest for birds and bats that forage across of variety of habitat types, including Gang-gang Cockatoo, Swift Parrot, Black-chinned Honeyeater, Superb Fruit-dove, Regent Honeyeater, Grey-headed Flying-fox and six microbat species. However, when considering this habitat loss at a regional level, the percentage of secondary habitat removed as a result of the NWRL would be very low (0.05 - 0.06%) for the birds and Grey-headed Flying-fox; and low for the Regent Honeyeater (0.11%) and six microbat species (0.10%). Given that all these species are highly mobile, while they will experience some loss of foraging habitat, they can move to more preferable areas of habitat throughout the region.

Small losses of potential secondary habitat are predicted for Glossy Black-Cockatoo, Brown Treecreeper, Powerful Owl and Barking Owl, based on their foraging habitat preferences being relatively poorly represented within the study area. Consequently, the impacts to secondary habitat at a regional level are very low for these species.

Loss of secondary habitat for the Turquoise Parrot is still very low (0.13%), but is higher than all other species. This is largely a result of the assumptions made when calculating habitat at a regional level. Secondary habitat was defined as good to moderate condition Cumberland Plain Woodland and River Flat Eucalypt Forest and the regional extent of habitat for this species was defined as this same habitat type/condition within the Cumberland Plain. Most of the other regional habitat ranges extended beyond the Cumberland Plain and included the Sydney Metro CMA mapping project study area. The actual range of the Turquoise Parrot extends from southern Queensland to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. The minor loss of secondary habitat that would result from the NWRL is unlikely to negatively impact this highly mobile species.

The only threatened non-flying mammal that may occur within the study area is the Spotted-tailed Quoll. This species requires a large foraging area and has very large home ranges and is unlikely to breed in the study area given the specific habitat requirements, including an abundance of prey items, maternal den sites and largely intact forest with a diversity of structural layers. Dispersing individuals may wander into the study area from time to time from better areas of habitat to the north. A small area of secondary habitat would be removed for this species and a very small percentage of habitats impacted on a regional scale for impacts to be considered negligible.

Table 22: Summary of primary and secondary habitat lost for each threatened fauna species with the potential to occur in the construction footprint area.

SPECIES	TSC ACT *	EPBC ACT *	HABITAT IMPACTED (HA)				TOTAL AREA IMPACTED (HA)	AREA IMPACTED INCLUDING NWGC (HA)	AREA OF HABITAT WITHIN THE REGION (HA)	% OF HABITAT IMPACTED ED
			PRIMARY		SECONDARY					
			DIRECT	INDIRECT	DIRECT	INDIRECT				
Cumberland Plain Land Snail	E	-	0.63 (3.83)	2.43 (1.76)	Same as primary habitat		3.06 (5.59)	8.65	8519.73	0.10
Green and Golden Bell Frog	E	V	0.11 (0.50)	0.02 (0.00)	1.72 (1.53)	0.81 (0.20)	2.66 (2.23)	4.89	N/A	N/A
Glossy Black-cockatoo	V	-	13 (0) hollows	24 (0) hollows	4.83 (0.94)	3.24 (0.69)	8.07 (1.63)	9.70	33262.44	0.03
Gang-gang Cockatoo	V, E2	-	9 (0) hollows	8 (0) hollows	18.71 (12.16)	4.56 (1.76)	23.27 (13.92)	37.19	50009.98	0.07
Swift Parrot	E	E	None Known	None Known	18.71 (12.16)	4.56 (1.76)	23.27 (13.92)	37.19	50009.98	0.07
Turquoise Parrot	V	-	37 (0) hollows	24 (0) hollows	9.41 (5.22)	1.48 (0.79)	10.89 (6.01)	16.90	11474.3	0.15
Powerful Owl	V	-	2 (0) hollows	1 (0) hollows	2.39 (0.00)	2.32 (0.00)	4.71 (0.00)	4.71	17467.82	0.03
Barking Owl	V	-	2 (0) hollows	1 (0) hollows	2.39 (0.00)	2.32 (0.00)	4.71 (0.00)	4.71	17467.82	0.03
Scarlet Robin	V	-	0.63 (3.26)	0.00 (0.05)	Same as primary habitat		0.63 (3.31)	3.94	5250.71	0.08
Brown Treecreeper	V	-	0 (0) hollows	0 (0) hollows	0.63 (3.83)	0.00 (0.36)	0.63 (4.19)	4.82	8519.73	0.06
Varied Sittella	V	-	1.52 (3.83)	1.10 (0.36)	Same as primary habitat		2.62 (4.19)	6.81	19914.17	0.03
Black-chinned Honeyeater	V	-	None Known	None Known	16.05 (12.16)	None Known	16.05 (12.16)	28.21	43195.36	0.07
Superb Fruit-dove	V	-	None Known	None Known	17.19 (8.33)	None Known	17.19 (8.33)	25.52	50009.98	0.05
Regent Honeyeater	E	E & M	None Known	None Known	15.27 (12.16)	2.43 (1.76)	17.70 (13.92)	31.62	24785.67	0.13
Yellow-bellied Sheathtail-bat	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Eastern False Pipistrelle	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
East Coast Freetail Bat	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Greater Broad-nosed Bat	V	-	58 (0) hollows	19 (0) hollows	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Eastern Bent-wing Bat	V	-	None Known	Known roosting culvert under M2 at Cheltenham	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Large-footed Myotis	V	-	None Known	None Known	Foraging habitat comprises waterbodies such as small farm dams and creeklines					N/A
Large-eared Pied Bat	V	V	None Known	None Known	18.71 (12.16)	13.56 (6.53)	32.27 (18.69)	50.96	50009.98	0.10
Grey-headed Flying-fox	V	V	None Known	None Known	18.71 (12.16)	None Known	18.71 (12.16)	30.87	50009.98	0.06
Spotted-tailed Quoll	V	E	None Known	None Known	1.38 (0.00)	None Known	1.38 (0.00)	1.38	17467.82	0.01

* E = Endangered, E2 = Endangered Population, M = listed migratory species, V = Vulnerable

Notes: separate figures in (brackets) represent the impacted habitat in the Growth Centres.

Third last column shows the total of impacted habitat inside and outside the Growth Centres.

Columns showing total impacted habitat areas do not include tree hollows.

4.3.6 Risk of Fauna Collision with Trains or Other Infrastructure

Although a majority of the railway line would be underground and not present a collision risk for fauna, there would also be above ground elements, including construction machinery and static structures (to be assessed under EIS 2 for the NWRL project), which have the potential to present collision hazard to fauna. Trains travelling at high speeds would also present a risk. However, the NWRL will be constructed 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.

Where the NWRL emerges, and particularly for viaduct sections, infrastructure may present a collision risk. It is likely that most fauna will detect solid above ground structures and be able to avoid collisions. Wires or other smaller elements may be more difficult to detect. It is likely that the greatest fauna collision risk is with trains travelling at speed along the viaduct. Scientific research is sparse on the mortality of Australian fauna due to train collisions, and thus it is difficult to predict the impact of train movements and potential collisions with fauna. The rail viaduct will generally occur within an open landscape where flight pathways are less influenced by canopy density and vegetation structure, and thus it is likely the openness of the landscape will assist in reducing the likelihood that trains will collide with fauna.

Factors reducing the likelihood of ground dwelling fauna being at risk include: a large part of the NWRL being underground and/or on viaduct sections, fencing to be erected along ground-access portions of the alignment, and a paucity of ground dwelling native mammals present, or likely to be present, in the study area.

Many migratory and regional movements of bird species (eg 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.

While there is a risk that the construction and operation of the NWRL will increase the injury/mortality rates of wildlife due to collision with moving trains or other associated static infrastructure, this risk is considered to be low. The highest risk will 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.

4.4 INDIRECT IMPACTS

4.4.1 Increased Weed Invasion

Much of the vegetation in the study area comprises small remnants in an urban environment and is already impacted by high levels of weed invasion. Vegetation clearance associated with the construction footprint would increase the potential for weed invasion in adjacent retained vegetation. However, this impact will be minimised through clearing controls, stockpile and stormwater management and weed control during construction and appropriate rehabilitation and/or landscaping following completion of works.

Vegetation management plans (VMPs) for riparian areas, addressed in the riparian assessment report for NWRL (ELA 2012b), will provide an ongoing mechanism to ensure weed vectors are not introduced as a result of the Project. Provided controls and mitigation measures are implemented

effectively, weed spread is unlikely to impact on retained native vegetation.

4.4.2 Fragmentation

Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with a new habitat type occurring in the area between the fragments. Fragmentation can impact on fauna species within the newly created fragments by creating barriers to movement, which can result in genetic isolation of populations, and by compounding edge effects. 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. Furthermore, the majority of the threatened species recorded on, or within proximity to, the study area (or with potential to utilise the site) are highly mobile bat and bird species, and therefore the Project is unlikely to restrict movement for many species to and from areas of potential habitat.

The exception to these generalisations is the Cumberland Plain Land Snail which has the potential to be impacted by fragmentation. Although the Cumberland Plain Land Snail was not recorded in targeted surveys as part of this assessment, it has previously been recorded in the Project area and has potential habitat in the areas of Cumberland Plain Woodland vegetation affected by the Project. Clark and Richardson (2002) found that significant movement of Cumberland Plain Land Snail individuals within a single generation is limited to about 350m. As such, clearance of the Cumberland Plain Woodland vegetation which further isolates existing patches of suitable Cumberland Plain Land Snail habitat or fragments a larger patch by more than 300m may result in local extinctions of this species.

4.4.3 Hydrological Changes

The Project works involving tunnel boring and construction of underground stations will require the collection and discharge of large volumes of groundwater to local waterways, potentially impacting vegetation and fauna habitat within the riparian zone. Potential indirect impacts will include creek bank erosion and sedimentation downstream, loss of riparian vegetation, and increased weed invasion.

The Project will also establish large impervious areas in the form of roads, commuter car parks, the Rouse Hill stabling facility, viaduct, and bridges, which will alter the local hydrology through increasing stormwater run-off volume and velocity. Run-off from the impervious areas is also 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.

4.4.4 Sediment, Erosion and Pollution

The major construction component of the Project has considerable potential to result in sedimentation, erosion and potential pollution of creeklines and native vegetation across the construction footprint. Particular construction activities that could generate large quantities of sediment laden run-off include:

- Clearance of vegetation for the rail infrastructure, access roads and construction work sites.

- Excavation and temporary storage of spoil from the tunnelling and underground stations.
- Storage of construction materials such as ballast, aggregate, and cement.
- Bulk earthworks and drainage for the above ground sections including cuttings and embankments, bridges and viaduct.

Detailed sediment and erosion control plans will be incorporated into the Environmental Management Framework for every construction stage event. Impact assessments for riparian and aquatic ecosystems are detailed in the Riparian Assessment Report for the NWRL (Eco Logical Australia, 2012b).

4.4.5 Increased Noise

The Project will result in increased noise levels originating from work sites and the tunnel-boring process during the construction phase, and from built infrastructure, such as car parks, train stations, and train movements, during the operational phase. Weather conditions (e.g. prevailing wind direction, inversions) would also influence the location of noise impacts and sensitive receivers affected by noise.

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. However, a number of overseas studies have been conducted which indicate how related species may respond (e.g. Delaney *et al* 1999, Konishi 2003, Schaub 2008).

A study of *Strix occidentalis lucida* (Mexican Spotted Owls) found that owls flushed at noises such as those from aircraft overflights at levels of 92 dB(A) or greater, and were more disturbed by the sound of chainsaws (only 46 dB (A)) compared to overflights (Delaney *et al.* 1999). Observations showed that noise sources on the ground were of greater concern than noise sources in the air. Noise can 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 studies on Greater Mouse-eared Bats (*Myotis myotis*) have found that these bats avoid areas with noise disturbance while foraging (Schaub et al. 2008, Siemers and Schaub 2011). However, Greater Mouse-eared Bats have also been recorded roosting in areas with high ambient noise (Schaub *et al.* 2008). Thus, responses to noise may be dependent on activities.

In overseas investigations of woodland birds and noise, Brotons and Herrando (2001) found reduced bird occurrence, breeding density, and breeding success in fragments associated with road proximity in a Mediterranean agricultural area, attributing these results to a response to noise. Reijen *et al.* (1995) found about 60% of woodland birds were found in lower densities adjacent to highways with higher noise levels compared with areas further away from highways. While it could be that other effects or interactions might contribute to these results (e.g. patch size or resource availability), there is evidence that habitat may be as, or more, important than noise in determining use of areas impacted by noise disturbances by some bird species (Warner 1992). These studies indicate a trend of avoidance to noise disturbance for woodland bird species.

A review of these studies has indicated that threatened microbat species and birds that occur, or have the potential to occur, in the study area will 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 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.

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, particularly during the construction phase, these impacts are unlikely to affect threatened fauna to a degree greater than that already in place in what is a predominately urban habitat.

4.4.6 Increased Light

The Project will result in increased light levels in the study area. Potential impacts that could result from the introduction of artificial light during construction and 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.

Construction works not associated with tunnelling will generally occur during daylight hours and will not increase light levels. Currently, the proposal is for 24/7 working at TBM sites to support tunnelling (e.g. spoil removal), therefore associated lighting of these sites will be required, albeit temporarily, for three years. During operation, artificial lighting around built infrastructure, such as car parks and train stations, will be introduced and may have the potential to indirectly impact fauna species.

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. Construction lighting for nightworks would be temporary and appropriate mitigation measures would be put in place to reduce impacts during construction. During operation, increased light levels will be most pronounced surrounding 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.

4.5 KEY THREATENING PROCESSES

The following key threatening processes are considered relevant to the Project:

- *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands*

  The Project has been designed to minimise as far as possible the potential impacts on Caddies Creek and other drainage lines throughout the study area. The number of creek crossings has been minimised and riparian zones have been avoided, where possible.

Mitigation measures will be implemented to prevent sedimentation and erosion which may, in turn, alter natural flow regimes. The potential impacts from water discharge to creeklines are considered in the riparian assessment report (ELA 2012b).

- *Clearing of native vegetation (TSC Act)*

  Impacts of the Project on native vegetation in terms of clearing have been outlined in section 4.1. Given that areas of native vegetation will be cleared, the Project will exacerbate this key threatening process. However, much of the vegetation to be cleared comprises fragmented patches impacted by edge effects, such as weed invasion, and in poor condition. Offsets will be provided to compensate for vegetation loss, and recommendations are made for management of native vegetation outside of the construction footprint with higher biodiversity values in accordance with Vegetation Management Plans.

  Also, areas to be cleared represent a very small percentage of remaining vegetation in the region.

- *Human-caused climate change (TSC Act)*

  The potential effects of climate change in Australia include higher temperature, changes in rainfall (and flood events), an increase in evaporation, changes in storm and fire regimes, sea level rise, and continuing increases in atmospheric CO_2 (Hughes 2003).

  The potential impacts of climate change on the ecology of the study area include increased weed invasion and changes to natural fire regimes. However, the natural vegetation and fauna habitat of the study area is already subject to significant disturbances associated with fragmentation and the urbanised landscape.

- *Infection of native plants by Phytophthora cinnamomi (TSC Act)*

  Phytophthora cinnamomi is not known to be present within the construction footprint and therefore it is unlikely that the Project would exacerbate this key threatening process.

- *Invasion of native plant communities by exotic perennial grasses (TSC Act)*

  There is the potential for the Project to result in the spread of exotic perennial grasses. A number of mitigation measures have been proposed to prevent the spread of weeds and exotic perennial grasses (section 5). This will help to reduce the potential for the remaining native vegetation to be invaded by exotic perennial grasses.

- *Loss of hollow-bearing trees (TSC Act)*

  Impacts of the Project on hollow bearing trees have been outlined in section 4.3.1. The Project will result in the removal of some hollow-bearing trees as it is not possible for a linear project to deviate to avoid all hollow-bearing trees.

  Loss of hollow bearing trees are expected to be generally compensated through the delivery of vegetation community offsets (see **Appendix N**).

- *Removal of dead wood and dead trees (TSC Act)*

  Dead wood is present in relatively small amounts within the native vegetation areas of the study site and provides habitat for a number of reptile and ground-dwelling mammal species. Dead trees are also present and generally contain hollows, providing habitat for some hollow-

dependent species including birds, bats, mammals, and reptiles. Section 5 details options for the harvesting and re-use of dead wood and hollows within suitable areas of retained vegetation.

4.6 SEPP19 ASSESSMENT

4.6.1 Policy Objectives

State Environmental Planning Policy No 19 – Bushland in Urban Areas (SEPP 19) applies to all bushland within the Sydney Metropolitan Area which is zoned or reserved as public open space. The aim of the Policy is to preserve remnant vegetation within urban areas for its natural heritage, aesthetic, recreational, educational and scientific values.

Specifically the aims of SEPP 19 are to:

a) protect the remnants of plant communities which were once characteristic of land now within an urban area,
b) retain bushland in parcels of a size and configuration which will enable the existing plant and animal communities to survive in the long term,
c) protect rare and endangered flora and fauna species,
d) protect habitats for native flora and fauna,
e) protect wildlife corridors and vegetation links with other nearby bushland,
f) protect bushland as a natural stabiliser of the soil surface,
g) protect bushland for its scenic values, and to retain the unique visual identity of the landscape,
h) protect significant geological features,
i) protect existing landforms, such as natural drainage lines, watercourses and foreshores,
j) protect archaeological relics,
k) protect the recreational potential of bushland,
l) protect the educational potential of bushland,
m) maintain bushland in locations which are readily accessible to the community, and
n) promote the management of bushland in a manner which protects and enhances the quality of the bushland and facilitates public enjoyment of the bushland compatible with its conservation.

SEPP 19 requires consent authorities to give priority to retaining the bushland, unless significant environmental, economic or social benefits outweigh the value of keeping the bushland. SEPP 19 also applies to development on land which adjoins bushland zoned or reserved for public open space and requires consideration of impacts of clearing on soil erosion, siltation of streams and the spread of exotic weeds and plants.

4.6.2 Additional assessment required to meet SEPP 19

The ecological aspects of the SEPP are generally covered in this report (i.e. impact on biodiversity) and riparian values are considered in the Riparian and Aquatic Assessment (Eco Logical Australia 2011). The following section presents an assessment of the following aspects of SEPP:

- scenic values

- geological features
- recreational potential
- educational potential
- maintenance of bushland which are readily accessible to the community
- management

The protection of archaeological relics is considered for the NWRL in separate stand-alone reports undertaken by Godden Mackay Logan (GML 2012a and GML 2012b).

4.6.3 Areas of Public Open Space or Reserve within the NWRL project area

Table 23 details the areas within the development footprint that are zoned open space. Refer to **Appendix O** for maps showing the relationship between zoned open space and the development footprint.

4.6.4 Assessment

Of the four areas zoned for public open space within the alignment of the NWRL, only two contain intact remnant vegetation. The ecological impact on these areas is addressed in the impact assessment in this report. The additional items for consideration under SEPP 19 are outlined in **Table 24**. "Known Uses" and "Potential Uses" are used to encompass recreational, educational, or community use value.

Table 23: Bushland in Public Open Space affected by the NWRL

NO.	NAME	LOCATION	LGA	ZONING AND AREA (HA) Within footprint	AREA IMPACTED (HA)	AREA NOT IMPACTED (HA)	BUSHLAND IN THE LGA (HA)	PUBLIC OPEN SPACE IN THE LGA (HA)	MAP AND ZONING REFERENCE	IMPACTS ON BUSHLAND
1	Epping Reserve	Between Beecroft Road and Edensor St	Hornsby	RE 1 1.76 ha	0.00	1.76	38,089 ha	1285 ha (SOE 2010 Report)	Tile 1 in Appendix O http://www.hornsby.nsw.gov.au/media/documents/planning-and-building/clep/draft-clep-19-may-2011/Draft-CLEP-Land-Zoning-Map.pdf	Construction site adjacent to bushland and some removal of trees
2	Cheltenham Oval	Between Castle Howard Road and the M2	Hornsby	RE 1 17.48 ha	1.56	15.92	38,089 ha	1285 ha (SOE 2010 Report)	Tile 2 in Appendix O http://www.hornsby.nsw.gov.au/media/documents/planning-and-building/clep/draft-clep-19-may-2011/Draft-CLEP-Land-Zoning-Map.pdf	Construction Site within Public open space (bushland)
3	Arthur Whitling Park	Old Castle Hill Road and McMullen Ave	Hills	6(a) 1.62 ha	1.61	0.01	23,937 ha	1055.18 ha – existing and proposed (SOE 2010 Report)	Tile 3 in Appendix O http://www.thehills.nsw.gov.au/IgnitionSuite/uploads/docs/Zone_Sheet_04_internet.pdf	New Station within Public open space but not bushland
4	Castle Hill Showground	Showground Road and Carrington Road	Hills	6(a) 16.65	2.40	14.25	23,937 ha	1055.18 ha – existing and proposed (SOE 2010 Report)	Tile 4 in Appendix O http://www.thehills.nsw.gov.au/IgnitionSuite/uploads/docs/Zone_Sheet_03_internet.pdf	New Station within Public open space but not bushland

Table 24: Detail of non-ecological SEPP 19 considerations

NO.	NAME	SCENIC VALUES	GEOLOGICAL FEATURE	KNOWN USES	POTENTIAL USES	MANAGEMENT	CONCLUSION
1	Epping Reserve	Provides vegetated buffer for residences to west from Beecroft Road	There are no obvious geological features and no listings on the LEP register or Register of the National Estate.	Concrete drainage channel	Limited passive recreation and education opportunities due to weedy nature of site	Generic	Unlikely to impact on public space use or activities within bushland
2	Cheltenham Oval	Bounded by the M2 noise walls on the south. Residences on the ridge are afforded a visual screen from the M2 by the trees and ridgeline.	Extensive sandstone rock outcrops and boulders. No listings on the LEP register or Register of the National Estate.	Active bush regeneration, picnic tables, walking tracks and mountain biking in bushland areas. Active recreational zone (ie. oval, netball/tennis courts) and playground.	Ongoing uses and education resource for surrounding schools and residents. Conservation values for threatened and migratory species and endangered communities.	Large numbers and volunteer hours have been spent in bush regeneration activities within the reserve.	Loss of public open space, bushland and amenity values with significant community connection.
3	Arthur Whitling Park	Large fig trees and green space in a retail environment.	There are no obvious geological features and no listings on the LEP register or Register of the National Estate.	Passive recreational (lunch time escape).	Playground and physical or outdoor exercise.	Generic	Improvements can be incorporated into new design for the station.
4	Castle Hill Showground	Large open space.	There are no obvious geological features and no listings on the LEP register or Register of the National Estate.	The site has a long history (since 1880s) of a variety of recreational, horse racing agricultural, festive and community activities and now has suitable grandstands, food serving facilities, offices and car parking.	The site provides a wide variety of uses given its size and central location to Castle Hill. The Hills Council's Recreation Strategy notes uncertainty around the future development of the open space.	Castle Hill Showground Management Committee (pursuant to Section 355 of LG Act 1993) oversees the care and hire of the Harvey Lowe Pavilion and the Main Arena within Castle Hill Showground.	Improvements in public space access and amenity can be incorporated into new design for the station.

Both The Hills and Hornsby have large numbers of bush regeneration volunteers contributing a significant volume of hours to weed removal and native species planting in urban bushlands. Councils also contribute capital and have dedicated staff in managing these areas.

The alignment of the NWRL impacts on small areas of public open space with bushland. The area impacting bushland in public open space is relatively small within the context of the LGA's and for the scale of the project (less than 1% in both LGAs – 0.12% in Hornsby and 0.38% in The Hills). The design of the infrastructure in the impacted area has attempted to constrain the footprint to the smallest area possible in order to minimise impacts on public open space. Bushland in Epping and Cheltenham will be reinstated upon completion of works as far as is possible. These measures include Vegetation Management Plans (VMPs) for the sites in line with the controls that will be incorporated into the Construction and Environmental Management Plan (Environmental Management Framework) as outlined in the mitigation section of this report.

At all four public open sites site identified there will be short term impacts during construction works. Longer term, at Epping Reserve there is unlikely to impact on public space use or activities within bushland, at Cheltenham Oval there is likely to be some loss of public open space, bushland and amenity values with significant community connection, at Arthur Whitling Park improvements can be incorporated into new design for the station, whilst at Castle Hill Showground improvements in public space access and amenity can be incorporated into new design for the station.

5 Mitigation Measures

The following mitigation measures and ecological management procedures have been developed for implementation during the pre-construction, construction, and operational phases of the Project to reduce impacts on threatened species, populations and ecological communities.

The mitigation measures / ecological management procedures generally apply to the entire study area. Specific mitigation measures for Vegetation Management Plans (VMPs) at individual Project locations are provided in **Section 5.2**.

5.1 ENVIRONMENTAL MANAGEMENT FRAMEWORK

An Environmental Management Framework for the Project will be prepared prior to the commencement of any construction works. The Environmental Management Framework will span the entire project duration, from the pre-construction period through to the construction and post-construction period.

Table 25: Mitigation measures to be incorporated into the Project Environmental Management Framework

ITEM	MITIGATION MEASURE / ECOLOGICAL MANAGEMENT PROCEDURE	TIMING
Site-specific environmental induction	Ensure that all staff working on the Project undertakes a site-specific environmental induction for work sites adjacent to, or within close vicinity of, waterways and native vegetation. The induction should include items such as: • 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) • What to do in case of emergency (chemical spills, fire, injured fauna) • Key contacts in case of environmental emergency e.g. WIRES	Pre-construction and during construction for new staff
Pre-clearance search for *Epacris purpurascens* var. *purpurascens* at Cheltenham	Prior to clearing of vegetation within the Cheltenham Services Facility construction footprint, additional targeted searches for the threatened flora species *Epacris purpurascens* var. *purpurascens* will be undertaken. The result of this survey is to be provided to OEH, as well as the scope of any impact to *Epacris purpurascens* var. *purpurascens* and if necessary additional mitigation measures.	Pre-construction
Identification of clearing limits (construction footprint edges)	Clearly mark out the limits of clearing (ie. edge of construction site footprint). Where native vegetation is to be retained adjacent, or within close proximity, to construction sites, protection fencing and signage is to be	Pre- and during construction

ITEM	MITIGATION MEASURE / ECOLOGICAL MANAGEMENT PROCEDURE	TIMING
and protective fencing	installed in accordance with Australian Standard 4970 – 2009 Protection of Trees.	
Vegetation clearance procedure	"Slow drop" techniques are to be used to fell trees. This involves nudging and shaking the tree, followed by a controlled lowering of the tree to the ground. Practical execution of this method involves using the bull dozer blade to push the tree mid-trunk to initiate felling, followed by lowering the blade to the base of the tree trunk, with the blade securing, and slowly lowering, the tree via the tree base.	Construction
Reuse of top soil and habitat elements	Harvest, store, and reuse topsoil from sites identified in VMP(s) (those that have few weed species) in accordance with VMP guidelines. Consider the reuse of logs and felled trees. First preference in the Environmental Management Framework should be given to the reuse of logs and felled trees for ecological habitat enhancement within NWRL VMP areas, but alternatives may also be considered.	Construction
Site office, stockpiles, machinery wash down areas, and plant/fuel storage	Ensure these areas are located outside of any ecologically sensitive areas being retained. Bunding for stockpiles, machinery wash down areas, and plant/fuel storage. Fuel (or other chemical) storage to be located outside all riparian zones, and at least 10m from any retained ecologically sensitive areas.	During construction
Erosion and sediment control	Provide appropriate stormwater runoff controls to manage stockpiles and prevent sediment discharge into waterways and native vegetation. Commence rehabilitation of bare soil as soon as practicable to minimise the risks of erosion.	Pre- and during, construction
Riparian Areas	As per *Riparian Assessment Report for the North West Rail Link* (ELA 2012b) to control impacts on riparian areas.	Pre- and during construction
Water Quality	As per Surface Water and Flooding Assessment for NWRL to control impacts on water quality.	Pre- and during construction
Weed Management	The objective of the weed management controls is to prevent the establishment or spread of noxious and environmental weeds to areas of retained remnant native vegetation. Actions for the Environmental Management Framework are: • Clean machinery before entering work sites to minimise transportation and introduction of weed propagules. • Undertake noxious and environmental weed removal within mapped native vegetation at least 10m from the edge of the construction footprint using appropriate weed control techniques during the construction period at various worksites. • Remove and dispose of weed vegetative material to a site licensed to receive green waste.	Pre-, during, and post-construction

ITEM	MITIGATION MEASURE / ECOLOGICAL MANAGEMENT PROCEDURE	TIMING
Monitoring	Develop a monitoring program, including checklist(s), to ensure that ecological mitigation measures have been undertaken. The checklist(s) should include items such as fencing, sediment and erosion control, and weed management.	Pre-, during, and post-construction

5.2 VEGETATION MANAGEMENT PLANS

Vegetation Management Plan(s) (VMP) are to be prepared for reaches of riparian zones which intersect with the construction footprint as identified in the riparian assessment report for NWRL (ELA 2012b). It is recommended that VMP(s) are to be prepared by TfNSW for native vegetation up to 50m adjacent to the construction footprint (in addition to vegetation inside riparian zones) for the following sites:

- Epping (Tile 1);
- Cheltenham (Tiles 2 and 3); and,
- Cherrybrook (Tile 6).

It is recommended that revegetation occur at the Cheltenham Services Facility site, with the aim of re-establishing Coastal Shale-Sandstone Forest in areas not required for sporting facilities or NWRL operational purposes.

A VMP is to be prepared for each identified site, but the VMP for a particular site may cover both riparian and terrestrial ecology requirements (where relevant).

Where TfNSW is not the landholder for vegetation for lands where VMPs are recommended or required, TfNSW is to consult with landholder(s) to discuss the rehabilitation works and to seek permission for the VMP works.

Implementation of the VMP(s) is to span the construction period through to the post-construction period. The VMP(s) will provide specifications and guidelines on the following aspects:

- Area(s) of native vegetation which are the subject of each VMP;
- Management of native vegetation through the construction works period, and rehabilitation works to be performed. Recommended performance criteria for rehabilitation works; and,
- Where appropriate, details of topsoil harvesting, storage and future reuse, and areas where logs and felled trees may be reused.

Specific objectives and approaches to be included in the VMP(s) for riparian areas are detailed in the *Riparian Assessment Report for the North West Rail Link* (ELA 2012b).

Within the Cheltenham site study area, there is potential to collect seed from *Epacris purpurascens* var. *purpurascens* (listed as Vulnerable under the TSC Act), and release it in within potential habitat to the west of Cheltenham oval. This action would essentially substitute for the function of wind in seed dispersal for this species, as the chances of wind carrying seed from the existing population to potential habitat areas in the west (ie. across the oval) is low. Such works would need a section 132C licence,

and to be undertaken on consultation with Hornsby Shire Council who currently manage the population of *Epacris purpurascens* var. *purpurascens* at the study area.

5.3 SPECIFIC PROJECT OPERATION MITIGATION MEASURES

Specific measures to mitigate the ongoing indirect impacts of the project upon native vegetation and fauna are detailed in **Table 26** below.

Table 26: Mitigation measures associated with the Project operation

INDIRECT IMPACT	MITIGATION MEASURE
Ongoing stormwater runoff impacts upon native vegetation from increased impervious areas and landform changes.	• Water quality treatment devices, such as sediment basins and constructed wetlands designed to reduce sediment and pollutant loads to appropriate water quality levels. • Monitoring and maintenance of water quality treatment devices to achieve appropriate water quality levels for the life of the Project.
Noise and light disturbance to bats and nocturnal birds originating from built infrastructure such as train stations and train movements	In locations close to suitable habitat, where possible, incorporation of the following measures into the design phase of the Project: • Direct artificial lighting to where it is needed and in a downwards orientation to avoid light spillage, with baffles or shields installed to direct light below the horizontal plane, at an angle less than 70 degrees. Face artificial light away from areas of native vegetation. • Low-pressure sodium lamps instead of high-pressure sodium or mercury lights should be used. Where mercury lights are used, UV filters should be fitted. • Reduce the brightness of lights to as low as legally possible. • Direct amplified speakers downwards and away from areas of native vegetation to minimise disturbance from noise. • Noise producing equipment should be fitted with noise attenuation devices (mufflers).
Degradation of ephemeral breeding habitat for Green and Golden Bell Frog from changes to hydrological regimes	• Incorporation of potential ephemeral breeding habitat – in the form of micro scale depressions and overflow paths within the landscaping design of permanent detention structures

5.4 OFFSET STRATEGY

Although avoidance and mitigation measures have been considered and implemented during the design of the rail footprint, impacts on native vegetation (including Endangered Ecological Communities) and threatened flora and fauna have been identified. Both the Concept Plan Approval (3.13) and Statement of Commitments (No. 27) require the ecological impacts of the Project to be measured, and the offsets required to be described.

Appendix N provides the offset strategy to meet these requirements. Summary points are:

- The proposed NWRL is subject to several offsetting policies and principles, depending on the location of impact including:
    - Sydney Region Growth Centres State Environmental Planning Policy (SEPP) (referred to as the 'Growth Centres SEPP');
    - Principles for the use of Biodiversity Offsets in NSW (DECC 2008);
    - NSW OEH interim policy on assessing and offsetting biodiversity impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) projects; and
    - EPBC Act Environmental Offsets Policy - Consultation draft (SE 2011).
- Certified lands within the NWGC have previously been offset by the Growth Centres SEPP, and therefore any impacts to vegetation within certified lands as part of this Project (currently calculated as 12.92 ha) do not require additional offsets.
- Impacts to EPBC Act matters within the NWGC have been considered by the Strategic Assessment of Sydney's Growth Centres and will be addressed in accordance with any requirements in the EPBC Act determination.
- The offset ratios proposed for the EEC Project are:
    - 5:1 for vegetation and habitat in good condition.
    - 4:1 for vegetation and habitat in moderate condition.
    - 3:1 for vegetation and habitat in poor condition.
- It is recommended that the Best Practice Guidelines - Green and Golden Bell Frog Habitat (DECC 2008) be followed during the project.
- Roosting habitat for the Eastern Bentwing-bat has been identified within the project footprint in a culvert along the M2. Direct impacts to this culvert are currently not anticipated, however if impacts do occur the provision of replacement roosting habitat will be investigated. Again, it is anticipated that with avoidance and/or mitigation measures offset habitat will not be required for the Eastern Bentwing-bat.
- Should the clearing footprint change a new assessment of impacts, and associated offsets, will be completed and provided to the OEH and SEWPaC.
- Cumberland Plain Woodland requires the largest offset, at 51.22 ha (32.58 ha of NSW CEEC and 18.64 ha of both NSW CEEC and Commonwealth CEEC), followed by Coastal Shale-Sandstone Forest requiring 5.75 ha. All remaining vegetation types require offsets of <5 ha (see **Table 27**).
- Impact on up to 0.50 ha of non-certified ENV within the North West Growth Centre is to be offset as per the Growth Centres Biodiversity Certification Order requirements.

Table 27: Summary of offset requirements by vegetation type

VEGETATION COMMUNITY	LEGISLATIVE STATUS	OFFSET REQUIRED (HA)
Blue Gum High Forest	TSC- CEEC	0.30
	TSC- CEEC EPBC- CEEC	2.73
Coastal Shale-Sandstone Forest	N/A	5.75
Cumberland Plain Woodland	TSC- CEEC	32.58
	TSC- CEEC EPBC- CEEC	18.64
River Flat Eucalypt Forest	TSC- EEC	4.63
Shale/Sandstone Transition Forest	TSC- EEC EPBC- EEC	2.34
Sydney Turpentine-Ironbark Forest	TSC- EEC	0.86
	TSC- EEC EPBC- EEC	0.12
Total		**67.95**

The following performance measures are applicable to offsets for the project outside of the Western Sydney Growth Centres:

- Offset lands are to consist of viable, ecologically functioning native vegetation wherever possible or, if degraded, are to be improved with sufficient funding and long term management;
- Offsets are to be "like for like" in terms of vegetation by meeting the minimum areas of offset vegetation, with the quality being accounted for with a greater offset ratio;
- Management for each offset site is to be in perpetuity;
- A management plan is to be prepared for each offset site which identifies the proposed in perpetuity management actions. The cost to deliver the proposed actions is to be identified, as well as the total amount of capital required to provide for in perpetuity management (it is noted that an accepted Biobank Site Agreement would automatically address these requirements);
- Funding is to be provided for the management of offsets in perpetuity via the Biobank Trust Fund, or another form of Trust Fund agreed to by OEH and SEWPaC;
- Offsets are to be provided within the Sydney Metropolitan CMA and Hawkesbury Nepean CMA regions; and,
- Appropriate offset sites are to be secured (purchased by Transport for NSW, written agreement from landholder, or Biobank credits purchased) within commencement timeframe agreed with government agencies. Management Plans for offset sites are to be agreed with the OEH and SEWPaC within 3 years of commencement of on ground works. The offset sites are to be maintained in the interim period so as to prevent degradation in the ecological condition of the sites.

6 Conclusions

A total of 30.87 ha of direct impacts on vegetation communities associated with the proposed construction footprint have been identified, comprised of:

- Blue Gum High Forest 1.01 ha;
- Coastal Shale/Sandstone Forest 1.33 ha;
- Cumberland Plain Woodland 25.10 ha;
- River Flat Eucalypt Forest 2.33 ha;
- Shale/Sandstone Transition Forest 0.78 ha; and,
- Sydney Turpentine-Ironbark Forest 0.32 ha.

Impacts on threatened flora and threatened and migratory fauna have been identified as potentially occurring within the NWRL study area. These impacts have been assessed in accordance with the guidelines and legislative requirements outlined in the Conditions of Consent, DGRs and Statement of Commitments.

Secondary impacts (eg; noise, light) on native flora and fauna have been considered and assessed. These secondary impacts are not considered to constitute a significant additional impact as the NWRL is located within an urban and peri urban context (i.e. the vegetation and habitat which may be affected by the NWRL is to a large degree already subject to these disturbances).

Mitigation measures are proposed, including an Environmental Management Framework for the project; Vegetation Management Plan(s) (VMP) are recommended for riparian zones and for three additional areas of native vegetation with more significant biodiversity values; and other specific measures to minimise and mitigate the ongoing indirect impacts of the project upon native vegetation and fauna.

An offset strategy has been prepared to offset the loss of native vegetation and threatened species habitat which cannot be avoided or mitigated. Vegetation impacted within the NWGC that is non-certified will need to comply with the Growth Centres Conservation Plan. Outside of the NWGC it is proposed that vegetation be offset at a ratio of 5:1 for good quality vegetation, 4:1 for moderate quality, and 3:1 for poor quality. This would require a total ecological offset of 67.95 ha, the majority of which would be Cumberland Plain Woodland. Offsets would need to be delivered by identifying, conserving and providing for in perpetuity ecological management of the offsets.

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