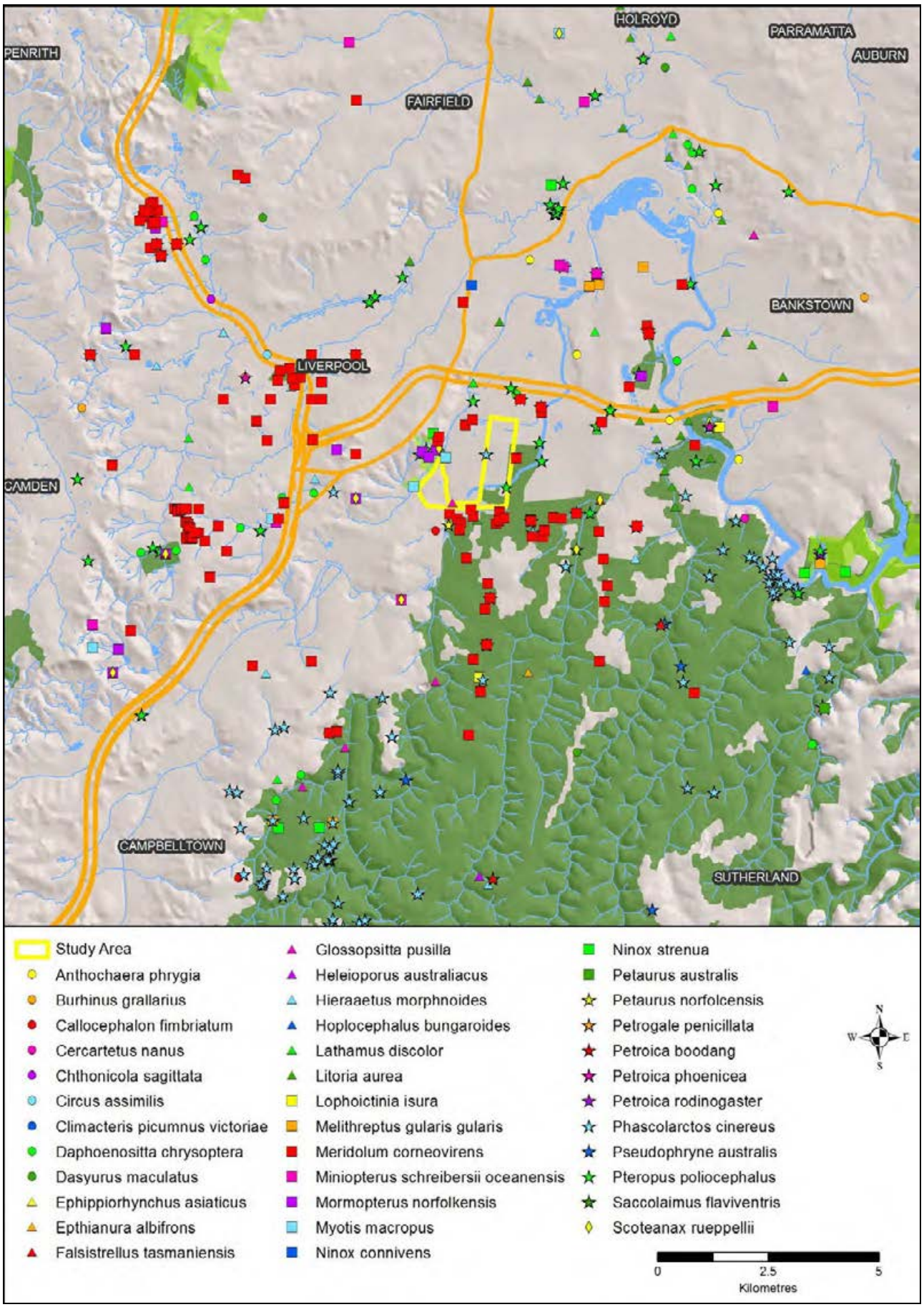

Figure 11: Threatened fauna species records within 10 kilometres of the study area

3.3.2 Field Survey

3.3.2.1 Terrestrial Fauna Habitats

Five broad terrestrial fauna habitat types were identified from the study area; remnant vegetation, riparian habitats, landscaped areas and cleared and disturbed areas (Figure 12).

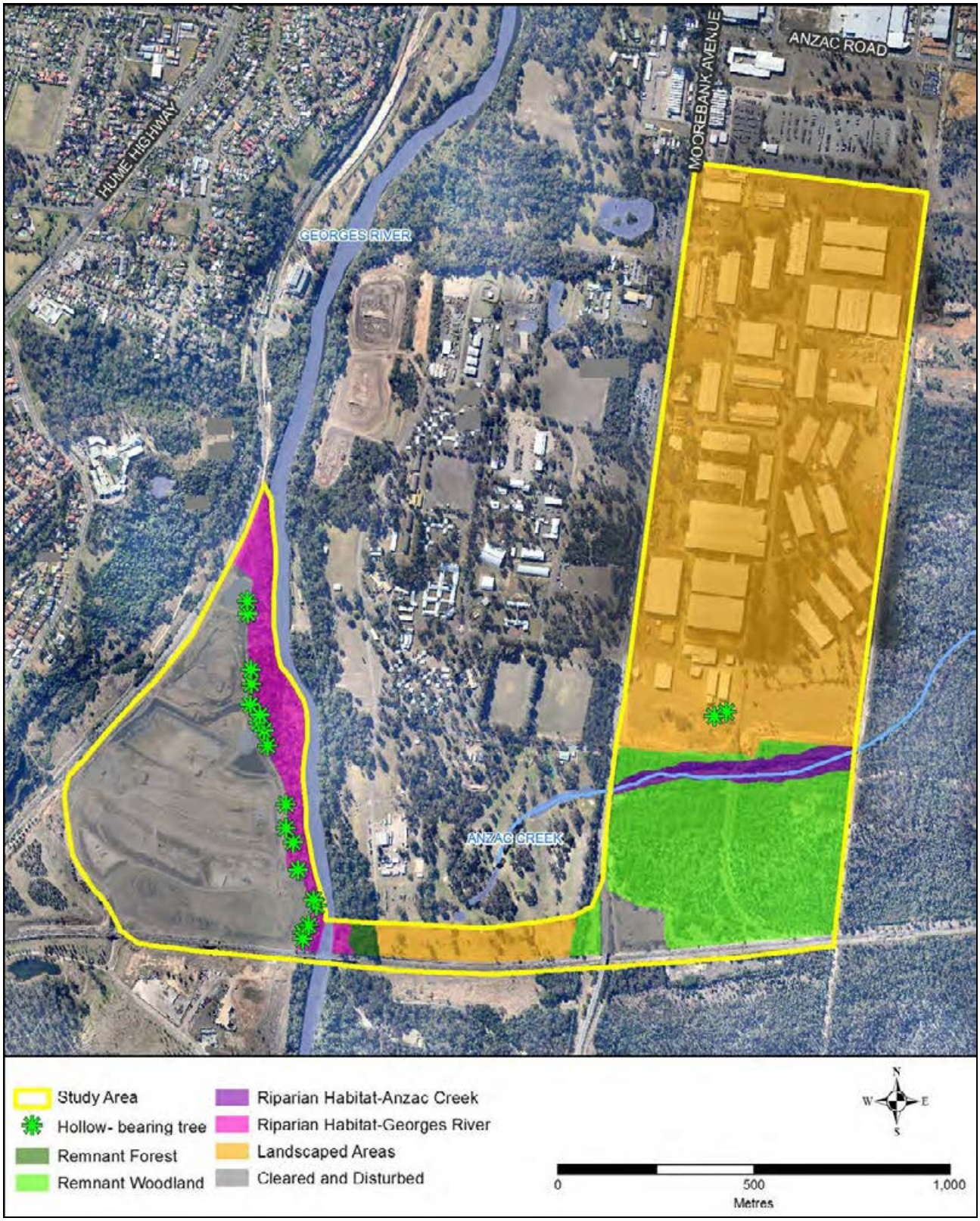

Figure 12: Fauna habitat in the study area

Remnant Vegetation

Remnant Woodland

Plate 27. Remnant woodland of rail corridor

Plate 28. Remnant woodland of rail corridor

Remnant woodland communities occur across the proposed rail corridor south of the SIMTA site (Plate 27, Plate 28). The low canopy is dominated by eucalypts and melaleucas, providing potential nesting, roosting and sheltering habitat for birds such as Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Spotted Pardalote (*Pardalotus punctatus*).

The dense shrub layer offers sheltering and foraging habitat for birds such as Red-browed Finch (*Neochmia temporalis*). Well-developed leaf litter and groundlayer vegetation offers sheltering and foraging habitat for reptiles such as Red-bellied Black Snake (*Pseudechis porphyriacus*) and Eastern brown Snake (*Pseudonaja textilis*). Micro-chiropteran bat species including Gould's Wattled Bat (*Chalinolobus gouldii)* and the threatened Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis)* were recorded by Anabats placed in remnant woodland, suggesting these species may forage for invertebrates above, within and along the margins of woodland vegetation.

Remnant Forest

Plate 29. Remnant forest upslope of Georges River riparian zone

Plate 30. Remnant forest upslope of Georges River riparian zone

Remnant forest upslope of the Georges river riparian zone (Plate 29, Plate 30) supports large canopy trees, predominantly eucalypts, that offer nesting and sheltering habitat to birds including Golden Whistler (*Pachycephala pectoralis*), Eastern Rosella (*Platycercus eximius*) and Eastern Yellow Robin (*Eopsaltria australis*).

The mid-storey of small trees and shrubs of the understorey offer sheltering and foraging habitat arboreal mammals such as Ringtail Possum (*Pseudocheirus peregrines*). Groundlayer features including well-developed leaf litter and ground timber offers foraging and sheltering habitat to reptiles and small terrestrial mammals. Possible recordings of microchiropteran bat species including the threatened Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) the Southern Myotis (*Myotis macropus*) and an unidentified Long-eared Bat (*Nyctophilus sp*.), were made by Anabats placed in remnant forest; such species may forage amongst forest vegetation or along Georges River.

Riparian Habitats

Anzac Creek

Plate 31. Anzac Creek within rail corridor

Plate 32. Anzac Creek within rail corridor

Anzac Creek is heavily vegetated and contains few pools of open water. Aquatic vegetation included *Typha, Salvinia molesta* and the dense covering of ferns, sedges and rushes fringing the creek provides habitat for amphibians such as Common Eastern Froglet (*Crinia signifera*) (Plate 31, Plate 32). Riparian vegetation is dominated by a canopy of melaleucas and eucalypts with a dense understorey of flowering shrubs such as *Hakea sp., Banksia sp.* and *Acacia,* providing sheltering, nesting and foraging habitat for a variety of birds including Brown Gerygone (*Gerygone mouki*), Grey Butcherbird (*Cracticus torquatus*) and Fan-tailed Cuckoo (*Cacomantis flabelliformis*). Well-developed leaf litter and small ground timber offers shelter and foraging habitat to small terrestrial mammals and reptiles, although there is an absence of rocky features and hollow logs.

Georges River

Plate 33. Dense infestation of Balloon Vine within Georges River riparian vegetation (eastern bank)

Plate 34. Georges River (looking towards western bank from eastern bank)

Plate 35. Dense infestation of Lantana within Georges River riparian vegetation (western bank)

Plate 36. Georges River (looking towards eastern bank from western bank)

Georges River is approximately 50m wide and slow-flowing through the study area, providing habitat for water birds such as Pacific Black Duck (*Anas superciliosa*), Dusky Moorhen (*Gallinula tenebrosa*) and Purple Swamphen (*Poryphyrio poryphyri*).

Riparian vegetation associated with Georges River is highly disturbed on both the western and eastern banks (Plate 33 to Plate 36). Canopy trees on the eastern bank do not appear to support hollows of any size. An abundance of trees supporting small to medium-sized branch hollows are located on the western bank of the Georges River. These hollows offer potential nesting and roosting habitat to hollow-dependent fauna. Decorticating bark of eucalypts offer potential roosting habitat to microchiropteran bat species.

The understorey and groundlayer strata are dominated by woody weeds such as Small-leaved Privet (*Ligustrum sinense*), African Olive (*Olea europaea ssp. Cuspidata*) and Lantana (*Lantana camara)* and exotic climbers such as Balloon Vine (*Cardiospermum grandiflorum)*. Dense infestations of these weeds offer potential sheltering and foraging habitat to birds such as Superb Fairy Wren (*Malurus cyaneus*) and Eastern Whipbird (*Psophodes olivaceus*). Leaf litter and small ground timber offers shelter and foraging habitat to small terrestrial mammals and reptiles. Rocky features and large hollow logs are absent.

A diversity of microchirpoteran bat species were recorded in Georges River riparian vegetation, including Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio),* and the threatened Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) and East Coast Freetail Bat (*Mormopterus norfolkensis*).

Small gaps between the concrete spans of the existing rail bridge spanning Georges River may offer potential roosting habitat to microchiropteran bat species. Rock gabions of the western bridge abutment offer potential habitat to small reptiles.

Landscaped Areas

Landscaped areas occur across the entire SIMTA site and the southern portion of the rail corridor (the Royal Engineers Golf Course) that adjoins the East Hills Railway. Native vegetation has been predominantly cleared from these areas and persists as isolated trees amongst expanses of mown exotic and native grasses (Plate 37). The buildings currently on the SIMTA site have been included in this habitat classification, although it is acknowledged that they offer limited habitat features to native fauna.

Isolated trees (Plate 38) offer potential nesting, sheltering and roosting habitat to birds such as Pied Currawong (*Strepera graculina*) and Noisy Miner (*Manorina melanocephala*). Flowering eucalypts also provide foraging habitat for Grey-headed Flying Fox (*Pteropus poliocephalus)*. A small number of scribbly gums (*Eucalyptus sclerophylla)* located in the south of the SIMTA site

support small and medium-sized hollows, offering nesting habitat to hollow-dependent species such as Rainbow Lorikeet (*Trichoglossus haematodus*) and Scaly-breasted Lorikeet (*Trichoglossus chlorolepidotus*).

A diversity of microchiropteran bat species were recorded in cleared and disturbed areas, including White-striped Mastiff Bat (*Tadarida australis*), Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), Little Forest Bat (*Vespadelus vulturnus*) and the threatened Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*).

Open grassy areas provide foraging habitat for ground-feeding birds such as White-winged Chough (*Corcorax melanorhamphos*), Red-rumped parrot (*Psephotus haematonotus*) and small terrestrial mammals such as the Brown Hare (*Lupus capensis*).

Scattered native and exotic shrubs and trees associated with the formalised drainages channels in the south of the SIMTA site, such as Black She-oak (*Allocasuarina littoralis*), eucalypts, Camphor laurel (*Cinnamomum camphora*) and *Cotoneaster* sp., offer foraging, sheltering and roosting habitat to birds such as Noisy Miner (*Manorina melanocephala*), Raven (*Corvus coronoides*) and Magpie Lark (*Grallina cyanoleuca*). Other small trees and shrubs throughout the SIMTA site that may offer sheltering and nesting habitat to smaller birds are restricted to small areas of horticultural plantings.

Other fauna habitat features such as rocky features, well-developed leaf litter, ground timber and hollow logs are absent from cleared and disturbed areas. As a result, availability of sheltering and foraging habitat for reptiles and cover-dependent terrestrial mammals is reduced. Depressions in open areas that contain temporary water following rain events offer habitat to colonising amphibians such as Common Eastern Froglet (*Crinia signifera*).

Plate 37. Cleared areas of rail corridor

Plate 38. Isolated trees of SIMTA site

Cleared and Disturbed

The type and abundance of habitat features within cleared and disturbed areas are limited, as native vegetation has been almost entirely cleared. Weedy exotic herbs and grasses may offer sheltering and foraging habitat to small mammals and reptiles, while native shrubs and small trees may offer roosting, nesting, sheltering and foraging habitat to small birds. Potential foraging resources for nectivorous fauna species such as *Angophora floribunda, Acacia decurrens* and *Acacia binervia* were abundant on the slope adjoining the eastern haul road.

Plate 39. Glenfield Waste Disposal site

Plate 40. Glenfield Waste Disposal site

3.3.2.2 Aquatic fauna habitats

Anzac Creek

Plate 41. Anzac Creek – upstream of existing rail spur

Plate 42. Anzac Creek – downstream of existing rail spur

Anzac Creek comprises a named waterway with intermittent flow supporting semi-permanent to permanent water in pools and as such, is classified as Class 3 (Minimal Fish Habitat) in accordance with Fairfull and Witheridge (2003).

Aquatic habitat types of Anzac Creek within the study area included soft substrate pools and extensive macrophyte cover. Water in Anzac Creek was mostly static and shallow; small pools were heavily vegetated with floating and emergent macrophytes such as *Typha sp*. and *Salvinia molesta* (Plate 41, Plate 42).

Georges River

Plate 43. Georges River

Plate 44. Georges River beneath rail bridge

Georges River (Plate 43, Plate 44) comprises a major permanently flowing river and as such, is classified as Class 1 (Major Fish Habitat) in accordance with Fairfull and Witheridge (2003). Aquatic habitats of Georges River within the study area included soft substrate pool habitat, large woody debris and extensive macrophyte cover. Overhanging vegetation, fallen logs, mats of sticks, submerged (*Elodea canadiensis*) and floating aquatic plants (*Azolla sp., Salvinia molesta*) were present along the bank. This extensive macrophyte cover of submerged and floating aquatic plants has reduced the heterogeneity of aquatic habitat and most likely affects the composition of the macroinvertebrate community present.

Movement of fish species into the study area is limited by the presence of the Liverpool weir, located approximately 3.5 kilometres downstream of the study area. The weir is located approximately 40 kilometres upstream from the mouth of the Georges River and forms its tidal limit. A vertical slot fishway has attempted to restore fish passage and re-establish native fish in the Georges River (NFA 2012).However, there was no indication that large numbers of fish have migrated past the fishway (Steller and Bryant 2004).

Georges River within the study area may be considered poor quality habitat, attributed to the lack of diversity of micro-habitats required to support a diverse and healthy macroinvertebrate community (ALS 2011).

Other aquatic habitats

In addition to Georges River and Anzac Creek, formalised drainage channels are located in the south-east of the SIMTA site (Plate 45, Plate 46). These channels do not all support permanent water; some flow only ephemerally following rain. Channels that support aquatic and fringing vegetation, such as *Typha* sp, offer habitat for reptiles and amphibians such as Common Eastern Froglet (*Crinia signifera*).

Plate 45. Formalised channels of SIMTA site

Plate 46. Formalised channels of SIMTA site

Plate 47. Dam in Glenfield Waste Disposal Site

Plate 48. Leachate dam in Glenfield Waste Disposal site

Constructed artificial wetlands within the Royal Engineers Golf Course offer potential habitat to amphibians, fish and aquatic birds. Those wetlands supporting aquatic and fringing vegetation offer sheltering and potential nesting habitat to such species. Several dams are located within Glenfield Waste Disposal site which offer potential habitat to those species of amphibians, fish and aquatic birds that are tolerant of highgly degraded aquatic habitats (Plate 47, Plate 48).

Groundwater Dependent Ecosystems

Groundwater dependent ecosystems are those ecosystems that rely upon groundwater for their survival and may include wetlands, native vegetation, cave ecosystems, mangroves, springs and hanging swamps. An ecosystem may be entirely dependent upon groundwater or utilise groundwater during unfavourable conditions, such as drought.

A previous investigation of groundwater in the wider study area (URS, 2002) indicates that the depth to groundwater on the SIMTA site is generally between 4.0 to 5.0 metres below ground level. Groundwater flow is generally radial from the topographic high with the location of the Georges River, indicating that groundwater flow underlying the area would be predominantly westerly (URS, 2002).

Groundwater was not sampled as part of the current study, as no groundwater monitoring bores were located in the study area. Results from the URS (2002) study indicated that local recharge is occurring, which suggests that groundwater contributes to existing surface water flows, particularly in Anzac Creek, and there is connectivity between the groundwater and the Georges River. Although the extent of groundwater distribution in the area is not clear it is probable, due to local hydrogeology, that groundwater across the study area and the wider region is interconnected. This would suggest that if stygofauna were present they are unlikely to be isolated to the vicinity of the study area, and while isolated areas of the groundwater may be influenced, a significant impact on the wider region is highly unlikely (ALS 2011).

It is possible that the swamp woodland vegetation within the study area is somewhat dependent upon groundwater, although the extent to which this community is influenced by groundwater is unknown.

3.3.2.3 Habitat Connectivity

The study is located within a relatively industrialised and urbanised landscape. Vegetation of landscaped and cleared and disturbed areas is generally limited to single, isolated trees amongst expanses of mown exotic and native grasses; habitat features of these areas do not maintain connectivity with habitat features elsewhere within the study area.

Larger expanses of habitat within the study area are isolated from habitat adjacent to the study area, due to the presence of significant barriers to fauna movement. These barriers include Moorebank Ave, the East Hills Railway Line and chain-mesh fencing surrounding the SIMTA site (Plate 49), East Hills rail corridor (Plate 50), Glenfield waste disposal site (Plate 51, Plate 52) and Royal Australian Engineers Golf Course. The chain-mesh fencing would limit movement into and through the study to small terrestrial mammals, reptiles, amphibians and birds and bats. Larger terrestrial mammals that may occur in the locality would be excluded from much of the study area as a result.

A lack of habitat connectivity within the study area, and between the study area and adjacent areas, reduces potential movement of arboreal mammals and cover-dependent fauna into and through the study area.

Plate 49. SIMTA site bound by chain mesh fencing and adjoining Moorebank Avenue

Plate 50. Rail corridor bound by chain mesh fencing adjoining East Hills Railway

Plate 51. Glenfield waste disposal site is bound by chain-mesh fencing

Plate 52. Glenfield waste disposal site is bound by chain-mesh fencing

Riparian vegetation associated with Georges River maintains connectivity with riparian vegetation to the north and south, including Holsworthy Military Area. This riparian corridor may facilitate the movement of less mobile species, including cover-dependent species, larger terrestrial mammals and arboreal mammals.

Substantial areas of intact native vegetation are contained with the Holsworthy Military Area. Holsworthy Military Area, located to the east and south of the study area, comprises approximately 18,000 hectares of continuous native vegetation, much of which has remained largely undisturbed as a result of restricted access to the Military Area (French *et al.* 2000). The diversity of vegetation communities within the Military Area includes forests, woodlands, heath

and swamp communities, which in turn provide important habitat to locally and regionally occurring, and threatened flora and fauna species.

Highly mobile fauna species such as birds and some mammals may predominantly reside within the Holsworthy Military Area and utilise the resources offered by the study area on a temporary or transient basis. Such species may include Powerful owl (*Ninox strenua*) and Greater broad-nosed bat (*Scoteanax rueppellii*) (DEH 2004).

3.3.2.1 Fauna Species

Terrestrial Fauna Species

A total of 59 terrestrial vertebrate fauna species, comprising 54 native and 5 exotic species, were recorded during the current field investigation (Appendix 3). Thirty-eight species of birds, 15 species of mammals, four species of reptiles and two species of amphibians were aurally and visually identified from the study area. Examples are shown in Plate 52 to Plate 56.

Four threatened mammal species: East Coast Freetail Bat (Mormopterus norfolkensis); Southern Myotis (*Myotis macropus*); Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) and Grey-headed Flying Fox (*Pteropus poliocephalus*) were recorded in the study area. These species are discussed in further detail in Section 3.3.2.4.

Plate 53. White-winged Choughs on SIMTA site

Plate 54. Rainbow Lorikeets in tree hollow on SIMTA site

Plate 55. Red-bellied Black Snake in rail corridor

Plate 56. Red-rumped Parrots on SIMTA site

Fish

Three fish species were recorded within the study area; one native species, Flathead Gudgeon (*Philypnodon grandiceps*), and the introduced Gambusia (*Gambusia holbrooki*). A single

Flathead Gudgeon was recorded at the Georges River site while Gambusia was recorded at both sites. Gambusia was more abundant in Georges River than in Anzac Creek. One Long-fin Eel (*Anguilla reinhardtii*) was identified in the upper reaches of Anzac Creek within the Royal Engineers Golf Course (outside of the study area).

The Georges River at Cambridge Avenue was sampled for the *Biodiversity of the Georges River Catchment* study (Steller and Bryant 2004) and was classified as an "Urban" site. Five fish species were recorded: Long-finned Eel (*Anguilla reinhardtii*), Goldfish (*Carassius auratus*) Striped gudgeon (*Gobiomorphus australis*), Empire gudgeon (*Hypseleotris compressa*) and Australian bass (*Macquaria novemaculeata*). These species, with the exception of Australian bass, have been classified as relatively tolerant of general disturbance. The study concluded that urbanised parts of the Georges River contain fewer species of native fish, higher abundances of introduced species of fish, lower numbers of species known to be intolerant of environmental disturbance, and have higher incidence of fish with visible signs of disease (Steller and Bryant 2004).

The presence and abundance of fish species may be influenced by the presence of the Liverpool weir, located approximately 3.5 kilometres downstream of the study area. The weir is located approximately 40 kilometres upstream from the mouth of the Georges River and forms its tidal limit.

A vertical slot fishway has attempted to restore fish passage and re-establish native fish in the Georges River (NFA 2012); however, Steller and Bryant (2004) found that there was no indication that large numbers of fish have migrated past the fishway. The small numbers of migratory fish upstream of the weir suggest that some fish are able to use the fishway, but that recovery of upstream fish communities is likely to be a slow process (Steller and Bryant 2004).

Aquatic Macroinvertebrates

A total of 27 macroinvertebrate families were recorded in aquatic environments of the study area; 18 families in Georges River site and 23 families in Anzac Creek site (ALS 2011).

Both sites have relatively poor macroinvertebrate communities. Family diversity was generally low and many sensitive taxa were not recorded. The Georges River site falls into Band C in accordance with the AUSRIVAS model, indicating that it is 'severely impaired'; fewer macroinvertebrate families were observed than expected.

This result may be attributed to 'substantial' impacts on water quality, habitat quality, or both. Anzac Creek falls into Band B, indicating that the macroinvertebrate community was 'significantly impaired'; fewer families than expected were observed. This result may be attributed to a 'potential' impact on water quality or habitat quality or both (ALS 2011).

3.3.3 Significant Fauna

3.3.3.1 Threatened Species

Four threatened fauna species were recorded within the study area (Figure 13).

Assessments of Significance have been undertaken for threatened species listed under the TSC Act (Appendix 6).

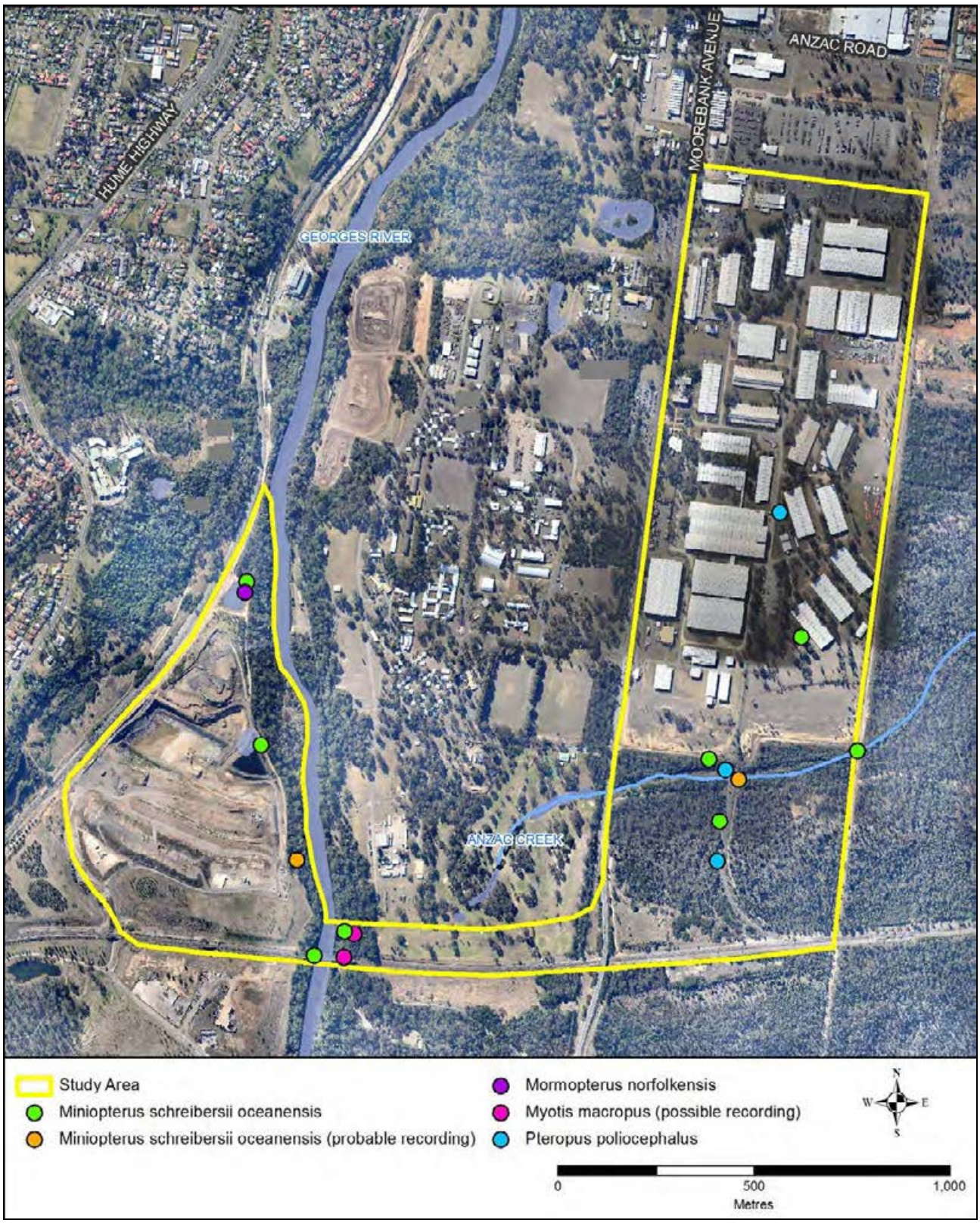

Figure 13: Locations of threatened fauna species recorded in the study area

Southern Myotis (*Myotis macropus*)

The Southern Myotis (previously known as the Fishing Bat) is listed as Vulnerable under the TSC Act. A possible ultrasonic call of the species was recorded at two locations in proximity to Georges River; in remnant forest, upslope of Georges River riparian vegetation and under the existing railway bridge abutment that adjoins the study area to the south.

The Southern Myotis occurs across the northern and eastern coasts of Australia (from the Kimberley to Victoria) and is rarely found more than 100 kilometres inland. Although widespread it is considered to be relatively rare and is only patchily distributed within areas of apparently suitable habitat (Lumsden and Menkhorst 1995).

The species is typically found in association with riparian vegetation and also in mangroves, paperbark swamps, rainforest, wet and dry sclerophyll forest and open woodland. The species forages over water for insects and small fish that they catch by raking their large feet of the water surface, however, also forage aerially for moths, beetles, crickets and flies.

The species roosts communally in groups of up to 15 individuals in caves, mine shafts, tree hollows, under bridges and in buildings, stormwater drains and amongst dense vegetation fringing watercourses. Less commonly, the species has been recorded roosting in partly submerged dead trees and within limestone cliffs. Roosts are typically located in proximity to water.

Within the study area the Southern Myotis may forage along the slow-flowing waters of Georges River for fish and invertebrates. Hollow-bearing trees occurring on the western bank of the Georges River in riparian habitats offer potential roosting habitat to the species. There is also potential for the species to roost under the existing rail bridge or amongst dense vegetation of the Georges River riparian zone.

Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)

The Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) is listed as Vulnerable under the TSC Act. Ultrasonic calls of the species were recorded at five locations across the SIMTA site and rail corridor.

The Eastern Bent-wing Bat occurs along the east and north-west coasts of Australia (DEC 2005b) where it is known from a variety of habitats including rainforest, dry and wet sclerophyll forest, open woodland, paperbark forest and open grassland. The species hunts for moths and other flying insects above the canopy or open areas (DEC 2005b). Eastern Bent-wing bats are known to utilise a number of roost sites throughout the year (Chuchill 1998).

Caves are the primary roosting habitat for this species; however Eastern Bent-wing Bats also use derelict mines, storm-water tunnels, buildings and other man-made structures (DEC 2005b). The most significant of these roosts are maternity roosts and those roosts used over winter for hibernation (DEC 2004b).

Female Eastern Bent-wing Bats inhabit and congregate in specific caves that provide constant high temperate and humidity to give birth and raise young (Dwyer 1995). Maternity caves are used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within a territorial range of about 300 kilometres from the maternity cave (Churchill, 2008). Movement between territories is rare. Breeding or roosting colonies can range from 100 to 150,000 individuals. As such, they are prone to population damage if their roosting site is disturbed or modified.

The Eastern Bent-wing Bat was recorded in remnant woodland and forest, and cleared and disturbed areas, suggesting that these areas may offer foraging habitat to this species. The species may also forage over the larger, continuous canopy of vegetation occurring in the

adjoining Holsworthy Military and on occasion extend its nightly foraging flights into the study area.

The study area does not support cave systems and as such, no preferred roosting habitat was identified.

Eastern Free-tail Bat (*Mormopterus norfolkensis*)

The Eastern Freetail-bat is listed as Vulnerable under the TSC Act. A definite ultrasonic call of the species was recorded in the riparian vegetation of the western bank of the Georges River.

The Eastern Freetail-bat is found east of the Great Dividing Range, from Brisbane in south-east Queensland to Picton in NSW. The habitat requirements of the species are poorly known, however, the species has been most commonly recorded in dry eucalypt forest and woodland, and shows a preference for open spaces in woodland or forest. The species has also been recorded in swamp forests and mangrove forests. The Eastern Freetail-bat forages in openings, forest edges and gaps, and over larger waterways (Environment Australia 1999a, Churchill 2008). The diet of this species has not been studied, but is most probably insectivorous (DEC 2005c). The Eastern Freetail-bat roost mainly in tree hollows; usually in hollow spouts of large mature trees, but will also roost under exfoliating bark or in man-made structures and buildings (DEC 2005c, Churchill 2008).

Within the study area the Eastern Free-tail Bat may forage in openings and gaps within remnant woodland, landscaped areas and over the Georges River. The species may roost in tree hollows occurring on the western bank of the Georges River, or under exfoliating bark of rough-barked eucalypts in riparian habitats.

Grey-headed Flying Fox (*Pteropus poliocephalus*)

The Grey-headed Flying-Fox is listed as Vulnerable under both the TSC Act and the EPBC Act. The Grey-Headed Flying fox was observed foraging amongst eucalypts in the SIMTA site and flying over remnant woodland of the proposed rail corridor south of the SIMTA site.

The Grey-headed Flying-fox occurs from Bundaberg in Queensland in the north to Melbourne in Victoria to the south, typically between the coast and the western slopes of the Great Dividing Range. In NSW, it occurs along the east coast, eastern slopes of the Great Dividing Range and the tablelands. The species may be found in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps, while additional foraging is provided by urban gardens and cultivated fruit crops.

The Grey-Headed Flying-Fox is a highly mobile species with a nightly feeding range of 20 to 50 kilometres from a roosting camp. Diet typically comprises a wide variety of flowering and fruiting plants (Tidemann 1995, Churchill 2008); in summer, diet mainly comprises fruits of rainforest trees and vines in addition to the nectar and blossom of Eucalyptus, Melaleuca and Banksia. In winter, diet is dominated by nectar and blossom.

Non-indigenous and exotic tree species introduced to the urban landscape provide additional foraging habitat for this species within the locality; where previously existed a period of reduced availability of native food resource during the winter months, non-native species now supply food resources throughout the year (Parry-Jones & Augee 2001, Williams *et al.* 2006).

Grey-headed Flying-foxes roost in large numbers, with up to tens of thousands of flying foxes using individual camps for mating, birth and rearing of young. Camps are typically located in gullies, close to water, in vegetation with a dense canopy, within 20 kilometres of a regular food source. Site fidelity to camps is high, with some camps being used for over 100 years (NPWS 2001). The closest known roosting camp to the study area is located at Cabramatta Creek, approximately five kilometres to the north of the study area in Jacqui Osmond Reserve adjoining

Cabramatta Creek. Other roosting camps are located within the Botanic Gardens at Farm Cove 27 kilometres to the east and Gordon 35 kilometres to the north-east.

The study area does not contain roosting habitat for this species. Habitat features of the study area which may support the Grey-Headed Flying-Fox include foraging habitat provided by a number of flowering exotic and native trees, predominantly eucalypts, located within the study area.

A tree survey has been conducted on the SIMTA site and 590 trees occurring on the site were mapped. Of those trees identified to species, at least 147 comprise known feed tree species (ABS 2001) for the Grey-headed Flying Fox including *Corymbia maculata* (Spotted Gum), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus longifolia* (Woolybutt), *Eucalyptus saligna (*Sydney Blue Gum), *Lophostomon confertus* (Brush Box), *Angophora subvelutina* (Broad-leaved Apple) and *Eucalyptus parramattensis* (Parramatta Gum).

3.3.3.2 Probability of Occurrence of Threatened and Migratory Species

The probability of each of the locally recorded threatened and migratory fauna species to occur within the study area was assessed using knowledge of each species' habitat and lifecycle requirements with regard to the habitat present within the study area (Table 18). Species were assessed as being either Unlikely, Possible, Likely or Known to occur in the study area. The location and number of nearby, recent records (Figure 11) were also considered in determining probability of occurrence.

Table 19: Probability of threatened fauna species identified from the locality to occur in the study area

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Anthochaera phrygia Regent Honeyeater	Distribution is extremely patchy; in NSW the species has been recorded from coastal areas to Narrabri with important breeding areas west of Armidale. Occurs in temperate eucalypt woodlands, most commonly box-ironbark associations and wet lowland coastal forests. Nests usually constructed in eucalypts, casuarinas or mistletoes. Forage for nectar and arthropods.	Possible. Study area supports potential foraging habitat.
Apus pacificus Fork-tailed Swift	Migrates from north-eastern Asia for the summer. Summer distribution is throughout Australia. Spend almost all day and night on the wing, hunting resting and sleeping.	Unlikely. Species rarely visits terrestrial habitats.
Ardea alba Great Egret	Occurs throughout Australia excluding arid areas. Inhabit lakes, swamps, dams and rivers and occasionally damp grasslands. Wades through shallows to hunt fish and invertebrates. Constructs a nest platform in a tree over water.	Possible. Georges River offers potential foraging habitat.
Adrea ibis Cattle Egret	Migrates south from Asia and northern Australia for the winter. Occurs in woodlands and wetlands, damp pasture and grassland around the northern, eastern and western Australian coasts where it forages for invertebrates. Commonly forage in proximity to grazing cattle. Nest in trees and shrubs along watercourses.	Possible. Species may nest in proximity to Georges River or Anzac Creek.
Botaurus poiciloptilus Australasian Bittern	Widespread distribution but uncommon across south-eastern Australia. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spike rushes (*Eleoacharis* spp), where it forages at night for amphibians, invertebrates and crustaceans. Nests are built within densely vegetated wetlands on a platform of reeds.	Unlikely. The study area does not support preferred habitat.
Burhinus grallarius Bush Stone-curlew	Rare throughout south-eastern Australia where it inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Forages nocturnally for insects and small vertebrates. Nests in a shallow scrape on the ground.	Unlikely. Study area does not support preferred habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Callocephalon fimbriatum Gang-gang Cockatoo	Found in the central NSW coast and tableland areas, including Canberra and the Hawkesbury/Nepean and Sydney Metro region. Usually frequents forested areas with old growth attributes required for nesting and roosting purposes. Also utilises less heavily timbered woodlands and urban fringe areas to forage, but appears to favour well timbered country.	Possible. Study area supports marginal foraging habitat. Study area does not support preferred nesting or roosting habitat.
Cercartetus nanus Eastern Pygmy-possum	Occurs from the coast inland to the Pillaga, Dubbo, Parkes and Wagga Wagga on the western slopes. Inhabits woodlands and heath, occasionally rainforest where it forages for nectar and pollen of banksias, eucalypts and bottlebrushes. Shelters in tree hollows, rotten stumps, holes in the ground or abandoned bird-nests.	Possible. Study area supports marginal foraging habitat. Study area does not support preferred nesting habitat.
Chalinolobus dwyeri Large-eared Pied Bat	Found mainly in areas with extensive cliffs and caves. It is generally rare with a very patchy distribution in NSW, with scattered records from the New England Tablelands and North-west Slopes. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Hirundo ariel). Forage in low to mid-elevation dry open forest and woodland and well-timbered areas containing gullies close to roosting habitat, for small, flying insects. Most likely hibernates through coolest months.	Unlikely. Study area does not support preferred foraging habitat or a roost site.
Circus assimilis Spotted Harrier	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Hunts for small terrestrial mammals including bandicoots, bettongs and rabbits. Nest constructed in open or remnant woodland.	Possible. Study area supports nesting habitat and potential prey species (small terrestrial mammals and ground-birds).
Climacteris picumnus victoriae Brown Treecreeper	Occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. Western boundary of its distribution is through Wagga Wagga, Forbes, Dubbo and Inverell. It is less commonly found on coastal plains and ranges. Forage mainly for invertebrates in fallen timber, trees and shrubs. Require hollows in standing dead or live trees and tree stumps for nesting.	Unlikely. Study area offers marginal nesting and foraging habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Cthonicola sagittata Speckled Warbler	In NSW, occurs throughout the hills and tablelands of the Great Dividing Range, rarely from the coast. Inhabits Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies where it forages for insects and seeds. Nests in a depression in the ground or the base of a low dense plant, often among fallen branches and other litter.	Unlikely. Study area does not support preferred foraging habitat.
Daphoenositta chrysoptera Varied Sittella	Widespread throughout mainland Australia, where it is found in eucalypt woodlands. Forages for insects in rough-bark eucalypts. Nests in a tree branch or fork.	Unlikely. Study area does not support preferred foraging habitat.
Dasyornis brachypterus Eastern Bristlebird	Occurs in three geographically-separate regional populations in south-eastern Australia: the Queensland/NSW border, the Illawarra and the NSW/Victoria border. Inhabits low dense vegetation in a broad range of habitat types. Forages on the ground for insect, rarely flies. Nest constructed on the ground amongst dense vegetation.	Unlikely. The study area does not support preferred habitat.
Dasyurus maculatus maculatus Spotted-tailed Quoll	Found along the escarpments, tablelands and coast of the eastern seaboard from the Bundaberg area in south-east Qld south through NSW to Victoria and Tasmania. Known from dry and moist eucalypt forests and rainforest. Species tends to move along drainage lines and make dens in fallen hollow logs or among large rocky outcrops. Usually nocturnal but are known to hunt and bask during the day. Hunts terrestrially and arboreally.	Unlikely. Study area does not support preferred habitat.
Ephippiorhynchus asiaticus Black-necked Stork	Widespread in coastal and subcoastal northern and eastern Australia; in NSW, the species becomes increasingly uncommon south of the Northern Rivers region. Rarely occurs south of Sydney. Found in association with wetlands, swamps, billabongs, estuaries and surrounding vegetation. Forages in shallow still water, for small vertebrates and crustaceans. Nests in a tall live tree, including paddock trees and paperbarks.	Possible Study area supports marginal nesting habitat. Study area does not support preferred foraging habitat.
Epinephelus daemelii Black Rockcod	Recorded from the temperate and subtropical waters of the south western Pacific: Australia, Norfolk Island, Kermadec Islands and New Zealand. An aggressive territorial species that may occupy a particular cave for life.	Not applicable. The study area does not support marine habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Epthianura albifrons White-fronted Chat	In NSW, occurs in association with damp, open habitats below 1000m elevation along the coast (such as wetlands and saltmarsh), and in association with waterways in the west. Forage for insects on the ground. Nests in low vegetation elevated from the ground.	Unlikely. Study area does not support preferred habitat.
Erythrotriorchis radiatus Red Goshawk	Sparsely dispersed across coastal and sub-coastal Australia, from western Kimberley Division to north-eastern NSW and occasionally on continental islands. Found in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia. Hunts for birds; mammals, reptiles and insects are rarely taken. Nests in large trees, frequently the tallest and most massive in a tall stand, typically within one km of permanent water.	Unlikely. The study area does not support preferred habitat.
Falsistrellus tasmaniensis Eastern False Pipistrelle	Occurs along the east coast of NSW, where it inhabits tall moist forests. Roosts in hollows of eucalypts, occasionally under loose bark on trees or in buildings. Hunts for flying insects above or below the tree canopy.	Unlikely. Study area does not support preferred habitat.
Glossopsitta pusilla Little Lorikeet	In NSW, the species occurs from the coast to the western slopes of the Great Dividing Range. Inhabits forests and woodlands, where it forages for nectar and pollen within the canopy stratum. Requires living, hollow-bearing eucalypts for nesting habitat.	Possible. Study area support potential foraging and marginal nesting habitat.
Haliaeetus leucogaster White-bellied Sea Eagle	Occurs throughout coastal Australia, along the coast, large lowland rivers and lakes. Occasionally found in association with inland lakes. Mainly hunts over water for aquatic animals; small terrestrial mammals and carrion may be taken from land. Typically nests in large trees to 30m, less often in smaller trees, on rocks or the ground.	Possible. Study area offers potential terrestrial and aquatic foraging habitat.
Heleioporus australiacus Giant Burrowing Frog	Distribution largely restricted to sandstone geology of Sydney Basin, within heath, woodland and open dry sclerophyll forest. Moves to breeding habitat before or after heavy rain in autumn; typically soaks, pools in first or second order streams or hanging swamps. Outside of breeding period, inhabits burrows below soil surface or leaf litter, within 300m of breeding habitat. Generalist diet of invertebrates.	Unlikely. Study area does not support preferred habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Hieraaetus morphnoides Little Eagle	Widespread throughout mainland Australia, often observed over woodland, forested land and open country. Appears to avoid rainforest and dense forest. Hunts for small terrestrial and arboreal mammals. Nests in a large living tree in open woodland or tree-lined watercourses.	Possible. Study area support potential foraging habitat.
Hirundapus caudacutus White-throated Needletail	Migrates from northern Asia to eastern Australia for the summer. In NSW, occurs from the coast to the western slopes of the Great Dividing Range. Species is almost exclusively aerial, most commonly recorded above open forest and rainforest. Rarely recorded flying over treeless areas. Forages aerially for insects. May roost aerially or in tree canopies or hollows in forests and woodland.	Unlikely. Study area does not support roosting habitat. Species may forage aerially above study area.
Hoplocephalus bungaroides Broad-headed Snake	Distribution restricted to sandstone habitats within approximately 250 kilometres of Sydney. Requires rock crevices and flat sandstone rocks on exposed cliff edges for sheltering in cooler months, shelters in tree hollows near sandstone escarpments in summer. Forages for small reptiles, occasionally frogs and small mammals.	Unlikely. Study area does not support preferred habitat.
Gallinago hardwickii Latham's Snipe	Migrates to south-east Australia for the summer. Inhabits freshwater wetlands on or near the coast, generally among dense cover. Also known from short-grassed marshes and wet, treeless grasslands. Occasionally found in crops and pasture. An omnivorous species that forages in soft mudflats or shallow water. Roosts amongst low vegetation during the day.	Unlikely. Study area does not support preferred habitat.
Isodon obesulus obesulus Southern Brown Bandicoot	Occurs east of the Great Dividing Range, south from the Hawkesbury River, where it is found in heath or open forest with a heathy understorey on sandy or friable soils. Nests in a shallow depression in the ground covered by vegetation. Searches for insects or underground-fruiting fungi by digging conical holes in the soil.	Unlikely. Study area does not support preferred habitat.
Lathamus discolor Swift Parrot	Migrates from breeding grounds in Tasmania to the Australian mainland in winter. Preferred over-winter habitat is woodlands and riparian vegetation where there are winter flowering eucalypts such as the Swamp Mahogany, *Eucalyptus robusta* in coastal areas.	Possible. Study area supports marginal foraging habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Litoria aurea Green and Golden Bell Frog	Isolated, scattered populations throughout coastal NSW, several within the Sydney metropolitan area, Shoalhaven and mid-north coast. Breeding habitat comprises natural and constructed waterbodies including wetlands, stormwater detention basins, marshes, dams and streams-side, preferably those that are unshaded but with fringing vegetation. Forage for invertebrates within grassy habitats near breeding habitat. May shelter under vegetation, rocks and building materials such as fibro, sheet iron or bricks.	Unlikely. Anzac Creek contains some preferred habitat features, however infestation of *Gambusia holbrooki* (a predator of tadpoles) reduced the likelihood of occurrence.
Litoria littlejohni Littlejohn's Tree Frog	Distributed throughout the plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Breeds in the upper reaches of permanent streams and in perched swamps where it lays eggs on temporary or permanent slow flowing pools. Outside of the breeding season, inhabits forests and woodlands where it shelters under leaf litter and low vegetation and hunts for invertebrates.	Unlikely. Study area does not support preferred habitat.
Litoria raniformis Growling Grass Frog	Occurs in association with the Murray and Murrumbidgee River valleys and their tributaries. Inhabits emergent vegetation within or fringing still or slow-flowing waterbodies, including lagoons, ponds, swamps and dams. Basks on rocks or vegetation in summer and shelters in soil cracks, fallen timber, dense vegetation. Requires permanent, freshwater shallow lagoons for breeding.	Unlikely. Study area is outside of current geographic range of the species.
Lophoictinia isura Square-tailed Kite	Widespread but sparsely distributed throughout mainland Australia. Is a resident of the north and north-east of NSW and in association with major river systems where it is often found in association with forest dominated by Woolybutts (*Eucalytus longiflora)*, Spotted Gum (*E. maculata)* or Peppermint Gum (*E. elata).* Hunts for smaller birds such as honeyeaters amongst the canopy layer. Nests on a large limb of a eucalypt or angophora along or near a watercourse.	Possible. Study area offers potential nesting and foraging habitat.
Macquaria australasica Macquarie Perch	Found within the southern tributaries of the Murray Darling Basin (particularly the upstream reaches), Hawkesbury-Nepean and Shoalhaven river systems of NSW. Inhabits rivers and lakes. Feed on aquatic insects, crustaceans and molluscs. Breeds during spring and summer in shallow upland streams or flowing rivers. Requires riffle over cobble and gravel substrates in which to deposit eggs. Deep rock pools, overhanging vegetation and snags provide refuge habitat for the species.	Possible. Georges River does not provide preferred breeding habitat. Georges River of the study area supports potential foraging and refuge habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Melithreptus gularis gularis Black-chinned Honeyeater (eastern subspecies)	Eastern subspecies occurs from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range. Inhabits forests or woodlands dominated by box and ironbark eucalypts where it forages for insects and nectar. Nests high in tree crown.	Unlikely. Study area does not support preferred habitat.
Meridolum corneovirens Cumberland Plain Land Snail	Distribution restricted to Cumberland Plain Woodland in western Sydney, from Richmond in the north to Picton in the south. Found under leaf litter, bark, logs or loose soil at the base of trees, may bury deep into the soil to evade drought. Species is a fungus specialist.	Possible. Study area supports small isolated areas of marginal habitat.
Merops ornatus Rainbow Bee-eater	Occurs throughout mainland Australia, excluding arid areas. Southern populations migrate north in winter. Found in open forest, woodland, shrubland and occasionally remnant vegetation within farmland, orchards and vineyards. Forages aerially for insects. Roosts in small shrubby trees. Constructs a tunnel in which to nest, in sandy bank or bare flat ground.	Possible. Study area offers potential roosting and nesting habitat. Species may forage aerially above study area.
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	Distributed throughout eastern and north-western Australia. In NSW, recorded from the coast to the western slopes of the Great Dividing Range. Occurring in forests and woodlands the species live in colonies and roost in caves, old mines and occasionally buildings. The species forages for insects above the tree canopy	Known. Ultrasonic recordings made of this species at five locations within the study area.
Mixophyes balbus Stuttering Frog	In NSW, known only from three locations south of Sydney. Inhabits rainforest and wet, tall forest in the foothills and escarpment east of the Great Dividing Range. Requires streams with rock shelves or shallow riffles for breeding in summer. Outside of breeding period, species is found under deep leaf little and thick understorey vegetation on forest floor.	Unlikely. Study area does not support preferred habitat.
Monarcha melanopsis Black-faced Monarch	Migrates to south-eastern coast of Australia from the north-eastern coast. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Forages on the wing or amongst vegetation for insects. Nests in small tree or shrub 3-6m above ground.	Unlikely. Study area does not support preferred habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Mormopterus norfolkensis Eastern Freetail-bat	Occurs along the east coast of NSW inland to the Great Dividing Range, where it is found in dry sclerophyll forest, woodland, swamp forest and mangrove forest. Roosts in trees hollows, occasionally under bark or in man-made structures. Forages for insects.	Known. Ultrasonic recordings made of this species at one location within the north-west of the study area.
Myiagra cyanoleuca Satin Flycatcher	Occurs along east coast of Australia, migrates north to Cape York Peninsula and Papua New Guinea in winter. Inhabits tall, wet eucalypts forests in gullies where it forages for insects. Nests in tree 3-25 m above ground.	Unlikely. Study area does not support preferred habitat.
Myotis macropus Southern Myotis	Distribution generally limited to within 100 kilometres of the coast. Forages over streams and pools for insects and small fish. Roosts communally in mine shafts, tree hollows, under bridges and storm water channels.	Possible. Possible ultrasonic recording made of this species in proximity to Georges River.
Neophema chrysogaster Orange-bellied Parrot	In NSW, occurs from the coastal plains to the western slopes of the Great Diving Range. Found along the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Forages on the ground for seeds and grasses. Nests in a tree hollow, log or post.	Unlikely. Study area does not support preferred habitat.
Ninox connivens Barking Owl	Scattered distribution throughout Australia, excluding central arid areas. In NSW, core populations located on western slopes and plains. Inhabits woodland and open forest, where it hunts for arboreal mammals, occasionally birds, invertebrates and small terrestrial mammals. Roosts in canopy or tall mid-storey trees. Requires large, hollow-bearing eucalypts for nesting habitat.	Unlikely. Study area does not support preferred nesting habitat.
Ninox strenua Powerful Owl	Widely distributed throughout NSW, from the coast inland to the tablelands. Inhabits woodland, open forest, tall wet forest and rainforest, where it hunts for arboreal mammals, occasionally birds. Roosts in dense vegetation, requires old, large hollow-bearing eucalypts for nesting habitat.	Unlikely. Study area does not support preferred nesting habitat.
Petaurus australis Yellow-bellied Glider	In NSW, distributed from the east coast to the western slopes of the Great Dividing Range. Occurs in association with tall mature eucalypt forest, generally in high rainfall areas and nutrient rich soils. Extract sap from favoured food trees, most commonly smooth-barked eucalypts. Dens in large tree hollows.	Unlikely. Study area supports marginal foraging habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Petaurus norfolcensis Squirrel Glider	Sparsely distributed throughout eastern Australia. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Require abundant tree hollows for refuge and nest sites. Forages for nectar, sap, invertebrates and pollen.	Unlikely. Study area does not support preferred habitat.
Petrogale penicillata Brush-tailed Rock-wallaby	Occurs along NSW coast, inland to the Warrumbungle Ranges. Occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Shelter in rock crevices and overhangs. Forages in and adjacent to rocky areas for grasses, foliage and fruits of shrubs and trees.	Unlikely. Study area does not support preferred habitat.
Petroica boodang Scarlet Robin	Distributed from the coast, inland to the western slopes of the Great Dividing Range. Inhabits open forests and woodlands, also found in grasslands in winter. Constructs a cup-shaped nest in a tree fork. Forages for insects on the ground. In NSW, the species breeds in tall moist eucalypt forests and woodlands in upland areas. In winter, moves to dry forests, open woodlands and grasslands of the inland slopes and plains. Forages amongst low branches for invertebrates. Nests near the ground in sheltered areas such as tree cavities or stumps.	Unlikely. Study area does not support preferred habitat.
Petroica phoenicea Flame Robin	In NSW, the species breeds in tall moist eucalypt forests and woodlands in upland areas. In winter, moves to dry forests, open woodlands and grasslands of the inland slopes and plains. Forages amongst low branches for invertebrates. Nests near the ground in sheltered areas such as tree cavities or stumps.	Unlikely. Study area does not support preferred habitat.
Petroica rodinogaster Pink Robin	Partly resident and partly dispersive throughout breeding habitat, typically rainforest, in Tasmania, King and Flinders Islands and the wetter parts of Victoria and far south eastern New South Wales. Nests in a mossy or lichen-covered fork of a tree or shrub. May migrate to areas in southern New South Wales in winter, after breeding. Forages for insects on the ground or from low bushes.	Unlikely. Study area supports marginal habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Phascolarctos cinereus Koala	Distribution of the species throughout Australia is highly fragmented. In NSW it mainly occurs on the central and north coasts with some populations in the western region inhabiting eucalypt woodlands and forests. The species feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	Unlikely. Study area does not support preferred habitat.
Potorous tridactylus tridactylus Long-nosed Potoroo	Distribution in NSW restricted to coastal heaths and forests east of the Great Dividing Range. Also known from dry and wet sclerophyll forest. Requires dense understory and groundlayer vegetation for sheltering. Forages from fungi, roots tubers and insects in the soil.	Unlikely. Study area does not support preferred habitat.
Pseudomys novaehollandiae New Holland Mouse	Fragmented distribution across Tasmania, Victoria, NSW and Queensland where it inhabits open heathlands, open woodlands with a heathland understorey and vegetated sand dunes. Forages for seeds, insects, leaves, flowers and fungi. Shelters and nests communally in burrows.	Unlikely. Study area does not support preferred habitat.
Pseudophryne australis Red-crowned Toadlet	Distribution restricted to the Sydney Basin, from Pokolbin, south to Nowra, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, where it typically inhabits periodically wet drainage lines below sandstone ridges. Breeds in dense vegetation and debris beside ephemeral creeks and gutters. Outside of breeding season, is found under rocks and logs on sandstone ridges where it forages amongst leaf-litter.	Unlikely. Study area does not support preferred habitat.
Pteropus poliocephalus Grey-headed Flying-fox	Found within 200 kilometres of the east coast of Australia. Roosting camps commonly found in gullies, close to water, in vegetation with a dense canopy. Camps typically located within 20 kilometres of a regular food source; nectar and pollen of native trees and fruits of rainforest trees and vines. Also forage in cultivated gardens and fruit crops.	Known. This species was visually identified at two locations within the study area.
Rhipidura rufifrons Rufous Fantail	Occurs throughout east coast of Australia, migrates from eastern NSW to north-eastern Queensland and Papua New Guinea in winter. Inhabits rainforest, wet forest, swamp woodlands and mangroves, where it forages amongst a shrubby understorey for insects. Constructs a nest suspended from a tree fork.	Unlikely. Study area does not support preferred habitat.

Scientific name	Habitat preference/ known distribution	Probability of occurrence in the study area
Rostratula australis Australian Painted Snipe	Occurs throughout Australia. Inhabits shallow freshwater wetlands, vegetated ephemeral and permanent lakes and swamps, and inundated grasslands. Roosts during the day in dense vegetation and is active at dusk, throughout the night and dawn. It nests on the ground amongst tall reed-like vegetation near water, and forages near the water's edge and on mudflats for invertebrates and seeds.	Unlikely. Study area does not support preferred habitat.
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat	Occurs throughout tropical and south-east of Australia, excluding Tasmania. Found in a variety of habitat types including wet and dry sclerophyll forest, open woodland, *Acacia* shrubland, mallee, grassland and desert. Forages for insects above the tree canopy. Roost in tree hollows, abandoned sugar glider nests or animals burrows.	Possible. Study area supports marginal foraging habitat.
Scoteanax rueppellii Greater Broad-nosed Bat	Found mainly in the gullies and river systems that drain the Great Dividing Range. Distribution of the species in NSW is widespread on the New England Tablelands, however does not occur at altitudes above 500m. The species is known from woodland through to moist and dry eucalypt forest and rainforest; most commonly found in tall wet forest. The species forages along creek and river corridors. The species typically roosts in tree hollows but has also been found roosting in buildings. Maternity roosts usually comprise a suitable tree hollow.	Possible. Study area supports marginal foraging habitat.
Sternula nereis nereis Fairy Tern	Occurs along the coasts of Victoria, Tasmania, South Australia and Western Australia. The subspecies has been known from NSW in the past but it is unknown if it persists there. Hunts for small fish, is also known to feed on plant material, molluscs and crustaceans. Nests on sheltered sandy beaches, spits and banks above the high tide line and below vegetation.	Unlikely. The study area does not support preferred habitat.

3.4 Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) are identified by the Protected Matters Report generated by the Protected Matters Search (Appendix 4). With the exception of the threatened and migratory species and ecological communities discussed in this report, no MNES were identified within 10 kilometres of the study area.

4 IMPACT ASSESSMENT

4.1 Construction Phase

SIMTA Site

The SIMTA site, approximately 83 hectares in area, will be developed into an intermodal terminal facility and warehouse/distribution facility, which will offer container storage and warehousing solutions with direct rail access to Port Botany.

A summary of construction activities to be undertaken during the construction phase of the SIMTA site are listed in Table 20.

Table 20: Summary of construction activities associated with the SIMTA site

Site area	Phase	Construction activities
SIMTA site	Site Preparation	Establishment of compound area, portable offices, amenities and connection to utilities.
		Demolition of existing structures and pavements.
		Clearing and grubbing of existing vegetation.
		Stripping of topsoil and stockpiling for re-use or disposal, followed by earthworks including excavation and filling.
	Earthworks, Drainage and Utilities Installation	Excavation and filling on SIMTA site.
		Excavation of trenches for construction of open stormwater channels
		Installation of utilities including electricity, sewage, water and gas
	Rail Construction	Construction of two permanent rail sidings and an interim siding within the SIMTA site
	Pavement Construction and Ancillary Works	Construction of pavement and base slabs including formwork and placement of reinforcement.
		Construction of kerbs, gutters and concrete barriers.
		Construction of an internal road network and truck transfer point
		Installation of signposts, lighting and guard rails.
	Building Structures	Construction of building slabs
		Erection of steel building frames, roof and wall cladding.

Rail Link

The proposed rail link would connect to the Southern Sydney Freight Line (SSFL), approximately 500 metres south of Casula railway station and extend south then east, crossing the Georges River via a new girder bridge, constructed from the south-east corner of the Glenfield Waste Disposal Centre to the eastern bank of the Georges River within the East Hills Railway corridor. The rail link would then continue east within the East Hills rail corridor, passing beneath Moorebank Avenue within the existing overbridge , before heading north into the

SIMTA site, crossing Anzac Creek via a series of culverts. Construction of each of these elements is discussed briefly below.

The proposed rail link would be constructed within an easement of variable width, ranging from approximately 35 metres at the south of the SIMTA site reducing to a 20 metre easement that extends through the forested area to the south of the SIMTA site. The rail link construction area covers an area of approximately six hectares.

Preliminary site establishment works

- Site establishment, including offices, services and amenities.
- Construction of temporary fences and access gates.
- Temporary access roads and car parks for construction staff
- Laydown and Workshop area
- Establishment of a protection barrier within the East Hills rail corridor and SSFL corridor where required to separate the construction sites from the live rail zones (danger zones).

East Hills Corridor and Southern Main Line Corridor Enabling Works

- Relocation of services, including potable water, sewer, telecommunications and gas.
- Relocation of signalling cables within the East Hills rail corridor and SSFL corridor.
- Relocation of a signalling hut within the East Hills rail corridor.
- Relocation of 33kv Aerial Power lines
- Construction of Protection slab for ethane gas pipeline

Track and associated works

- Bulk earthworks, drainage and retaining wall construction at several locations across the site
- Placement and compaction of subgrade and blanket (Capping Layer).
- Placement of bottom ballast.
- Placement of sleepers.
- Placement of rail and connection to sleepers.
- Track tamping ,ballast cleaning and Track Stabilisation

Signalling and Associated works

- Piled foundations for Signalling Posts
- Installation of signalling posts
- Installation of Combined Service Route(CSR) for Cables, either GST/GLT
- Installation of Underline Crossing (ULX)

Georges River Underbridge

The construction methodology for the George's River railway bridge will be confirmed during detail design; however, the current bridge options investigated will result in a potential for the following construction techniques:

- Piling.
- Forming and pouring of structural concrete members.

- Piling and crane platform
- Erection and craning into place precast concrete or steel girders.
- Forming and pouring of bridge decks prior to the installation of ballast and rail tracks.
- Installation of walkways and other safety structures
- Installation of any services required, galvanised steel trough, conduits etc.

Anzac Creek culverts

The rail link would cross Anzac Creek via a series of culverts that would be sized to accommodate the 1 in 100 year Average Recurrence Interval (**ARI**) flood event. At a minimum, the culverts will match the sizing of existing culverts under the existing, disused rail line to the east of the rail link. Sizing of the culverts would be determined during detail design and take into account requirements for fish passage outlined in Fairfull and Witheridge (2002). Construction of the culverts would generally involve:

- Establish temporary creek diversion in accordance with *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).
- Excavation of Anzac Creek bed to the width of the culverts.
- Placement of bedding material for form an even surface.
- Placement of reinforcing bar, erection of formwork and pouring of concrete slab of sufficient bearing capacity to support the culverts.
- Placement of precast culverts.
- Backfill around the culverts.

Moorebank Avenue overbridge

The proposed rail link will pass under Moorebank Avenue at the existing overbridge of the East Hills Railway line. The rail link will be located within the third span of the overbridge, which is currently occupied by the road approach embankment batter slope.

Two feasible options are under consideration to accommodate the SIMTA rail link and the future quadruplication of the East Hills Railway line within the East Hills rail corridor beneath Moorebank Avenue:

- Installation of an additional span at northern end of overbridge: This would involve construction of an additional span at the northern end of the existing overbridge, comprising standard Roads and Maritime Services (RMS) spaced pretensioned concrete planks and a cast insitu deck slab, together with construction of a new abutment.
- Contiguous pile wall behind northern abutment: This would involve the construction of a contiguous pile wall immediately behind the existing northern abutment. The contiguous pile wall would retain the approach road embankment and obviate the need to extend the overbridge.

The preferred option will be identified during detail design and developed in consultation with RMS and RailCorp. Construction of any option would be staged to minimise impacts on road traffic and rail operations on the East Hills Railway line.

A summary of construction activities to be undertaken during the construction phase of the rail link are listed in Table 21.

Table 21: Summary of construction activities associated with the rail link

Activity	Area	Description
Site Establishment	All	Clearing of native vegetation, including access and maintenance tracks and ancillary areas.
		Clearing within a maximum a variable easement width ranging from 35 to 20 m.
		Verification of underground service by potholing
	Moore Bank Avenue to proposed Terminal	Site office, amenities and services
		Car Park for construction staff
		Lay Down area and work Shop
Preliminary/Preparation Works	East Hills rail corridor area	Establishment of a protection barrier within the East Hills rail corridor where required to separate the construction sites from the live rail zones (danger zones).
		Relocation of existing Underground services affected by the SIMTA track and Construction of protection slab for the High Pressure Ethane Gas Pipe line
		Relocation of High voltage aerial feeder for Georges river to Moore bank avenue overbridge.
	Southern Sydney freight corridor area	Establishment of a protection barrier within SSFL corridor where required to separate the construction sites from the live rail zones (danger zones).
		Relocation of High Voltage aerial feeder
Rail Bridges construction	George River under bridge	Construction of a single-track railway bridge over the Georges River. (To be confirmed during detailed design).
	Anzac Creek	Construction of a small box culvert-style railway bridge over Anzac Creek (to be confirmed during detailed design).
	Moorebank Avenue overbridge	Construction of additional span in the existing bridge to accommodate SIMTA Track
Bulk Earth Works	All	Earthworks, drainage and retaining wall construction at several locations across the site

Activity	Area	Description
Rail Systems	SSFL connection	Installation of 3 x Turnouts Installation Signalling Post Installation of points motor Signalling cable route and Cable installation
	SSFL and Georges River	Installation of New Track and 1 X Turnout Installation of signalling post Installation of Points motor Installation of signalling cable route and cabling
	Georges River to Moorebank	Installation of new Track Installation of signalling cable route and cabling
	Moorebank to Terminal	Installation of new Track Installation of signalling post. Installation of signalling cable route and cabling

4.1.1 Likely Impacts

Likely impacts are those impacts that may arise as a result of unmitigated activities associated with the construction of the SIMTA proposal.

Loss of native vegetation, including TSC Act listed Threatened Ecological Communities

Clearing of native vegetation is required for the Proposal. The area of each vegetation community that occurs within the study area are listed in Table 22.

Table 22: Native vegetation within the study area and SIMTA proposal footprint

Vegetation Community	Area in study area (ha)	Area to be cleared (ha)	Percentage within SIMTA proposal footprint
Native vegetation communities			
Castlereagh Scribbly Gum Woodland	18.93	0.76	4%
Castlereagh Swamp Woodland	4.37	0.05	1%
Freshwater Wetlands	0.66	0.03	5%

Vegetation Community	Area in study area (ha)	Area to be cleared (ha)	Percentage within SIMTA proposal footprint
River Flat Eucalypt Forest	7.23	0.35	5%
Total	**31.19**	**1.19**	4%
Other vegetation			
Urban/exotic	13.64	9.44	69%
TOTAL	**44.83**	**10.63**	

The majority of mapped vegetation to be cleared consists of planted trees on the SIMTA site (Figure 14). The 1.19 hectares of native vegetation communities to be cleared are primarily located within the rail corridor, in the predominantly 20 metre wide footprint for the proposed rail link. Although the proposed rail link construction area covers an area of approximately six hectares, most of this is comprised of cleared and disturbed areas within the Glenfield Waste Disposal site, and only 1.19 hectares supports native vegetation. The linear clearing for the rail link and installation of fencing will result in fragmentation of the remaining vegetation in the rail corridor and increase the risk of edge effects within this vegetation. All four native vegetation communities fall within the definitions of threatened ecological communities under the TSC Act.

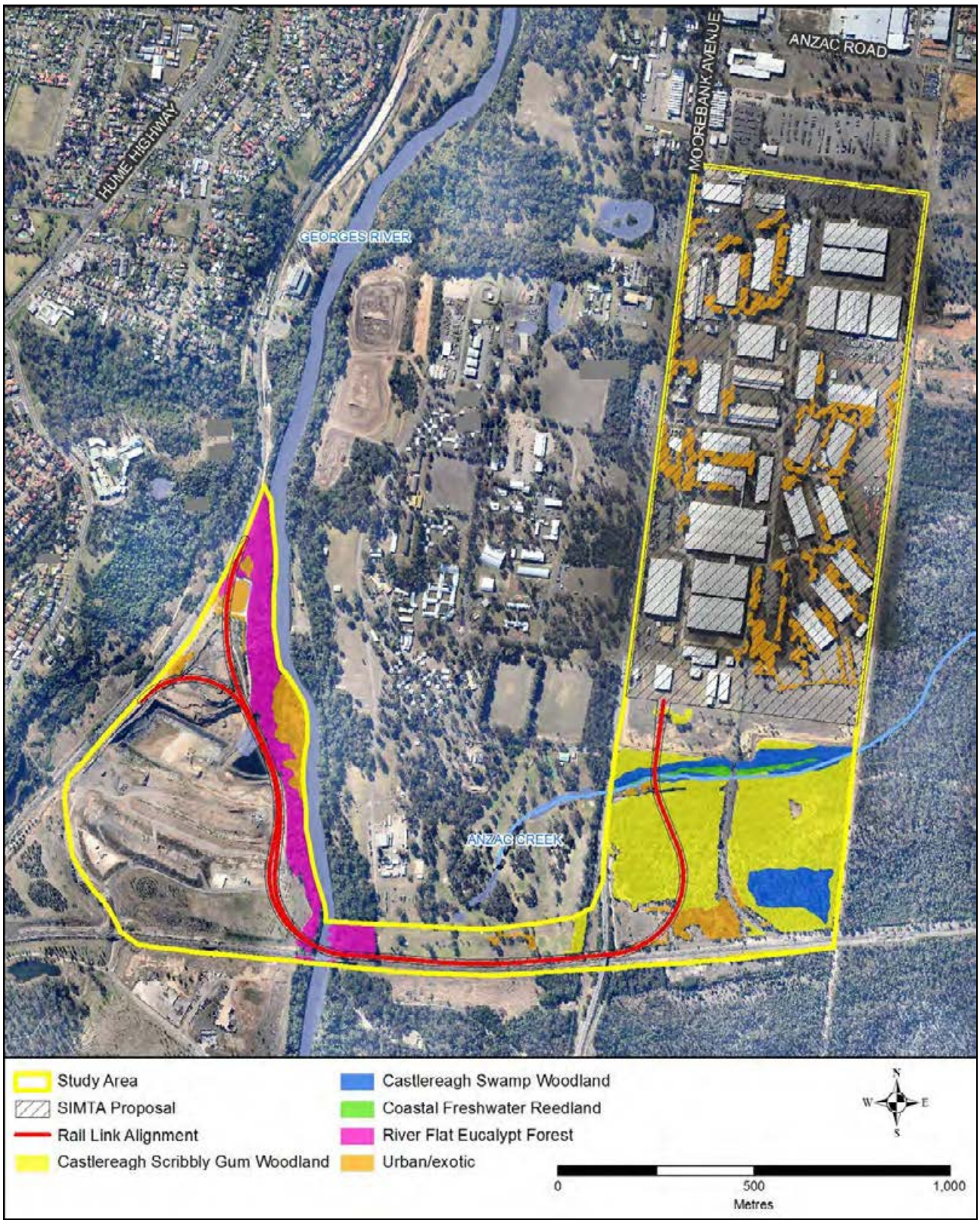

Figure 14: Vegetation to be cleared from the study area

Loss of threatened plant species and fragmentation of habitat

The construction of the rail link will also have direct impacts on populations of two threatened plant species in the rail corridor. The rail link intersects the centre of the sub-population of the endangered species *Persoonia nutans* (Nodding Geebung) mapped in the rail corridor and the western edge of the core population of the vulnerable species *Grevillea parviflora* subsp. *parviflora* in the rail corridor (Figure 15,Table 23).

Table 23: Threatened flora species within the study area and SIMTA proposal footprint

Threatened Flora Species	Number in study area	Number to be cleared	Percentage to be cleared
Persoonia nutans	126 individuals	17 individuals	14%
Grevillea parviflora	4110 stems (estimated)	464 stems	11%

Table 24 shows the occupied and potential habitat areas for *P. nutans* and *G. parviflora* within the study area and area of impact The habitat areas are defined as follows:

- Occupied habitat: areas where individuals of the species have been recorded.
- Potential habitat: areas where no individuals of the species have been recorded, but which represent suitable habitat.

Table 24: Threatened flora species habitat within the study area and SIMTA proposal footprint

Threatened Flora Species	Type of habitat	Area of habitat in study area (ha)	Area of habitat to be cleared (ha)	Percentage of habitat to be cleared
Persoonia nutans	Potential	19.14	0.65	3%
	Occupied	0.79	0.09	11%
	Total	19.93	0.74	4%
Grevillea parviflora	Potential	15.35	0.56	4%
	Occupied	4.58	0.18	4%
	Total	19.93	0.74	4%

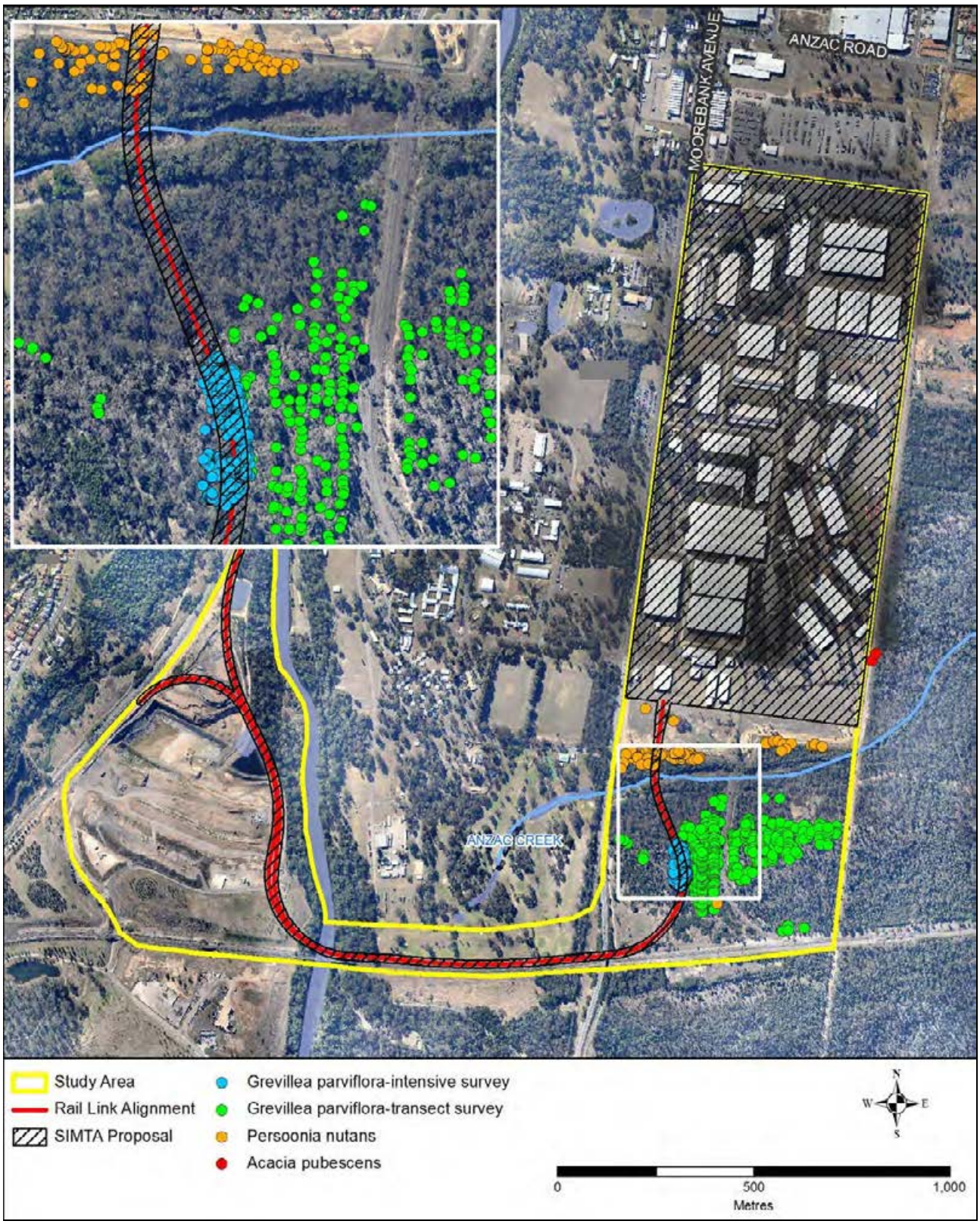

Figure 15: Threatened flora species to be cleared from the study area

Loss of fauna habitat including that of threatened and migratory species

Clearing of native vegetation for the Proposal will result in the removal of fauna habitat (Figure 16). The areas of each fauna habitat type that occur within the study area, requiring removal, are listed in Table 25.

Table 25: Areas of fauna habitat within the study area and the SIMTA proposal footprint

Fauna habitat type	Area in study area (ha)	Area within project footprint (ha)	Percentage within footprint
Remnant Forest	0.58	0.07	12%
Remnant Woodland	25.82	0.95	4%
Riparian Habitat-Anzac Creek	3.21	0.07	2%
Riparian Habitat-Georges River	8.72	0.39	4%
Landscaped	92.58	82.66	89%
Cleared and Disturbed	38.94	4.08	10%
TOTAL	**169.85**	**88.22**	**52%**

The clearing of vegetation will result in the loss of specific fauna habitat components, including live trees, tree hollows, foraging resources (myrtaceous and flowering trees and shrubs), groundlayer habitats such as ground timber and well-developed leaf litter. These resources offer sheltering, foraging, nesting and roosting habitat to a variety of fauna occurring within the locality. A total of 88.22 hectares of habitat occurs within the SIMTA proposal footprint and would be disturbed during construction of the project.

Remnant woodland and forest offers the greatest diversity of fauna habitat features, offering habitat to a diversity of birds, reptile and mammal species. Clearing of remnant vegetation will reduce the localised extent of habitat (and the foraging, roosting and breeding areas they provide) for some animals. Approximately seven hollow-bearing trees are located in the proposal rail link, and two within the SIMTA site that will be required to be removed. The loss of hollow-bearing trees reduces available nesting and roosting habitat to hollow-dependent currently utilising these hollows, such as Rainbow Lorikeet (*Trichoglossus haematodus*) and Scaly-breasted Lorikeet (*Trichoglossus chlorolepidotus*). The loss of tree hollows also reduces potential roosting habitat for threatened microchirpoteran bats species known to occur in the study area.

Impacts to riparian vegetation are expected only where the rail link will be constructed over Anzac Creek and the Georges River. Riparian vegetation associated with Georges River to be removed is highly disturbed and is dominated by woody weeds such as Small-leaved Privet (*Ligustrum sinense*), African Olive (*Olea europaea ssp. Cuspidata*) and Lantana (*Lantana camara*) and exotic climbers such as Balloon Vine (*Cardiospermum grandiflorum*).

The area of habitat to be cleared does not comprise a significant area of habitat within the wider locality. Habitat features and vegetation communities that will be cleared are prevalent within

the wider landscape, particularly within the Holsworthy Military Area to the south and bushland to the east of the SIMTA proposal.

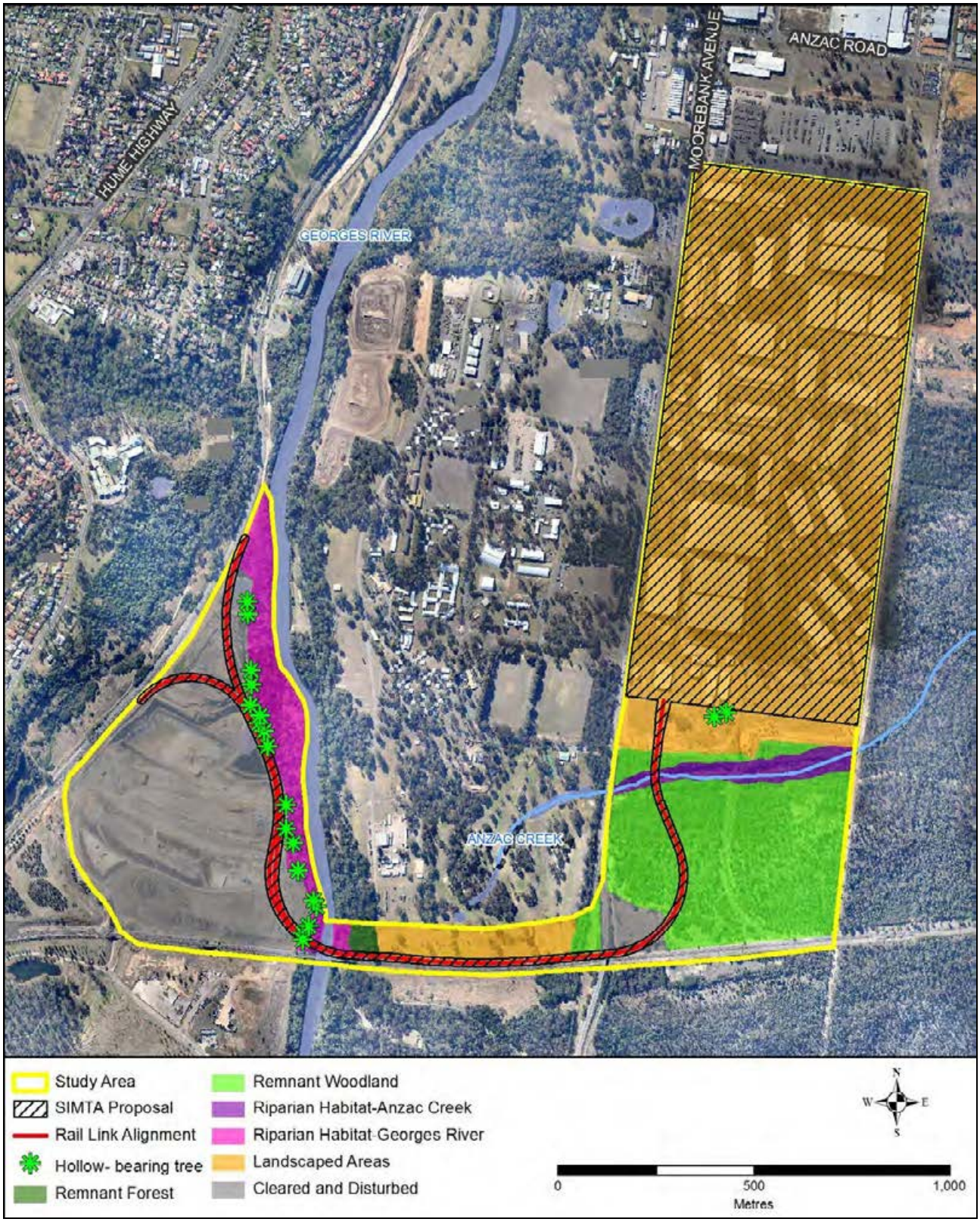

Figure 16: Fauna habitat within SIMTA proposal footprint study area

Habitat fragmentation/ loss of fauna habitat connectivity

The study is located within a relatively industrialised and urbanised landscape. Habitat connectivity is currently severely restricted by significant barriers to fauna movement and is unlikely to be further fragmented as a result of the SIMTA proposal. These barriers include Moorebank Ave, the East Hills Railway Line and chain-mesh fencing surrounding the SIMTA site, East Hills rail corridor, Glenfield Waste disposal site and Royal Engineers Golf Course.

The construction phase of the SIMTA proposal is not considered likely to reduce fauna movement throughout the locality. However, clearing of vegetation within the study area may reduce the capacity of some less mobile fauna to move within and between patches of remaining habitat. This is particularly relevant to locally occurring small, ground-dwelling fauna such as amphibians, reptiles and small ground-dwelling and arboreal mammals.

Alteration and degradation of aquatic habitats

Construction activities in proximity to and across Anzac Creek and the Georges River have the potential to adversely affect aquatic habitat, particularly the construction of piers for the Georges River rail bridge that are within the main waterway. Construction activities in proximity to these watercourses may increase the volumes of sediments carried downstream and reduce water quality occurring downstream. The mobilisation of sediments and pollutants has the potential to reduce the suitability of aquatic environments for some aquatic flora and fauna species.

Some aquatic vegetation occurring within and fringing Anzac Creek and Georges River will be lost; including submerged, floating and emergent plants such as *Elodea canadiensis* , *Azolla sp., Typha sp*. and exotic species such as *Salvinia molesta.* Other aquatic habitat features such as woody debris and fallen logs may be lost.

Other minor areas of aquatic habitat will be lost, such as the formalised channels that support aquatic and fringing vegetation and , offer habitat for reptiles and amphibians such as Common Eastern Froglet (*Crinia signifera*).

Fauna mortality

Fauna injury or mortality is most likely to occur during vegetation clearing activities, but also may result from collisions with vehicles or plant, or accidental entrapment in plant, trenches or other earthworks.

The majority of fauna species recorded within the study were highly mobile bird species and these species are likely to be able to move away from vegetation clearing activities quite readily. Any fauna inhabiting the hollows in hollow-bearing trees may be injured during tree-felling. This could potentially include hollow-dependent birds and mammals and threatened microchiropteran bat species. Those animals that are unable to disperse away from areas under active clearing are also particularly susceptible to injury or death. This includes amphibians, reptiles and fish.

Edge effects and weed invasion

Fragmentation of vegetation will result in sections of edge habitat. This is most likely to occur where the rail link is to be constructed within woodland south of the SIMTA site. Edge effects include alterations in humidity, light, moisture, wind, temperature and noise and soil profile conditions. These effects impact on the adjoining native vegetation by affecting seed germination, flora and fauna species composition and weed establishment.

Fourteen of the 89 exotic species recorded in the study area are listed as noxious weeds in the Liverpool City Council local government area (Table 15). Nine of the noxious weeds are also listed as Weeds of National Significance under the National Weeds Strategy (Thorp and Wilson 2012). The occurrence of noxious weeds in the study area was localised; the most severe

infestations were on the lower slopes adjoining the banks of the Georges River, where there were large stands of privet *Ligustrum sinense* (Small-leaved Privet) and *Lantana camara* (Lantana). Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the introduction of spread of these weeds within the study area.

Alteration to air quality and noise levels

The construction phase of the SIMTA proposal may impact upon the roosting, breeding and foraging activities of locally occurring fauna, as a result of increased exposure to light, noise, dust, vehicles and people.

4.2 Operational Phase

4.2.1 Operational Activities

The SIMTA proposal will incorporate operational activities listed in Table 26.

Table 26: Operational activities of the SIMTA proposal

Site area	Operational activities
SIMTA site	Internal vehicle movements within the SIMTA sits as vehicles transport freight to internal warehouses.
	Vehicle movements to and from the SIMTA site as trucks transport freight from the intermodal terminal and warehouses to logistic centres.
Rail Corridor	Estimated twenty one train paths between the SIMTA site and Port Botany.

4.2.2 Likely Impacts

Likely impacts are those impacts that may arise as a result of unmitigated activities associated with the operation of the SIMTA proposal. Likely impacts include:

Fauna mortality

Fauna injury or mortality may result from collisions with vehicles or plant in operation within the SIMTA site, or as a result from increased traffic movements within the vicinity of the SIMTA site.

Edge effects and weed invasion

Increased movement of people, vehicles, machinery, vegetation waste and soil may facilitate the introduction of spread of these weeds within the study area.

Degradation of aquatic habitats

Oils, fuel, lubricants and other chemical substance will be required for the operation of vehicles, plant and machinery on the SIMTA site. Accidental spills or leaks on the SIMTA site have the potential to result in contaminants being transported to the aquatic environment of Anzac Creek or the Georges River via rainfall runoff.

Alteration to air quality and noise environments

Operation of the SIMTA site will increase utilisation of the site by both people and vehicles from current levels. This may impact upon the roosting, breeding and foraging activities of locally occurring fauna, as a result of increased exposure to light, noise, dust, vehicles and people.

4.3 Summary of Impacts

The extent or scale of values likely to be affected as a result of the SIMTA proposal is summarised in Table 27.

Table 27: Summary of Impacts

Likely Impact	Details	Extent/scale
Loss of native vegetation	Woodland, forest and wetland vegetation communities	1.19 hectares of native vegetation will be cleared
Loss of threatened ecological communities	Castlereagh Scribbly Gum Woodland	0.76 hectares
	Castlereagh Swamp Woodland	0.05 hectares
	River-flat Eucalypt Forest	0.35 hectares
	Freshwater Wetlands	0.03 hectares
Loss of threatened flora species	*Persoonia nutans*	17 individuals
	Grevillea parviflora	464 stems
Loss of fauna habitat	Remnant woodland and forest, riparian habitats and landscaped areas offer habitat for a diversity of reptiles, amphibians, birds and mammals. A total of 88.22 hectares of fauna habitat will be removed for the SIMTA proposal, comprising 1.48 ha of remnant forest, woodland and riparian habitat and 86.74 ha of landscaped, cleared and disturbed habitat.	88.22 hectares of fauna habitat proposed to be cleared Approximately seven hollow-bearing trees located in proposed rail link
Fauna fragmentation	May reduce the capacity of some less mobile fauna to move within and between patches of remaining habitat.	Rail link will fragment woodland vegetation south of the SIMTA site and riparian vegetation of Anzac Creek and Georges River
Fauna mortality	May result from collisions with vehicles or plant, or accidental entrapment in plant, trenches or other earthworks.	Most likely during clearing activities

Likely Impact	Details	Extent/scale
Degradation of aquatic habitats	Caused by changes in runoff, redirection of flows, influences to groundwater, infiltration, pollution and erosion. May influence downstream habitats.	Anzac Creek and Georges River most susceptible during constructions works in riparian vegetation and of rail bridges
Impacts on fish passage	During construction of rail link across Anzac Creek and Georges River, particularly construction of piers in Georges River	Temporary and localised scale impacts
Edge effects and weed invasion	Vehicles and plant may transport weed propagules into the study area. Creation of new edges will increase fragmentation and vulnerability of native vegetation to weed incursions	New edges where rail link will transects woodland vegetation south of the SIMTA site most susceptible
Alteration to air quality and noise environments	May impact upon the roosting, breeding and foraging activities of locally occurring fauna	Temporary and localised scale impacts during construction. Potential longer-term impacts during operation.

4.4 Cumulative Impacts

There are two proposed developments within the immediate vicinity of the SIMTA proposal as shown in Figure 17. These are:

1 MICL intermodal terminal proposal.

2 DNSDC relocation.

These proposals and the cumulative impacts predicted from their development and the SIMTA proposal are discussed below.

Figure 17: Projects within the immediate vicinity of the SIMTA proposal

4.4.1 MICL Intermodal Terminal proposal

The Commonwealth Department of Finance and Deregulation is currently undertaking a feasibility study into the potential development of an intermodal terminal on the site of the Moorebank and Steele Barracks, which lies immediately to the west of the SIMTA site across Moorebank Avenue. The MICL intermodal terminal project was referred to DSEWPC in August 2011 and was determined by DSEWPC to be a controlled action requiring an Environmental Impact Statement (EIS) in September 2011.

In March, NSW Department of Planning and Infrastructure (DoPI) has issued Director General's Requirements (DGRs) that are the State equivalent of the DSEWPC requirements. The Commonwealth has also lodged a submission under the EPBC Act and elected to make a submission under Part 4 of the New South Wales *Environmental Planning and Assessment Act* 1979.

Three TSC Act listed Threatened Ecological Communities were identified from the MICL site that also occur within the SIMTA study area:

- River-flat Eucalypt Forest, listed as Endangered under the TSC Act (comprised of Riparian Forest located along the Cooks River, and Alluvial Woodland in the north-west of the site).
- Castlereagh Swamp Woodland, listed as Endangered under the TSC Act, is found in small patches in low-lying areas in the east of the site.
- Castlereagh Scribbly Gum Woodland, listed as Vulnerable under the TSC Act, is located primarily in the east of the site along Moorebank Avenue. .

The two threatened plant species recorded on the SIMTA study area, *Persoonia nutans* and *Grevillea parviflora subsp. parviflora*, were also recorded on the MICL site (Parsons Brinckerhoff 2011).

Development of the IMT may result in the removal of approximately 6.5 hectares of habitat known to be occupied by *Grevillea parviflora subsp. parviflora* within the MICL site, including at least 16 individuals of the species (Parsons Brinckerhoff 2011). The habitat that would be removed occurs to the west of Moorebank Ave, is in good to moderately degraded condition, however is isolated from other areas of habitat in the locality. This area has been estimated to comprise no more than 2% of the local habitat for the species. Approximately 6.5 hectares of habitat known to be occupied by *Persoonia nutans* may be removed for development of the IMT which includes at least 10 individuals of the species. This area of habitat has been estimated to comprise no more than 1.5% of the local habitat for the species.

Table 28: Cumulative losses of threatened flora species from the study area and MICL site

Threatened Flora Species	Number recorded in study area	Number recorded on MICL site*	Number to be cleared from study area	Number to be cleared from MICL site*
Persoonia nutans	126 individuals	Not stated	17 individuals	10 individuals
Grevillea parviflora	4110 stems (estimated)	Not stated	464 stems	"16 mature plants with many suckers"

* From Parsons Brinckerhoff 2011

The preliminary significance assessment for the two threatened plant species on the MICL site by Parsons Brinckerhoff (2011) concluded that potential impact from the project on the species

was not considered significant, as the populations on the MICL site are likely to make up a small proportion of the local populations under the EPBC Act definition, as the 6.5 hectares of potential habitat within the MICL site represents a small percentage of the estimated area of potential local habitat for the species.

In addition to the removal of three TSC Act listed TECs and two threatened species, fauna habitat features identified from the site that may be removed include hollow-bearing trees, artificial ponds and wetlands, flowering trees and shrubs, groundlayer vegetation and dense weed thickets. Patches of habitat were predominantly classified as having poor to moderate ecological integrity.

The MICL site covers approximately 220 hectares and the construction footprint for the SIMTA site covers approximately 93 hectares. In the context of the surrounding highly modified landscape, the patches of remnant vegetation and fauna habitat of the MICL site and SIMTA study area may assist in the maintenance of biodiversity that persists in the locality.

The development of the two adjoining sites will reduce or remove a diversity of biodiversity values, including available fauna habitat (including roosting, nesting and foraging habitat), potential threatened fauna habitat, threatened plant species, TSC Act listed TECs, local provenance plant species and potential seedbanks. Development of the SIMTA proposal and the MICL site together will result in a greater loss of biodiversity values from the locality. Concurrent construction of the two sites will also result in the loss of these values over a shorter temporal scale.

4.4.2 DNSDC Relocation

In order for the DNSDC to more effectively and efficiently deliver support to the Australian Defence Force, there is a need to consolidate the existing warehousing and maintenance functions at Moorebank (http://www.defence.gov.au/jlc/infrastructure/sites/moorebank.html). To this end, Defence is proposing to relocated the DNSDC from the SIMTA site to the north of the SIMTA site, as shown in Figure 17.

The site proposed for redevelopment of the DNSDC consists largely of cleared and disturbed areas, with scattered trees across the site and some fragmented bushland in the centre. Anzac Creek traverses the eastern edge of the site. The EEC Shale Gravel Transition Forest was mapped on the site by DECCW (2009). It is not known whether this vegetation has been ground-truthed; the classification and condition of the vegetation cannot be confirmed. It is not known whether the site supports threatened flora or fauna species; there are no records of threatened species in the NSW Wildlife Atlas recorded on the site. There is no publicly available flora and fauna assessment of this land at the date of the current report.

Relocation of the DNSDC site will involve clearing of most of the vegetation on the site and construction of new facilities. It is proposed to regenerate the section of Anzac Creek which runs along the eastern boundary of the site. The regeneration works will include replanting and revegetation works along the western boundary.

The impacts on biodiversity from the redevelopment of the DNSDC to the north and east of the SIMTA site are not known. The relocation of the DNSDC will require clearing of native vegetation that is likely to correspond with one or more EECs, and reduce and further fragment fauna habitat in the locality.

4.5 Key Threatening Processes

The SIMTA proposal is likely to result in the operation of one or more key threatening processes or the exacerbation of one or more key threatening processes currently in operation in the study area. Key threatening processes are listed under the TSC Act, FM Act and EPBC Act.

4.5.1 *Threatened Species Conservation Act* 1995

Key threatening processes are processes that "threaten or could threaten the survival or evolutionary development of species, populations or ecological communities". They are listed under Schedule 3 of the TSC Act and may adversely affect threatened species, populations or ecological communities or could cause species, populations or ecological communities that are not threatened to become threatened. The SIMTA proposal may contribute to the following key threatening processes:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands.
- Clearing of native vegetation.
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Infection of native plants by *Phytophthora cinnamomi*
- Invasion of native plant communities by exotic perennial grasses.
- Invasion and establishment of exotic vines and scramblers.
- Invasion, establishment and spread of *Lantana camara.*
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of hollow-bearing trees.

4.5.2 *Environment Protection and Biodiversity Conservation Act* 1999

The EPBC Act defines a key threatening process as one that "threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community." The SIMTA proposal may contribute to the following key threatening processes:

- Land clearance.

4.5.3 *Fisheries Management Act* 1994

Under the FM Act key threatening processes are processes that, in the opinion of the Fisheries Scientific Committee, adversely affect threatened species populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened The SIMTA proposal may contribute to the following Key Threatening Processes:

- Degradation of native riparian vegetation along New South Wales water courses.
- Removal of large woody debris from New South Wales rivers and streams
- Flow regimes of rivers and streams.

4.6 Commonwealth EIS Requirements

Section 3.3 of the tailored EIS guidelines for the SIMTA proposal (DSEWPC June 2012) lists seven particular threatened species and communities listed under the EPBC Act that are known or likely to be present in the vicinity of the proposed action area:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.
- Green and Gold Bell Frog (*Litoria aurea*).
- Downy Wattle (*Acacia pubescens*).
- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*).
- Nodding Geebung (*Persoonia nutans*).
- Macquarie Perch (*Macquaria australasica*).
- Spot-tailed Quoll (*Dasyurus maculatus*).

Specific information on the ecology, local and regional distribution and habitat, threats and assessment of the above species and communities of concern is required as part of the EIS. The requirements for assessment of the seven species and communities of concern are addressed in Appendix 5. A summary of the findings is provided in Table 29.

Table 29: Summary of assessments of EPBC Act listed matters

EPBC Act listed Matter	Summary of Assessment	Conclusion
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (CPSW)	CPSW is restricted to the Cumberland Plain where it occurs in association with clay soils derived from Wianamatta Shale. CPSW was not mapped within the study area in any regional vegetation mapping, but was mapped to the south and west. There is no potential habitat for the community in the study area and analysis of vegetation data collected from the study area found that the structure and floristics of the vegetation is not consistent with CPSW.	CPSW does not occur within the study area and will not be impacted by the SIMTA proposal.
Green and Gold Bell Frog (GGBF)	GGBF occurs along coastal lowland areas of eastern NSW and Victoria and is found in still, shallow, ephemeral waterbodies. The closest known extant population of GGBF is approximately 3.5 km east of the study area at Hammondville. Habitat connectivity between this population and the study area is low. Targeted diurnal and nocturnal surveys for GGBF for the current assessment, as well as other recent projects nearby,did not record this species. While the study area supports some preferred habitat features for GGBF, the presence of Mosquito Fish in aquatic habitats reduces the likelihood that the species occurs in the study area.	GGBF was not recorded in the study area and the closest known extant population is 3.5 km to the east. This species will not be impacted by the SIMTA proposal.

EPBC Act listed Matter	Summary of Assessment	Conclusion
Acacia pubescens	*Acacia pubescens* is restricted to the Sydney region where it occurs on alluviums, shales and the intergrade between shale and sandstone soil. *A. pubescens* was not recorded in the study area; two individuals were recorded at the edge of bushland to the east of the study area. These individuals, and potential habitat for the species further east, will be protected from impacts by the buffer that the managed powerline easement represents.	*A. pubescens* was not recorded in the study area and the two individuals of the species recorded to the east of the study area will not be impacted by the SIMTA proposal.
Grevillea parviflora subsp. *parviflora*	*Grevillea parviflora* subsp. *parviflora* has a widespread but sporadic distribution extending from Bargo to Heddon Greta. Only small populations have previously been recorded in western Sydney. Targeted surveys for the species in the study area recorded a total of 1644 stems of *G. parviflora* subsp. *parviflora* in the rail corridor lands and adjoining areas to the east of the existing rail spur. It is estimated that the study area supports approximately 4,110 stems, but the number of genetically distinct individuals is likely to be lower than this estimate given the suckering habit of this species. The population of this species in the study area was considered to be significant given its size and location. The proposed action will result in loss of individuals, clearing and fragmentation of habitat for *G. parviflora* subsp. *parviflora.*	A population of *Grevillea parviflora* subsp. *parviflora* was recorded in the study area and will be impacted by the SIMTA proposal.
Persoonia nutans	*Persoonia nutans* is endemic to the Cumberland Plain where it is confined to aeolian and alluvial sediments. The majority of the population occurs in the north of the species' range, and isolated and relatively small populations occur in the south of the range including around Moorebank and Holsworthy. Targeted surveys for the species in the study area recorded 126 individuals, of which 110 occurred within the rail corridor lands. The population of *P. nutans* in the study area is considered to be significant as it is the largest population recorded in the south of the species' range, and one of only 15 known populations with over 50 mature individuals. The proposed action will result in loss of individuals, clearing and fragmentation of habitat for *P. nutans.*	A population of *Persoonia nutans* was recorded in the study area and will be impacted by the SIMTA proposal.

EPBC Act listed Matter	Summary of Assessment	Conclusion
Macquarie Perch	The distribution of Macquarie Perch is restricted to the headwaters of rivers in the Murray-Darling Basin and the Hawkesbury-Nepean, Georges River and Shoalhaven basins on the east. The species was recorded in 2008 in the Georges River near Campbelltown, approximately 15 kilometres upstream of the study area, the first record from the river since 1894. The Macquarie Perch was not identified within the study area; Anzac Creek does not support preferred habitat for the species, while the Georges River supports potential foraging and refuge habitat for the species. The SIMTA proposal may temporarily reduce the quality of habitat, but will not impose any restrictions to fish movement through the Georges River during or post construction.	Macquarie Perch was not recorded in the study area, but the Georges River supports potential foraging and refuge habitat for the species. This species will not be impacted by the SIMTA proposal.
Spot-tailed Quoll	The Spotted-tail Quoll occurs along the east coast of Australia from south-east Queensland to Tasmania. Preferred habitat generally comprises mature wet forest habitat which supports a range of den sites, and the species requires large tracts of continuous vegetation. The species was not identified in the study area during fauna surveys; the closest record is six kilometres to the south-east in the Holsworthy Military Area. The study area does not support required habitat features for the species.	Spotted-tail Quoll was not recorded in the study area and it does not support preferred foraging, breeding or den habitat for the species. This species will not be impacted by the SIMTA proposal.

Of the seven particular threatened species and communities listed, the SIMTA proposal will have impacts on two, *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans.* The other five species and communities of concern do not occur in the study area and are not considered likely to be impacted by the SIMTA proposal. The impacts on the two threatened plant species are assessed in further detail in the assessments of significance for these species (Section 4.7, Appendix 6). The final point of Section 3.3 of the tailored EIS guidelines for the SIMTA proposal requires the assessment to:

- *Provide a local and regional scale analysis of the likely impacts of the action to biodiversity. The analysis must consider any species or communities which are endemic, rare, threatened or listed under other state or territory legislation likely to be impacted.*

This requirement is addressed broadly in Section 4 of this document, and in detail in the assessments of significance for threatened species and communities (Section 4.7, Appendix 6).

4.7 Assessment of Impacts

Assessments of Significance were undertaken for all relevant threatened species, populations and communities listed under the TSC Act or FM Act that were recorded, or for which habitat occurs in the study area (Table 30). An Assessment of Significance was not undertaken for Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion as this is a vulnerable

ecological community and the provisions of the EP&A Act relating to threatened species, populations and ecological communities do not apply to this community.

The Assessments of Significance are provided in Appendix 6.

Table 30: Threatened Species, Populations and Ecological Communities for which impact assessments have been undertaken

Threatened entity	EPBC Act Status	TSC Act Status	Likely to be significantly affected
Grevillea parviflora subsp. parviflora (Small-flowered Grevillea)	Vulnerable species	Vulnerable species	No
Persoonia nutans (Nodding Geebung)	Endangered species	Endangered species	Yes
Castlereagh Swamp Woodland	Not listed	Endangered Ecological Community	No
Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Not listed	Endangered Ecological Community	No
River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Not listed	Endangered Ecological Community	No
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	Not listed	Vulnerable species	No
Southern Myotis (*Myotis macropus*)	Not listed	Vulnerable species	No
Eastern Free-tail Bat (*Mormopterus norfolkensis*)	Not listed	Vulnerable species	No
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Vulnerable species	Vulnerable species	No
Macquarie Perch (*Macquaria australasica*)	Endangered species		No

5 MITIGATION MEASURES

The avoid, mitigate and offset approach is accepted by the NSW Office of Environment and Heritage and has been used in a number of case studies (DEC 2006a). Primary consideration should be given to measures to avoid or minimise impacts; where avoidance and mitigation are not possible, offset strategies may be considered as a last resort. The steps in the avoid, mitigate and offset approach are as follows:

- Avoid areas of high biodiversity value wherever possible,
- Mitigate actions and safeguard values identified for retention by prescribing appropriate controls.
- Compensate for or offset the removal of biodiversity values.

5.1 Avoid Impacts

The identified ecological values should be avoided as far as practicable (Table 31). The construction footprint incorporating the rail link footprint and construction access requirements should be reduced as far as possible; the rail link footprint has already been reduced from 35 metres in width to 20 metres in width for the majority of the rail link to minimise impacts on threatened plant species. Given the distribution of threatened plant species across the study area, impacts on threatened plant populations of *Persoonia nutans* and *Grevillea parviflora* will be unavoidable.

Table 31: Avoidance measures for proposed actions

Activity	Issue	Avoidance Measure
Site establishment, earthworks and rail link construction	Vegetation removal	Avoid Threatened Ecological Communities where possible.
	Threatened flora species	Avoid known locations of threatened flora species where possible.
	Fauna habitat loss	Avoid important fauna habitat features such as large hollow bearing trees where possible.

5.2 Mitigate Impacts

Where impacts cannot be avoided, safeguards should be implemented to mitigate these impacts during construction (Table 32).

Table 32: Mitigation measures for proposed actions

Activity	Impact	Mitigation Measure
Soil disturbance related to site establishment, earthworks and rail link construction	Sedimentation and erosion leading to a reduction in water quality and degradation of aquatic habitat	Install appropriate drainage infrastructure (e.g. sediment basins, diversion drains), sediment and erosion controls prior to the commencement of construction.
		Clearing of vegetation is not to be undertaken during overland flow events.
		Clearly identifying sensitive areas and areas for construction and managing clearing such that clearing activities are constrained to these approved areas only.
		Locate soil or mulch stockpiles away from watercourses and key stormwater flow paths to limit potential transport of these substances into the watercourses via runoff.
		Dust suppression activities to be undertaken where appropriate.
		Stabilisation of disturbed areas, including revegetation in accordance with the VMP, is to be undertaken as soon as practicable after disturbance.
		Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak to be clearly articulated in the Construction Environmental Management Plan.
		Spill kits to be located to allow for timely response to uncontained spills. Site inductions are to include a briefing on the use of spill kits.
	Weed establishment and invasion	Management of weeds in and adjacent to cleared areas will occur in accordance with a Weed Control and Restroration Plan. This plan will include details relating to the monitoring, management and where necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols if required.
		Management of noxious weeds are to be undertaken in accordance with the *Noxious Weeds Act* 1993.

Activity	Impact	Mitigation Measure
		Equipment used for treating weed infestation will be cleaned prior to moving to a new area within the project site to minimise the likelihood of transferring any plant material and soil
		Soil stripped and stockpiled from areas containing known weed infestations are to be stored separately and are not to be moved to areas free of weeds.
Vegetation clearance for rail construction, access and maintenance tracks	Loss of fauna habitat	Fauna microhabitat such as logs should be removed from areas to be cleared and relocated to suitable nearby bushland areas in the presence of an ecologist.
		Consider the installation of nest boxes in woodland vegetation in the rail corridor that may offer alternative nesting habitat to hollow-dependent species recorded in the study area.
		High visibility plastic fencing is to be installed to clearly define the limits of the works area as to not further encroach on fauna habitat.
	Fauna injury/mortality	Undertake a pre-start up check for sheltering native fauna of all infrastructure, plant and equipment and/or during relocation of stored construction materials.
		Undertake a two-stage approach to clearing: ▪ Remove non-hollow bearing trees at least 48 hours before habitat trees are removed. ▪ Hollow bearing trees are to be knocked with an excavator bucket or other machinery to encourage fauna to evacuate the tree immediately prior to felling. ▪ Felled trees must be left for a short period of time on the ground to give any fauna trapped in the trees an opportunity to escape before further processing of the trees. ▪ Felled hollow bearing trees must be inspected by the Project Ecologist as soon as possible (not longer than 2 hours after felling).
		Site inductions are to include a briefing regarding the local fauna of the site and identification of protocols to be undertaken if fauna are encountered.

Activity	Impact	Mitigation Measure
		If any pits/trenches are to remain open overnight, they are to be securely covered, if possible. Alternatively, fauna ramps (logs or wooden planks) are to be installed to provide an escape for trapped fauna.
	Loss and degradation of native vegetation including EECs	Clearance of native vegetation should be minimised as far as is practicable.
		Consider retention of some, or all, of the remnant scattered *E. sclerophylla* over patches of shrub and grass cover in the cleared grassland immediately south of the SIMTA site in landscaping areas.
		The extent of vegetation clearing is to be clearly identified on construction plans
		Any additional construction areas, such as site offices, construction stockpile locations and machinery/equipment laydown areas are to be located where possible within existing cleared or disturbed areas.
		Extent of clearing should be fenced with highly visible temporary fencing to ensure that clearing does not extend beyond the area necessary.
		A Vegetation Management Plan (VMP) should be prepared prior to construction, detailing restoration, regeneration and rehabilitation of areas of native vegetation in study area. The VMP should also detail appropriate management for the potential habitat of threatened plant species in the study area, including monitoring during and after construction works to ensure impacts are minimised.
		As soon as possible rehabilitation will commence where possible. Management of land disturbed as a result of construction works will occur in accordance with a VMP.
	Loss of threatened flora species	Detailed mitigation measures for threatened flora species are listed in Section 5.2.1 of this report.

Activity	Impact	Mitigation Measure
Construction in riparian areas/ in proximity to watercourses	Obstruction to or alteration of fish passage	Design and construction of rail crossings over Anzac Creek and Georges River to be in accordance with *Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003).
	Degradation of Riparian Zones	Minimise clearing and disturbance to the riparian zone where possible.
		Install appropriate drainage infrastructure (e.g. sediment basins, diversion drains), sediment and erosion controls prior to the commencement of construction.
		Construction disturbance areas will be clearly demarcated to avoid accidental clearing or stockpiling in riparian vegetation.
Construction of pavement, slabs and building structures	Altered hydrological regimes related to an increase in impervious surface such as changes in runoff and infiltration, redirection of flows	Landscaped zones to capture gross pollutants and oil and grits from pavement. These areas can be regularly maintained to remove rubbish and can be renewed on a regular basis.
		Bio-retention installed in base of channels and swales proposed to capture and store stormwater. This will consist of bio-filtration layers, planting and subsoil collection and drainage.
Hot works (including vegetation clearing requiring heat producing equipment)	Outbreak of bushfire	Hot work not to be undertaken on declared total fire ban days. Vehicles and plant should not block fire trails. Bushfire awareness included in staff induction and in toolbox talks pre-commencement.
Alteration to air quality and noise environments	Disruption of fauna foraging, nesting or roosting behaviours	Directional lighting will be used where lighting is required in construction areas.
		Frequent maintenance of construction machinery and plant will be undertaken to minimise unnecessary noise.
		Dust suppression activities to be undertaken where appropriate.
Operation of the SIMTA proposal	Fauna injury/ mortality	Speed limits will be developed so as to minimise the potential for fauna to be struck by a vehicle within the SIMTA site. All vehicles and plant in operation on the SIMTA site are to adhere to site rules relating to speed limits.

Activity	Impact	Mitigation Measure
		If and animal is injured, contact one of the following local wildlife rescue agency (e.g. WIRES) and/or veterinary surgery immediately
		Until the animal can be cared for by a suitably qualified animal handler, if possible minimise stress to the animal and reduce the risk of further injury by: ▪ Handling fauna with care and as little as possible. ▪ Covering larger animals with a towel or blanket and placing in a large cardboard box. ▪ Placing small animals in a cotton bag, tied at the top. ▪ Keeping the animal in a quiet, warm, ventilated and dark
	Introduction of weed/pest species	Weed infestations that are identified during the operation of the SIMTA proposal are to be managed in accordance with the removal methods outlined in the Weed Control and Restoration Plan.

5.2.1 Management of Threatened Plant Species

A Threatened Species Management Plan would be prepared and implemented for the *P. nutans* and *G. parviflora* populations within the rail corridor that would be affected by the rail link. The objectives of the plan would be:

- Protection of threatened plant species from the impacts of construction and operation of the rail link.
- Maintaining the size and health of threatened species populations in the rail corridor.
- Conserving and enhancing threatened species habitat in the rail corridor.

These objectives would be achieved by implementation of specific management strategies for *P. nutans* and *G. parviflora.*

Persoonia nutans (Nodding Geebung)

Mitigation measures are proposed to minimise the potential impacts on *P. nutans* as a result of the SIMTA proposal, in accordance with the measures identified in the *Persoonia nutans* Recovery Plan (DEC 2006b) (Table 33).

Table 33: Specific mitigation measures for *Persoonia nutans*

Impact	Mitigation Measure
Removal of individuals of threatened plant species	Investigate options for translocation of individuals removed from the project footprint.
	Collection of seed or other genetic material from individuals to be removed, and propagation of tube stock to be replanted in retained areas of habitat.
Removal of potential habitat for threatened plant species	Retain topsoil and seed bank from the occupied habitat area of *P. nutans* and reapply to disturbed areas once construction is complete. Ensure that stockpiling of topsoil is managed to maintain the viability of the seedbank.
Disturbance of threatened species habitat during construction	Fencing of areas of habitat to be retained should be undertaken and individuals of the threatened plant species should be clearly marked.
	Site inductions for construction staff are to include a briefing on the presence of threatened species and their habitat in and adjacent to the project footprint, its significance and locations and extents of no-go zones.
Fragmentation of habitat and edge effects	Detailed design of the rail link will minimise impacts on hydrology and maximise terrestrial connectivity beneath the proposed rail link during operation of the SIMTA proposal.
	Cleared edges supporting threatened species habitat to be managed with the habitat requirements of the species considered as a priority.
	Weeds should be removed by hand in areas of threatened species habitat.
	Given the specific disturbance regimes required by *Persoonia nutans*, the use of fire or other disturbance mechanisms as a long-term management tool should be considered, in consultation with OEH and DSEWPC.

Impact	Mitigation Measure
	The fencing around the bushland on site should be maintained to restrict public access and prevent trampling and rubbish dumping in areas of habitat.
	All wastes generated during construction to be handled in accordance with a Waste Management Plan and no dumping of rubbish permitted on site.
Fire management	In consultation with Defence, develop a land management plan such that an interval of at least 7 to 10 years between fires is maintained within the area of occupied habitat for *P. nutans*.

Grevillea parviflora subsp. *parviflora* (Small-flowered Grevillea)

Mitigation measures are proposed to minimise the potential impacts on *G. parviflora* subsp. *parviflora* as a result of the SIMTA proposal (Table 34).

Table 34: Specific mitigation measures for Grevillea parviflora subsp. parviflora

Impact	Mitigation Measure
Removal of individuals of threatened plant species	Investigate options for translocation of individuals removed from the project footprint.
	Collection of seed or other genetic material from individuals to be removed, and propagation of tube stock to be replanted in retained areas of habitat.
Removal of potential habitat for threatened plant species	Topsoil within the areas identified as habitat for *G. parviflora* subsp. *parviflora* will be stripped and stored on site for reapplication at those areas identified as *G. parviflora* subsp. *parviflora* habitat once works are complete. Topsoil from these areas will be managed to maintain the viability of the seedbank and *G. parviflora* subsp. *parviflora* suckers.
Disturbance of threatened species habitat during construction	Fencing of areas of habitat to be retained should be undertaken and individuals of the threatened plant species should be clearly marked.
	Site inductions for construction staff are to include a briefing on the presence of threatened species and their habitat in and adjacent to the project footprint, its significance and locations and extents of no-go zones.
Fragmentation of habitat and edge effects	Detailed design of the rail link will minimise impacts on hydrology and maximise terrestrial connectivity beneath the proposed rail link during operation of the SIMTA proposal.
	Cleared edges supporting threatened species habitat to be managed with the habitat requirements of the species considered as a priority.
	Weeds should be removed by hand in areas of threatened species habitat.

Impact	Mitigation Measure
	A Soil and Water Management Plan should be developed for construction of project in accordance with *Managing Urban Stormwater: Soils and Construction* Edition 4 (Landcom 2004). The Soil and Water Management Plan will be developed to minimise changes in hydrology and increases in soil nutrients in adjoining areas; particularly in the vicinity of habitat area of *G. parviflora* subsp. *parviflora*.
	A Weed Control and Restoration Plan will be developed to manage land disturbed by construction of the SIMTA proposal. The management plan will contain provisions for the identification and management of *Imperata cylindrica* (Blady Grass) and *Kunzea ambigua* (Tick Bush) within areas identified as habitat for *G. parviflora* subsp. *parviflora*.
	The fencing around the bushland on site should be maintained to restrict public access and prevent trampling and rubbish dumping in areas of habitat.
	All wastes generated during construction to be handled in accordance with a Waste Management Plan and no dumping of rubbish permitted on site.

The Threatened Species Management Plan should be prepared as an appendix to the Vegetation Management Plan for the project and in consultation with DSEWPC and OEH. The plan would be developed to align with the priorities for action identified by *Australia's Biodiversity Conservation Strategy 2010-2030* (NRMMC 2010). The Threatened Species Management Plan would be developed in consideration of the offset package developed (see section 5.3).The plan is to be implemented by qualified bush regenerators and supervised and monitored by a qualified and experienced restoration ecologist. The plan should include measures for ongoing maintenance and monitoring of the threatened plant species populations retained in the study area.

Opportunities for research and educational programs associated with management of threatened plant species as part of the project include:

- Long term monitoring of the survival, growth and reproduction of the threatened plant species populations in the study area,
- Develop a community conservation program to engage members of the local community in supervised restoration of threatened species habitat in the locality (subject to site access restrictions).

5.3 Offset impacts

Unavoidable impacts on biodiversity resulting from the SIMTA proposal trigger the requirement for provision of biodiversity offsets to counterbalance the impact of development on biodiversity. Offsets are to be determined with reference to the *Principles for the Use of Biodiversity Offsets in NSW* (OEH 2011a) and the *EPBC Act Environmental Offsets Policy* (Commonwealth of Australia 2012). The OEH principles and EPBC Acts policy have broadly similar requirements for offsets (Table 35).

Table 35: OEH and EPBC Act offsetting principles

OEH Offset Principles (OEH 2011a)	EPBC Act Offset Principles (Commonwealth of Australia 2012)
1. Impacts must be avoided first by using prevention and mitigation measures. 2. All regulatory requirements must be met. 3. Offsets must never reward ongoing poor performance. 4. Offsets will complement other government programs. 5. Offsets must be underpinned by sound ecological principles. 6. Offsets should aim to result in a net improvement in biodiversity over time. 7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs. 8. Offsets should be agreed prior to the impact occurring. 9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated. 10. Offsets must be targeted. 11. Offsets must be located appropriately. 12. Offsets must be supplementary. 13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	Suitable offsets must: 1. Deliver an overall conservation outcome that improves or maintains the viability of the protected matter. 2. Be built around direct offsets but may include other compensatory measures. 3. Be in proportion to the level of statutory protection that applies to the protected matter. 4. Be of a size and scale proportionate to the residual impacts on the protected matter. 5. Effectively account for and manage the risks of the offset not succeeding. 6. Be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs. 7. Be efficient, effective, timely, transparent, scientifically robust and reasonable. 8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced. In assessing the suitability of an offset, government decision-making will be: 9. Informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty. 10. Conducted in a consistent and transparent manner.

The EPBC Act Environmental Offsets Policy is accompanied by an Offsets Assessment Guide including an offset calculator in the form of a balance sheet. This guide was designed for departmental use but can be used by proponents to consider offset requirements.

In addition to the OEH offset principles and the EPBC Act guidelines, OEH prepared an interim policy on assessing and offsetting biodiversity impacts on State Significant development (SSD) projects (OEH 2011b). The interim policy requires the use of the Biobanking Assessment Methodology to quantify and categorise biodiversity values and impacts of SSD projects and to calculate offsets. Offsetting proposals should result in either an "improve or maintain", "no net loss" or "mitigated net loss" outcome for biodiversity, with "improve or maintain" being preferred.

A Preliminary Biodiversity Offset Strategy (Hyder Consulting 2013) has been prepared to demonstrate a commitment to offsetting the residual significant impacts on matters of national environmental significance resulting from the SIMTA proposal. The Strategy is a working document that will be developed and revised through the project approval processes and it provides the foundation for consultation with DSEWPC.

The Preliminary Biodiversity Offset Strategy summarises the impacts of the SIMTA proposal on protected matters, details the mitigation measures proposed to minimise biodiversity impacts, and sets out options for offsetting residual significant impacts on MNES and a framework for delivery of these options. The Strategy is guided by the EPBC Act Environmental Offset Policy as well as the recovery objectives and actions in the approved Recovery Plan for Persoonia nutans.

For assessments under the EPBC Act, offsets are only required if residual impacts are significant. The only MNES that is considered to be subject to residual significant impacts as a result of the SIMTA proposal is *Persoonia nutans.*

The Preliminary Biodiversity Offset Strategy proposes three offset measures for consideration. These are:

Offset Measure A Secure additional native vegetation protected through an appropriate legal instrument that ensures the land is managed for conservation. Additional vegetation to be acquired should have similar biodiversity values to those being impacted by the SIMTA proposal. In particular the MNES subject to residual significant impacts impacted in the study area, Persoonia nutans, or its habitat, must be present on any offset site.

Offset Measure B Retirement of an appropriate number and class of biodiversity credits under the NSW Biobanking scheme (note: proponents should engage with the department early in the process if they wish to utilise state schemes).

Offset Measure C Investment in research and/or education programs related to related to the impacted protected matters (note: under the EPBC Act Environmental Offsets Policy, such compensatory measures can form a maximum of 10% of an offset requirement).

Offset Measure A is SIMTA's first priority to achieve the objectives of the Biodiversity Offset Strategy. Offset Measures B and C would only be considered after further consultation with DSEWPC, OEH and DoPI.

6 CONCLUSION

This Flora and Fauna Assessment documents the biodiversity of the study area for the SIMTA proposal. It describes terrestrial and aquatic flora and fauna species that occur within the study area; identifies vegetation communities and habitat types and determines the likely occurrence of threatened entities and their habitats within the study area.

Five vegetation types were identified within the study area, consisting of four natural vegetation communities and one modified vegetation type, Urban/exotic vegetation. The four natural vegetation communities fall within the definition of threatened ecological communities listed under the TSC Act, based on analysis of existing vegetation maps and ground truthing:

Table 36: Vegetation communities recorded in the study area and their status

Vegetation type	Corresponding TEC	EPBC Act Status	TSC Act Status
Castlereagh Scribbly Gum Woodland	Castlereagh Scribbly Gum Woodland in the Sydney Basin bioregion	Not listed	Vulnerable
Castlereagh Swamp Woodland	Castlereagh Swamp Woodland	Not listed	Endangered
Freshwater Wetlands	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Not listed	Endangered
River-flat Eucalypt Forest	River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	Not listed	Endangered

A total of 310 vascular plant species in the study area, comprising 213 local native species, eight non-local native species (mainly planted trees) and 89 exotic species. Two threatened plant species listed under the EPBC Act and TSC Act were recorded within the study area:

Table 37: Threatened flora species recorded in the study area and their status

Threatened flora species	EPBC Act Status	TSC Act status
Persoonia nutans (Nodding Geebung)	Endangered	Endangered
Grevillea parviflora subsp. *parviflora* (Small-flower Grevillea)	Vulnerable	Vulnerable

Another threatened plant species, *Acacia pubescens* (Downy Wattle), listed as Vulnerable under the EPBC Act and TSC Act, was recorded at the edge of bushland to the east of the SIMTA site.

Five exotic and 54 native fauna species were identified from the study area. Four threatened fauna species listed under the TSC Act and/or EPBC Act were recorded in the study area:

Table 38: Threatend fauna species recorded in the study area and their status

Threatened fauna species	EPBC Act Status	TSC Act status
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	Not listed	Vulnerable

Threatened fauna species	EPBC Act Status	TSC Act status
Southern Myotis (*Myotis macropus*)	Not listed	Vulnerable
Eastern Free-tail Bat (*Mormopterus norfolkensis*)	Not listed	Vulnerable
Grey-headed Flying Fox (*Pteropus poliocephalus*)	Vulnerable	Vulnerable

Five broad fauna habitat types were identified from the study area; remnant vegetation, riparian habitats, landscaped areas and cleared and disturbed areas. Notable habitat features across the study area that offer potential sheltering, nesting, roosting or foraging resources to fauna include flowering trees and shrubs, hollow-bearing trees, rough-barked eucalypts with exfoliating bark, ground timber and well-developed leaf litter in places.

Georges River, Anzac Creek and damp areas offer habitat to a variety of fish and amphibian species. There is, however, an absence of other important features such as large hollow-bearing trees, stags, rocky features and hollow logs across the site. Aquatic fauna surveys identified a low diversity of macroinvertebrates and one native and one exotic fish species from sampling sites in the Georges River and Anzac Creek. Aquatic habitats in both the Georges River and Anzac Creek are considered to be poor quality.

The assessment considered both construction and operational impacts of the SIMTA proposal: the SIMTA site covering an area of 83 hectares; and the proposed rail link, to be constructed within a variable width, but predominantly 20 metre, easement and covering an area of six hectares. This includes a small box culvert-style railway bridge over Anzac Creek, widening of the Moorebank Avenue underpass and a railway bridge over the Georges River (bridge designs will be confirmed during detailed design).

Biodiversity values of the study areas that will be impacted as a result of the SIMTA proposal are:

Table 39: Summary of biodiversity impacts

Biodiversity value	EPBC Act status	TSC Act status	Extent/scale
Threatened Ecological Communities			
Castlereagh Scribbly Gum Woodland	Not listed	Vulnerable	0.76 hectares
Castlereagh Swamp Woodland	Not listed	Endangered	0.05 hectares
River-flat Eucalypt Forest	Not listed	Endangered	0.35 hectares
Freshwater Wetlands	Not listed	Endangered	0.03 hectares
Threatened species			
Persoonia nutans (Nodding Geebung)	Endangered	Endangered	17 individuals
Grevillea parviflora subsp. *parviflora* (Small-flower Grevillea)	Vulnerable	Vulnerable	464 stems
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*)	Not listed	Vulnerable	N/A – foraging habitat will be disturbed and seven hollow-
Southern Myotis (*Myotis macropus*)	Not listed	Vulnerable	

Biodiversity value	EPBC Act status	TSC Act status	Extent/scale
Eastern Free-tail Bat (*Mormopterus norfolkensis*)	Not listed	Vulnerable	bearing trees wil be removed.
Grey-headed Flying Fox (*Pteropus poliocephalus*)	Vulnerable	Vulnerable	
Native woodland, forest and wetland vegetation communities providing habitat for locally occurring and threatened flora and fauna species	N/A	N/A	1.19 hectares

Potential impacts that may arise as a result of unmitigated activities associated with the construction of the SIMTA proposal include:

- Loss of native vegetation, including threatened ecological communities and threatened flora species.
- Loss of fauna habitat including that of threatened and migratory species.
- Habitat fragmentation/ loss of fauna habitat connectivity.
- Alteration and degradation of aquatic habitats.
- Fauna mortality.
- Edge effects and weed invasion.
- Alteration to air quality and noise levels.

Impacts on the identified ecological values should be avoided as far as practicable. Where impacts cannot be avoided, the scale and extent of impacts has been determined, and a range of mitigation measures have been recommended to ameliorate impacts on the biodiversity values during and following construction.

In accordance with the EIS guidelines, assessment of seven particular threatened species and communities listed under the EPBC Act that are known or likely to be present in the vicinity of the proposed action area was undertaken:

- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest.
- Green and Gold Bell Frog (*Litoria aurea*).
- Downy Wattle (*Acacia pubescens*).
- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*).
- Nodding Geebung (*Persoonia nutans*).
- Macquarie Perch (*Macquaria australasica*).
- Spot-tailed Quoll (*Dasyurus maculatus*).

The assessment included specific information on the ecology, local and regional distribution and habitat, threats and assessment of the above species and communities of concern. The assessment concluded that of the seven particular threatened species and communities listed, the SIMTA proposal will have impacts on two, *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans.* The other five species and communities of concern do not occur in the study area and are not considered likely to be impacted by the SIMTA proposal.

Assessments of Significance have been prepared for the threatened species and ecological communities listed under the TSC Act known or likely to be impacted by the SIMTA proposal. These assessments concluded that the three endangered ecological communities, four threatened terrestrial fauna species and one aquatic fauna species assessed would not be significantly impacted by the SIMTA proposal. The threatened plant species *Grevillea parviflora* subsp. *parviflora* was also considered unlikely to be significantly impacted by the SIMTA proposal.

The Assessment of Significance for *Persoonia nutans* concluded that this Endangered species will be significantly impacted as a result of the SIMTA proposal. The population of this species in the study area is considered highly significant due to its size and location in the southern part of the species' distribution. The proposed rail link will require the clearing of a 20 metre wide alignment (at the area of impact on *P. nutans*) that will bisect the area of occupied habitat of *P. nutans* and require the removal of 14% of recorded individuals in the population. The remaining plants will be fragmented by a 20 metre wide, fenced gap and subject to associated edge impacts. Specific management measures are identified for conservation of threatened plant species in retained habitat adjoining the rail link.

It is recommended that a Vegetation Management Plan be prepared for management of native vegetation in the study area during and following construction. The Vegetation Management Plan should include a Threatened Species Management Plan to be prepared in consultation with DESWPC and OEH. The plan should include measures for management of impacts, maintenance and monitoring of populations and details of any offsetting requirements.

Offsetting of biodiversity losses on site may be achieved using a number of mechanisms including acquisition and conservation of land, restoration of habitat, retirement of biodiversity credits through the NSW Biobanking scheme or contributions to research and educational programs. A Preliminary Biodiversity Offset Strategy has been prepared to demonstrate a commitment to offsetting the residual significant impacts on matters of national environmental significance resulting from the SIMTA proposal. The Strategy is a working document that will be developed and revised through the project approval processes and it provides the foundation for consultation with DSEWPC.

7 REFERENCES

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APPENDIX 1

AQUATIC ECOLOGY REPORT

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HYDER CONSULTING

ASSESSMENT OF THE SYDNEY INTERMODAL TRANSPORT HUB, MOOREBANK

AQUATIC ECOLOGY

July 2011

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The ALS Water Sciences Group is part of the Environmental Division of ALS, one of the largest and most geographically diverse environmental testing businesses in the world.

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1 Introduction

1.1 Background

Hyder Consulting Pty Ltd (Hyder) is undertaking an environmental assessment for the Sydney Intermodal Terminal Alliance's (SIMTA) proposal for an intermodal freight terminal and warehouse/distribution facility. The project site is located at Moorebank Avenue, Moorebank and is currently the site of the Defence National Storage and Distribution Centre. The site covers approximately 80 hectares and contains several modified stream channels that collect overland flow.

A new rail line will also be constructed on supplementary lands of approximately 65 hectares to the south and west of the warehouse facility. This land currently contains a golf course, vacant land, extractive industries, and a waste disposal depot. Georges River, and its tributary Anzac Creek, cross the supplementary lands. Anzac Creek supports an example of the *Castlereagh Swamp Woodland*, an Endangered Ecological Community.

1.2 Scope of Works

Following the issue of the Director General's Requirements (DGRs), Hyder contracted ALS Water Sciences Group to provide the aquatic ecology component of the environmental assessment. This included:

- An assessment of threatened aquatic (including groundwater dependent) species and populations; and
- Ecological surveys commensurate with the biology/ecology of aquatic species and extent of habitat within and adjacent to the project site.

The aquatic ecosystems of the study area included a stretch of Anzac Creek (approximately 300m in length) to the south of the site and a 100m section of Georges River to the west. Construction of a rail bridge is proposed to traverse both of these waterways.

1.3 Study sites

Two study sites were selected for this study one site on Georges River, and one site on Anzac Creek. The Georges River site was 100m long and extended north from beneath the East Hills Railway Bridge. The Anzac Creek site was downstream of an old and currently unused rail crossing. A location map of the study area is provided in Figure 1-1and approximate locations of macroinvertebrate and fish sampling points are provided in Table 1-1.

Table 1-1: Location of sites selected for the Hyder aquatic ecology assessment

Site Name	Site Code	Latitude	Longitude
Georges River	HYD01Edge1	-33.96501	150.91329
	HYD01Edge2	-33.96417	150.91342
Anzac Creek	HYD02Edge1	-33.96103	150.92451
	HYD02Edge2	-33.96103	150.92497

Source: Hyder Consulting Pty Ltd

Figure 1-1: Study sites (red stars) at the SIMTA Supplementary Land Survey Area (outlined by dashed yellow line)

2 Methodology

2.1 Field sampling

Sampling was conducted on 12 May 2011 following an on-site meeting between representatives of Hyder and ALS. Hyder staff (Jane Rodd and Laura Worthington) escorted the ALS Field Team (Adrian Dickson and Peter Hancock) to both sites.

2.2 Survey methods

2.2.1 Surface Water Physico-chemistry

Water physico-chemistry was measured at each site prior to collecting macroinvertebrate and fish samples, using a multi-parameter water quality meter. The meter was calibrated in accordance with QS/QA (Quality System/Quality Assurance) requirements and the manufacturer's specifications prior to its use in the field. The *in-situ* water quality parameters recorded include;

- Water Temperature (°C)
- pH (pH units)
- Electrical Conductivity (µS/cm)
- Dissolved Oxygen (% saturation and mg/L)
- Turbidity (NTU)
- Alkalinity (mg/L $CaCO_3$)

In-situ water physico-chemistry was compared to the ANZECC (2000) guidelines for lowland aquatic ecosystems of south-eastern Australia. Any parameters outside the guideline value are highlighted and discussed.

2.2.2 Macroinvertebrates

Rapid Bioassessment (RBA) protocols as outlined in the NSW AUSRIVAS Sampling and Processing Manual (Turak *et al*, 2004) were used to collect macroinvertebrate samples. The AUSRIVAS program is a nationally recognised, standardised sampling protocol used to assess the health of Australian Rivers and developed for Australia's National River Health Program (NRHP). Sampling was conducted using a standard ISO 7828 (1983) design sweep-net with 250µm mesh.

At each site, the littoral or edge habitat was sampled by sweeping the collecting net along the edge of the stream in areas of little or no current. The net was swept around overhanging terrestrial vegetation, against snags, in backwaters, and through beds of macrophytes over approximately 10m of edge. Two replicate samples of 10m sweeps were collected at the Georges River and Anzac Creek sites.

The material collected for each sample was placed into a sorting tray, and macroinvertebrates were picked for a minimum of 40 minutes by professionally qualified and experienced aquatic biologists using forceps and pipettes. If new taxa were found between 30 and 40 minutes, sorting continued for a further 10 minutes up to a maximum total sorting time of 1 hour. Any by-catch was noted (e.g. fish, tadpoles, etc.) and fish specimens identified, measured and handled following methods as detailed in section 2.2.3.

The objective of the RBA sorting protocol is to obtain a sample containing as diverse a fauna as possible (and hence provide a useful measure of taxa richness). Attempts were made to collect all taxa present, including rare and cryptic animals. Samples were preserved in 100% ethanol and clearly labelled with information including site, habitat, sampling method, date and sampler.

Nets were cleaned thoroughly between sampling sites to remove any invertebrates retained on them.

2.2.3 Fish

Initially, fish were to be surveyed using a backpack electrofisher, seine nets, and bait traps. However, both sites presented logistical difficulties that prevented the use of the electrofisher and the seine net. Georges River was too deep for effective electrofishing, and contained too many submerged logs for effective seine netting. The lack of open water at Anzac Creek made electrofishing and seine netting impossible. To compensate for this, additional bait traps were deployed at each site. Twelve bait traps were set at Georges River, and six at Anzac Creek. Fewer traps were set in Anzac Creek because of a lack of suitably deep water (>30cm). Commercially available concertina bait traps with 3mm mesh were baited with cat food and left in position for at least 3 hours. Fish specimens caught as by-catch in the macroinvertebrate sweep net samples were also counted. Upon retrieval, fish were identified to species using Allen *et al.* (2002). Fish were measured and all native species were returned to the stream. Non-native species were euthanized and disposed of in accordance with fisheries and ethics permit requirements.

2.2.4 Groundwater Dependent Ecosystems (GDE) surveys

A previous investigation of groundwater in the wider study area (URS, 2002) ascertains the depth to groundwater to generally be between 4.0 to 5.0 mbgl. Groundwater flow is generally radially from the topographic high with the location of the Georges River indicating that groundwater flow underlying the area would be predominantly westerly (URS, 2002). No groundwater monitoring bores were located in the study area so no groundwater invertebrates could be sampled. As there was no groundwater monitoring bores available, groundwater quality could not be collected and compared to surface water. A visual assessment of any potential groundwater dependent ecosystems was made at both sites.

2.2.5 Aquatic and Riparian Habitat Assessment

At each site, the habitat of a 100m reach of river was assessed. The assessment included the habitats sampled, and the surrounding riparian environment. The information recorded was used to assist interpretation of the biological data, and as part of a habitat condition assessment.

Field data was recorded on a number of specialised recording sheets which ALS WSG modified from the First National Assessment of River Health (FNARH) data sheets. The modifications were undertaken to enhance the efficiency of assessment of habitat characteristics without any loss of data accuracy or detail. Descriptions are based on visual estimates of characteristics such as streambed composition (percentage of total composition for each substrate category), aquatic and riparian vegetation cover, amount of instream organic material, area of aquatic habitats and canopy cover. The mean width (wetted width in metres), mean depth and sample depth were determined. The assessment also includes sketches of the longitudinal and cross-sectional profiles of the river reach assessed displaying the biological sampling site, location of *in-situ* water quality sampling, riparian zone width, type and height and location where photos are taken. The cross-section includes the approximate bank height, stream width and depth, and the approximate height of riparian vegetation.

2.3 Data Analysis

2.3.1 Aquatic Macroinvertebrate Communities

In order to elucidate spatial trends in the data and (where possible) determine the underlying environmental factors responsible for any observed trends, a number of univariate and multivariate routines were adopted. Both techniques provide differing levels of information, with univariate indices concentrating mainly on assessing the condition or "health" of sites, whilst multivariate analysis allows comparisons between sites based upon community structure to determine if relationships exist between relevant environmental variables and macroinvertebrate communities.

The univariate and multivariate techniques employed on macroinvertebrate data include:

- Taxa Richness and EPT Taxa Richness
- SIGNAL 2 Biotic Index (Chessman, 2003), and
- Current NSW AUSRIVAS models appropriate for the study region.
- Relative Abundance

Taxa Richness and EPT Taxa Index

Richness refers to the number of different taxa contained in a sample. The EPT taxa index refers to the proportional representation of key macroinvertebrate taxa belonging to the Ephemeroptera, Plecoptera and Trichoptera groups.

SIGNAL2 (Stream Invertebrate Grade Number – Average Level)

SIGNAL is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrate families that have been derived from published and unpublished information on their tolerance to pollutants, such as sewage and nitrification (Chessman, 1995). Each family in a sample is assigned a sensitivity grade between 1 (most tolerant) and 10 (most sensitive), and these grades were improved in Chessman (2003) with the new version called SIGNAL2 with standard errors. Those families in a sample for which no grade can be assigned are excluded from the analysis. The SIGNAL2 index and its associated standard error are calculated as the average grade number for all families present in the sample. The resulting index score can then be interpreted by comparison with reference and/or control sites.

NSW AUSRIVAS Model

All macroinvertebrate data, water quality parameters and habitat variables required by the relevant AUSRIVAS models were collected according to the latest NSW AUSRIVAS manual (Turak *et. al,* 2004) and ANZECC & ARMCANZ (2000) Water Quality Guidelines for aquatic ecosystems in Southeast Australia. NSW-autumn-edge is the AUSRIVAS model which applies to the study area and environmental variables required by the model are provided in Table 2-1.

The appropriate NSW AUSRIVAS model and accompanying scores and bandings have been used to detect any changes in observed and expected macroinvertebrate communities within the sites samples. AUSRIVAS generates site-specific predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress. The expected fauna from sites with a similar set of physical and chemical characteristics are then compared to the observed fauna, and the ratio derived is used to indicate the extent of the impact. This ratio can range from zero (0), when none of the expected taxa are found at a site, to approximately one (1), when all of the expected taxa are present. The value can also be greater than one (1) when more families are found at the site than

predicted by the model. The ratio scores are placed in bands which indicate whether the site is richer than reference, reference quality, below reference quality, well below reference quality or impoverished (Table 2-2). The AUSRIVAS model also provides a list of missing taxa from individual sampling sites by comparing observed taxa against expected taxa. This data will be analysed and reported to provide a more detailed understanding of the health ratings assigned to individual sampling sites and observed trends in river health.

Table 2-1: Environmental variables required to run the AUSRIVAS NSW-autumn-edge model

Environmental Variable	Physical/Chemical Description
ALKALINITY	Total carbonates. (mg/l)
ALTITUDE	Height above sea level. (m)
BEDROCK	Percent bedrock in habitat. (%)
BOULDER	Percent boulder [>256mm] in habitat. (%)
COBBLE	Percent cobble [64-256mm] in habitat. (%)
LATITUDE	Latitude of site (decimal degrees to 4dp)
LOGDFSM	Log 10 [x] Distance from source. (log 10 [m])
LOGSLOPE1KUS	Log 10 [x] Slope: Elevation difference in metres between the middle of the site and a point 1km upstream. (log 10 [m])
LONGITUDE	Longitude of site (decimal degrees to 4dp)
RAINFALL	Mean annual rainfall. (mm)

Table 2-2: Key to AUSRIVAS O/E bands for NSW-autumn- edge model, scores vary according to model and season

Band Label	O/E 50 Bandwidth	Band Name	Comments
Band X	> 1.18	More biologically diverse than reference sites	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	0.82 - 1.17	Reference condition	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	0.47 - 0.81	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	0.12 - 0.46	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0 - 0.11	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

Relative Abundance

The relative abundance of the major taxonomic Orders is derived from the presence/absence (P/A) data for each of the samples. This measure provides an estimate of the percentage contribution of the major macroinvertebrate Orders and, when

presented in graphical form, allows for a visual representation of the macroinvertebrate community within each replicate sample, a pooled total for each site and a pooled total representing the macroinvertebrate community across the study area.

In addition to data analysis techniques macroinvertebrate taxa listed in the relevant legislation including the Environmental Protection and Biodiversity Conservation (EPBC) Act (1999), the Threatened Species Conservation (TSC) Act (1995) and the Fisheries Management (FM) Act (1994) will be highlighted.

2.3.2 Analysis of Fish Populations

At each site the first 50 specimens of each fish species caught were measured, general health condition assessed and identified to species level. This information was collated on an excel spreadsheet and basic univariate descriptive statistics derived. The main statistics generated for each site include the number of species and the maximum, minimum, and average length of each species. Length frequency distribution graphs, of each species with at least 25 specimens caught, were completed in Statistica 9.1 (StatSoft Inc., 2010). These graphs are used to examine the range of size classes and to determine if both adults and juveniles exist, indicating recruitment and consistent habitation of the species. Any species listed in the Environmental Protection and Biodiversity Conservation Act (EPBC) (1999) will be highlighted and possible impacts of the proposed development on the species discussed.

3 Results

3.1 Surface Water physico-chemistry

The majority of water quality parameters were within ANZECC (2000) guideline values for 95% species protection of lowland aquatic ecosystems in south eastern Australia, with the exceptions of pH and DO% (Table 3-1). pH was lowest at Anzac Creek (5.62) and was also below the lower guideline value of 6.5 at Georges River (6.06). DO% was also below the lower guideline value of 60% at both sample sites but was particularly low at Anzac Creek (11.6%). Alkalinity was considerably higher at Anzac Creek (70mg/l $CaCO_3$) compared to Georges River (18mg/L $CaCO_3$) but there is currently no ANZECC guideline value for this parameter.

Table 3-1: Results of *in-situ* water physico-chemistry (results highlighted in yellow are outside the ANZECC guideline values for 95% species protection of lowland aquatic ecosystems in south eastern Australia)

Water Quality Parameter	Georges River	Anzac Creek	ANZECC Guidelines
Sample Depth (m)	0.2	0.2	-
Temperature (°C)	12.45	9.50	-
Conductivity (µS/cm)	134.4	297.6	300
pH	6.06	5.62	6.5-9.0
DO (mg/L)	5.78	1.27	-
DO (% sat.)	48.8	11.6	60-120
Turbidity (NTU)	17.4	28.9	50
Alkalinity (mg/L $CaCO_3$)	18	70	-
Date	12/05/2011	12/05/2011	-
Time	10:00	14:00	-

3.2 Macroinvertebrates

A total of 27 macroinvertebrate taxa at the Family level were recorded across the study area, with a total of 18 taxa in the Georges River samples and 23 in the Anzac Creek samples (Table 3-2). Average taxa richness values were 14 and 18 for Georges River and Anzac Creek respectively. None of the macroinvertebrate taxa recorded are considered endangered or vulnerable by the TSC Act (1994), the FM Act (1995) or are listed in the EPBC Act (1999). Across the study area Odonata (Dragonflies and Damselflies) were the dominant Order accounting for just over 18% of all taxa recorded, and more than 22% in the Georges River samples and 17% in the Anzac Creek samples (Figure 3-1). Other Orders with substantial relative abundance included Coleoptera (Beetles) and Diptera (Flies) which each contributed almost 15% of the total taxa richness across the study area.

SIGNAL2 values for all macroinvertebrate samples were relatively low but the Anzac Creek samples scored slightly higher than the Georges River samples (Table 3-2). The SIGNAL2 results suggest the macroinvertebrate community is dominated by pollution tolerant taxa although low scores are common of lacustrine and low flow environments, and are not likely to be due solely to polluted or poor water quality but also to the limited diversity of habitats, as discussed in section 3.5.

Table 3-2: Summary of macroinvertebrate indices calculated for the Hyder samples collected in autumn (May 2011)

Site	Replicate	Taxa Richness	EPT Taxa Richness	SIGNAL2	AUSRIVAS O/E 50	AUSRIVAS Band
Georges River HYD01	Edge1	12	0	2.78	0.32	C
	Edge2	16	1	3.15	0.32	C
	Combined Samples	18	1	2.97	0.39	C
	Average	14	0.5	2.93	0.32	C
Anzac Creek HYD02	Edge1	20	1	3.35	0.73	B
	Edge2	16	0	3.15	0.37	C
	Combined Samples	23	1	3.15	0.73	B
	Average	18	0.5	3.25	0.61	B
All Samples Combined	**Average**	**16**	**0.5**	**3.11**	**0.48**	-
	Total	**27**	**1**	**2.92**	-	-

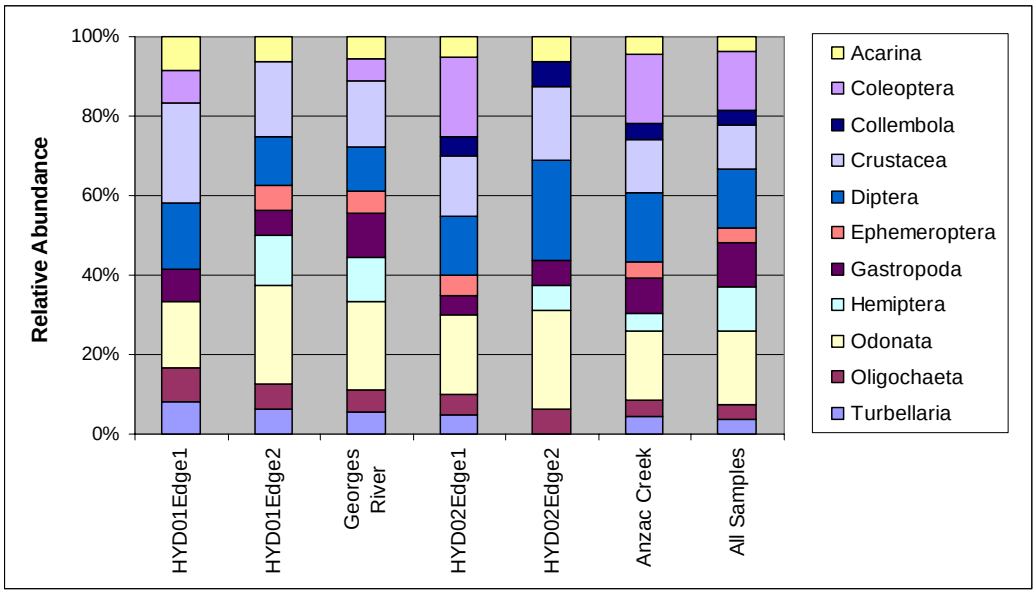

Figure 3-1: Relative abundance of macroinvertebrate taxa at the Order level for each of the Hyder samples, pooled replicate samples for each site (identified by name) and a combined total from both sites

The environmental variables used to run the NSW-autumn-edge AUSRIVAS model are provided in Table 3-3. AUSRIVAS results for the Georges River samples rated this site in Band C, suggesting that it is 'severely impaired' and that fewer macroinvertebrate families were observed than expected. This can indicate a loss of macroinvertebrate biodiversity, compared to reference sites, due to substantial impacts on water and/or habitat quality.

Each of the replicate samples from Anzac Creek scored a considerably different AUSRIVAS O/E 50, the difference being enough to separate the two samples in AUSRIVAS Band. The greater number of macroinvertebrate taxa in HYD02 Edge replicate 1 was the key reason for the difference as the environmental variables required for the model were identical for each replicate. Replicate 1 scored an O/E 50 of 0.73 while replicate 2 scored 0.37, the pooled sampled data scored 0.73 and the average of the two replicate samples was 0.63.

This provides an overall rating of AUSRIVAS Band B indicating that the macroinvertebrate community was 'significantly impaired'. This implies that fewer families than expected were observed and a 'potential impact' either on water quality, or habitat quality, or both.

Across all samples a large number of macroinvertebrate taxa were expected by the AUSRIVAS model to occur but were not observed. Approximately 48% of these missing taxa have a SIGNAL2 value above 5 and are considered to be sensitive to pollution and/or poor water quality. Of these missing taxa approximately 36% are from the EPT taxa groups which are highly sensitive to changes in water quality and/or habitat conditions. A complete list of the taxa expected but not observed is provided in Appendix B.

Table 3-3: Environmental variables used for input into AUSRIVAS NSW-autumn-edge model

Site Code	ALKALINITY	ALTITUDE	BEDROCK	BOULDER	COBBLE	LATITUDE	LOGDFSM	LOGSLOPE1KUS	LONGITUDE	RAINFALL
HYD01Edge1	18	16	0	0	0	-33.97	4.72	0.60	150.91	1300
HYD01Edge2	18	16	0	0	0	-33.96	4.72	0.60	150.91	1300
Georges River	18	16	0	0	0	-33.97	4.72	0.60	150.91	1300
HYD02Edge1	70	20	0	0	0	-33.96	2.69	0.30	150.92	1300
HYD02Edge2	70	20	0	0	0	-33.96	2.69	0.30	150.92	1300
Anzac Creek	70	20	0	0	0	-33.96	2.69	0.30	150.92	1300

3.3 Fish

A total of 65 specimens from 2 species were recorded at the Hyder sampling sites in May 2011 (Table 3-4). The species recorded included the native Flathead Gudgeon (*Philypnodon grandiceps*) and the introduced Gambusia (*Gambusia holbrooki*).Only one specimen of the native *P. grandiceps* was recorded and only at the Georges River site, thus no further summary statistics can be calculated for this species.

Table 3-4: Summary data for fish captured at the Hyder Consulting aquatic monitoring sites

Site Name & Code	Fish Species	Common Name	Count	Mean Length (mm)
Georges River HYD01	*Gambusia holbrooki*	Gambusia	50	26.4
	Philypnodon grandiceps	Flathead Gudgeon	1	32
Anzac Creek HYD02	*Gambusia holbrooki*	Gambusia	14	25.0
Total			**65**	

Gambusia were caught at both sample sites but were more abundant at Georges River (50+ specimens) compared to Anzac Creek (14 specimens). The mean length of Gambusia was 26.4mm and 25.0mm for Georges River and Anzac Creek respectively and both sites displayed a range of size classes (Figure 3-2) suggesting that both adults and juveniles were present and that recruiting populations exist. Bait traps were the most successful collection method at in the Georges River but due to the extensive macrophyte cover and

limited open water at Anzac Creek, the majority of fish specimens were caught as by-catch in the macroinvertebrate samples (Figure 3-3).

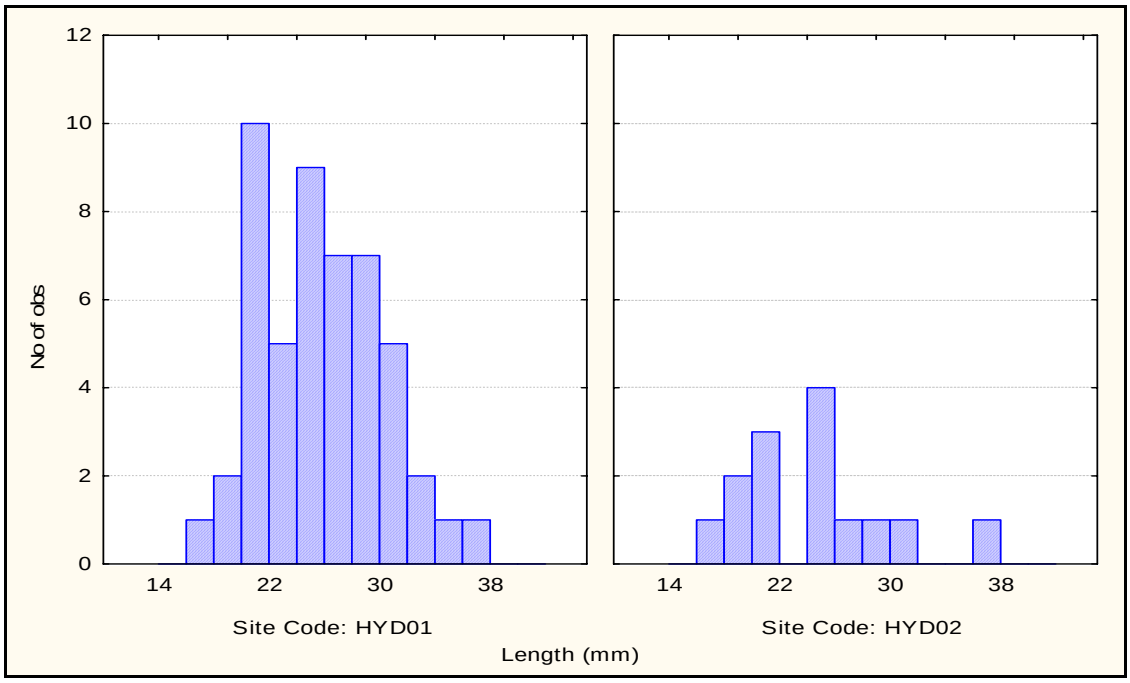

Figure 3-2: Length frequency distribution histograms of Gambusia (*Gambusia holbrooki*) at each of the Hyder aquatic monitoring sites

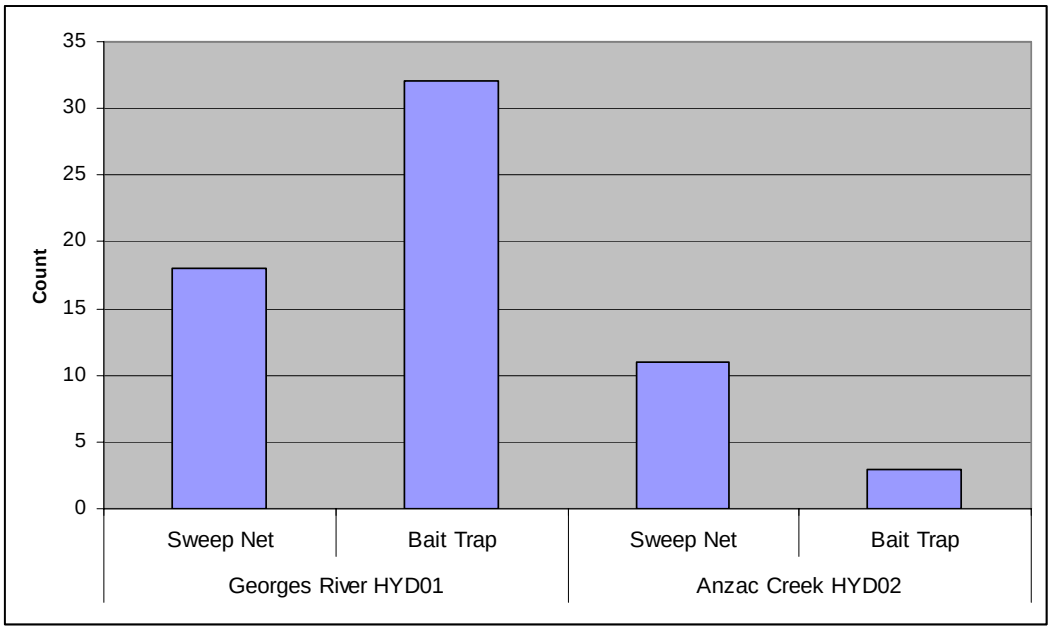

Figure 3-3: Total catch of Gambusia (*Gambusia holbrooki*) per collection method for each of the Hyder Consulting aquatic monitoring sites sampled in May 2011

3.4 Groundwater Dependant Ecosystems

A visual assessment of the site was made to consider the presence of groundwater and the potential for groundwater dependant communities to exist within the study area. No groundwater monitoring bores were located on the study site, so no groundwater samples could be collected.

Results from previous studies (URS, 2002) in an area adjacent to the Hyder study area, have shown the depth to groundwater to be generally between 4 - 5mbgl. This study suggested that groundwater flow is generally radially from the topographic high and that the location of the Georges River indicates groundwater flow underlying the study area would be predominantly westerly. Results from the URS (2002) study indicated that lower salinity waters are present in the shallow groundwater inferring that local recharge is occurring, and that the low/moderate salinity observed at deeper levels may be indicative of deep local recharge. This suggests that groundwater is likely to contribute to the existing surface water, particularly in Anzac Creek, and that there is connectivity between the groundwater and the Georges River. Analysis of the isotopic signature of the various water sources would be required to conclusively demonstrate this connectivity which would require groundwater monitoring bores at various locations across the site. Such bores could be sampled for both water quality and invertebrate communities. To ensure a sample is representative, newly constructed groundwater monitoring bores should not be sampled for at least 6 months post construction. Confirmation of the presence or absence of groundwater fauna is desirable, but construction of monitoring bores and an adequate sampling regime is likely to set back the proposed development considerably.

3.5 Aquatic and Riparian Habitat Assessment

3.5.1 Georges River

The Georges River site (Figure 3-4) was 100m long and extended north from beneath the East Hills Railway Bridge. The river was 40 to 60m wide, and the bank dropped rapidly to a depth of 1.2m before falling away at a steadier grade. Aquatic habitats present included soft substrate pool habitat, large woody debris and extensive macrophyte cover. Riparian vegetation was dominated by dense growth of Lantana (*Lantana camara)*, with occasional tall *Eucalyptus* spp. The western bank could not be sampled due to access restrictions, however observations from the eastern bank suggested that access would be difficult due to vertical banks. Overhanging vegetation, fallen logs, mats of sticks, submerged (*Elodea canadiensis*) and floating aquatic plants (*Azola* sp., *Salvinia molesta*) were present in the littoral and edge habitats throughout the study reach.

Figure 3-4: Georges River facing upstream from the macroinvertebrate and fish sampling site

3.5.2 Anzac Creek

The Anzac Creek site (Figure 3-5, Figure 3-6) was downstream of an old and currently unused rail crossing. The limited aquatic habitat included soft substrate pools and extensive macrophyte cover and there was no open or running water present at the site. The creek was obscured by dense growths of *Typha* sp. and *Salvinia molesta*. Water was mostly static and shallow (1 to 30cm deep) with a small pool of approximately 1m depth immediately downstream of the culvert tunnels running underneath the rail line. Riparian vegetation was dominated by *Melaleuca* sp., *Eucalyptus* spp., and other native shrub species.

Figure 3-5: Anzac Creek facing upstream of the railway culvert, displaying extensive growth of *Typha* sp. and *Salvinia molesta*, and the limited aquatic habitat available for macroinvertebrate and fish sampling

Figure 3-6: Anzac Creek facing downstream of the railway culvert, displaying the limited open water available for macroinvertebrate and fish sampling

4 Discussion

4.1 Surface Water Physico-chemistry

The *in-situ* water physico-chemistry showed that pH and dissolved oxygen were below the ANZECC guideline values at both sites. This maybe a factor influencing the macroinvertebrate community composition, but further monitoring would be required to confirm that the low pH and dissolved oxygen values recorded are consistent over time. The measured variables were limited to *in-situ* parameters and further laboratory analysis of pollutants, nutrients, metal concentrations, bacterial content etc. may find other conditions of water physico-chemistry that may be responsible for some impacts on the macroinvertebrate communities.

4.2 Macroinvertebrates

Results of the macroinvertebrate sampling showed both sites to have relatively depauperate macroinvertebrate communities. Richness values, at the taxonomic level of Family, were generally low and many sensitive taxa were not recorded. SIGNAL2 values for all samples suggest the macroinvertebrate community of these sites is dominated by pollution tolerant taxa. AUSRIVAS rated the Georges River site in Band C 'severely impaired' and results show that fewer macroinvertebrate families were observed than were expected by the AUSRIVAS model. This can indicate a loss of macroinvertebrate biodiversity due to 'substantial' impacts on water and habitat quality or both. Anzac Creek was rated slightly better, AUSRIVAS Band B, indicating that the macroinvertebrate community was 'significantly impaired'. This implies that fewer families than expected were observed and a 'potential' impact has occurred, either on water quality, or habitat quality or both, resulting in a loss of taxa.

Of the macroinvertebrate taxa that were expected but not observed, a large proportion are known to be sensitive to pollution and/or poor water quality (as indicated by their SIGNAL2 scores). The Family Baetidae from the Order Ephemeroptera (Mayflies) was the single representative of the sensitive EPT taxa groups but was recorded in only one replicate sample from each site. This suggests a limited distribution and low abundance of Mayflies across the study area. Across all samples Odonata (Dragonflies and Damselflies) were the most dominant Order, followed by Coleoptera (Beetles) and Diptera (Flies). These taxa generally have a highly motile adult stage. The dominance of these taxa suggests that aerial dispersal is a primary colonisation pathway and a major influence on macroinvertebrate community structure within the study area. None of the macroinvertebrate taxa recorded is considered endangered or vulnerable by the TSC Act (1994), the FM Act (1995) or is listed in the EPBC Act (1999).

The macroinvertebrate community at both sample sites was found to have at least some level of impairment and any further degradation of these sites is likely to influence the macroinvertebrate community on a local scale. The study area of the Georges River is isolated to a 100m stretch of the river. A large proportion of this reach is heavily vegetated with Lantana on the banks and dense submerged and floating aquatic plants including *Elodea Canadensis*, *Azolla* sp. and *Salvinia molesta*. This could be considered as poor quality habitat which lacks the diversity of micro-habitats to support a diverse and healthy macroinvertebrate community. While construction of a rail bridge may have localised impacts on the macroinvertebrate community it is unlikely to have any prolonged or widespread impacts and the community should recover from any disturbance in a short time following construction. Potential impacts such as increased sedimentation or instream habitat alterations should be minimised to ensure the macroinvertebrate community does not degrade further. Ongoing monitoring of the Georges River, both upstream and downstream of the proposed development, may help to identify and minimise any potential impacts to aquatic macroinvertebrate communities.

Assessment of the macroinvertebrate community at the Anzac Creek site showed it to be more diverse and healthy than that of the Georges River site. If development of the site alters the habitat of Anzac Creek, through direct habitat removal or indirect sources such as increased runoff and sedimentation, it is likely to impact the aquatic macroinvertebrate community. As previously mentioned much of the macroinvertebrate taxa recorded at the two sites have aerial adult stages. It is possible that Anzac Creek may be an important source of macroinvertebrate colonisers to the Georges River (and vice versa, but to a lesser extent) and as such consideration should be given to maintaining the condition of the macroinvertebrate community in Anzac Creek. As this site is at the top of the Anzac Creek catchment any changes to the aquatic or riparian habitats, or landuse within the catchment, are likely to have impacts on communities downstream. Ongoing monitoring of macroinvertebrate communities downstream of the development may assist in identifying changes in aquatic communities and help to minimise any potential impacts that may occur.

4.3 Fish

To identify the potential for fish presence at each of the study sites the assessed habitat was compared to the waterway types according to Faithfull and Witheridge (2003). The Georges River at the Hyder study site was a permanent water body which classifies it as a Class 1 Major fish habitat. This site was a wide deep pool with steep vegetated banks which made access to the site difficult. The edge habitats of the river were also densely covered with aquatic macrophyte and any region beyond the macrophyte was too deep to wade. The depth of the river, dense macrophyte cover, and cover of snags and large woody debris, prevented seine netting, fyke netting and backpack electrofishing from being conducted, thus bait traps and sweep nets were the only methodologies able to be employed. This limited the assessment of fish communities at the Georges River study site to the littoral and edge dwelling species only.

Anzac Creek was limited to small static pools with dense covering of macrophytes including *Typha* sp. and *Salvinia molesta* which limited the habitat available for fish sampling. Anzac Creek at the location of the Hyder study site could be considered an intermittent waterway or wetland that would only flow immediately following a substantial rain event. This would classify this site as a Class 3 Minimal fish habitat according to Faithfull and Witheridge (2003). As with the Georges River site bait traps and sweep netting only could be used and the limited open water reduced the number of bait traps able to be deployed.

Only one native fish species was recorded across the study area. One specimen of the native Flathead Gudgeon (*Philypnodon grandiceps*) was recorded within the Georges River and no native fish were recorded in Anzac Creek. Flathead Gudgeon is generally a benthic species that prefers slow flowing areas of lowland streams or lakes and dams and is often found in weedy or muddy areas with abundant cover (Lintermans, 2007). The extensive cover of aquatic macrophyte and woody debris in the edge habitats of the Georges River provide an ideal habitat for this species. Although only one specimen was recorded it is likely that further sampling would record additional specimens and that the species is widely distributed in the lower reaches of the Georges River. The species matures at 42-50mm length and breeds in spring and summer when water temperatures are between 18-27°C and eggs are laid attached to solid objects such as rock and wood (Lintermans, 2007). The specimen observed was 32mm and would be likely to reach sexual maturity in the next breeding season and, with abundant cover of woody debris, a consistent population of this species is highly likely to occur.

Flathead Gudgeon is not considered an endangered or vulnerable species in the FM Act (1994), nor is it listed in the EPBC Act (1999) and is common throughout its range. It occurs throughout the Murray-Darling Basin and in coastal drainages in Victoria, northern Tasmania, New South Wales and Queensland (Lintermans, 2007). Although a widely distributed and common species care should be taken to maintain the aquatic habitats preferable to this species as they are likely to be beneficial to other potential species.

Gambusia (*Gambusia holbrooki*) were caught at both sample sites but were more abundant at Georges River compared to Anzac Creek. This small, introduced fish rapidly reproduce, disperse widely, occupy diverse habitats and is also a highly aggressive predatory species, often to the detriment of native species (NSW National Parks and Wildlife Service, 2003). Predation by *G. holbrooki* is listed as a key threatening process under Schedule 3 of the TSC Act (1995). Gambusia are commonly found in lakes or slow flowing streams, mostly around the edges or amongst freshwater plants. Maturity can be reached after only two months, at about 25mm long, and females produce about fifty young in each batch, and up to nine batches per year (Lintermans, 2007). Both sites displayed a range of size classes and even though the Anzac Creek population was less abundant and possessed fewer size classes, data from both populations suggests that recruitment is occurring. Gambusia tolerates a wide range of water temperatures, oxygen levels, salinities and turbidities and due to it's ability to breed rapidly, it has assumed plague proportions in many habitats (Lintermans, 2007). Changes to the aquatic habitats, such as reduced habitat diversity and increased sedimentation, that may result from construction works are likely to benefit Gambusia and be detrimental to native fish species. Gambusia are known to display aggressive fin-nipping behaviour and often compete with small native fishes (McDowell, 1996). Any further increase in the Gambusia population is highly likely to negatively impact the native Flathead Gudgeon therefore processes which could potentially reduce aquatic habitat diversity, such as siltation during construction works, should be minimised if possible.

Previous studies within the Georges River catchment (Williams *et.al,* 2004) surveyed fish approximately 500m upstream of the Hyder Study site at the Cambridge Avenue road bridge. This survey recorded several other native species including Striped Gudgeon (*Gobiomorphus australis*), Empire Gudgeon (*Hypseleotris compressa*) and Australian Bass (*Macquaria novemaculeata)* and habitat requirements of these species are similar to those of Flat-head Gudgeon. The threatened Macquarie Perch (*Macquaria australasica*) has also been identified in parts of the upper Georges River catchment (NSW Industry & Investment, 2010), but generally, the Macquarie Perch are found upstream of areas inhabited by Australian Bass (Native Fish Australia, 2009b) so it is highly unlikely that Macquarie Perch occur in the lower reaches of the Georges River at or near this site.

It may be possible to conduct a more comprehensive assessment of the fish community at the Georges River site through other methods such as gill netting and/or boat electrofishing. These methods may be more costly and time consuming, as boat access to the river would be required, but are likely to provide more comprehensive and conclusive results of the fish species present at the site. The proposed development is confined to a small stretch of the Georges River and any construction works are likely to be confined to this site and possibly a small distance downstream. Development of a rail bridge at this site is likely to have limited impact on any other potential native fish populations which, if present, are likely to populate a much wider region of the lower reaches of the Georges River.

4.4 Groundwater Dependant Ecosystems

No groundwater monitoring bores were located on the study site, so no groundwater samples could be collected. Confirmation of the presence or absence of groundwater dependant fauna (stygofauna) is desirable, but construction of monitoring bores and an adequate sampling regime is likely to set back the proposed development considerably. Results from the URS (2002) study indicated that that local recharge is occurring, which suggests that groundwater contributes to the existing surface water, particularly in Anzac Creek, and there is connectivity between the groundwater and the Georges River. Although the extent of groundwater distribution in the area is not clear it is probable, due to local hydrogeology, that groundwater across the study area and the wider region is interconnected. This would suggest that if stygofauna were present they are unlikely to be isolated to the vicinity of the proposed developments and while isolated areas of the groundwater may be influenced, a significant impact on the wider region is highly unlikely.

An example of the Castlereagh Swamp Woodland (CSWL), listed as an Endangered Ecological Community in the TSC Act (1995), is located within the study area and surrounding the Anzac Creek study sites. Characteristic tree species in the CSWL are *Eucalyptus parramattensis subsp. parramattensis* and *Melaleuca decora* and small billabongs and/or wetlands may occur within the community (OEH, 2011). As Anzac Creek is likely to be predominantly a result of groundwater recharge specimens of these tree species within the Anzac Creek area are likely to be groundwater dependent. This suggests that the CSWL community within the study area could be considered a groundwater dependant ecosystem. Species composition at any site depends on local topography and drainage conditions and CSWL is typically associated with poorly-drained depressions and creeklines on clay soils associated with Tertiary alluvium (OEH, 2011). Any development within or in close proximity to the Anzac Creek CSWL community should thoroughly consider any potential impacts on groundwater quality and quantity as any localised pollution or reduction in the groundwater table is likely to influence this endangered community.

4.5 Aquatic and Riparian Habitat Assessment

The two sites assessed were vastly different in their habitat types. The Georges River site is a lowland, slow flowing river close to the end of the catchment. Landuse in the catchment upstream of the sampling site is a mixture of residential, light industrial and natural forest. The sampling site had steep heavily vegetated banks which made access difficult and the instream habitat was generally a deep soft bottomed pool and also heavily vegetated with aquatic macrophytes. The combination of these factors made macroinvertebrate and fish sampling difficult and limited the variety of habitats which could be successfully sampled. The extensive macrophyte cover of submerged *Elodea canadiensis* and floating aquatic plants (*Azola* sp., *Salvinia molesta*) present throughout the study reach, reduced the overall heterogeneity of the aquatic habitat and is likely a factor influencing the macroinvertebrate community composition. Riparian and bankside vegetation was dominated by the introduced Lantana (*Lantana camara*) and invasion, establishment and spread of this species is listed as a key threatening process in the TSC Act (1995) while degradation of native riparian vegetation along NSW water courses is also listed in the FM Act (1994). Consideration of these threatening processes should be given with management of the study area and development could consider control/removal of Lantana as an offset to any potential impacts that may result from construction works.

The site on Anzac Creek was quite different and more similar to a swamp or wetland environment than to a river. The dense macrophyte cover and small catchment area up-stream of the site (catchment area approximately 450m^2) provided static water only and the samplable aquatic habitat was limited to two small pools both heavily vegetated with floating and emergent macrophytes. The introduced Salvinia (*Salvinia molesta*) dominated the floating macrophyte composition at the Anzac Creek sample sites. Salvinia is a Weed of National Significance and is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts (Department of the Environment and Heritage and the CRC for Australian Weed Management, 2003). Salvinia is an aquatic weed that can grow rapidly to cover the entire water surface which shades out any submerged plant life and impedes oxygen exchange, making the water unsuitable for fish and other animals. The presence of Salvinia at the Anzac Creek study site has potential to negatively impact the aquatic ecosystem both directly at this site and downstream. Development of a rail bridge at this site should consider the management of Salvinia, both locally and downstream, as it may help to reduce any potential impacts that may result as a consequence of construction works.

The proposed development site is relatively small and only limited areas of development are expected to disturb the aquatic habitats. The section of rail proposed over the Georges River is unlikely to influence any potential surface water to groundwater connectivity as it is limited to a small stretch of the river. Development of the site around the upper areas of Anzac Creek may influence the potential connectivity of surface water and reduce the likelihood of it becoming habitat for native fish species. Consideration of

this connectivity should be given in the design and construction of the rail bridge to minimise impacts at this site that may have implications for ecosystems downstream.

The aquatic ecosystems within the proposed development area could be considered slightly to moderately disturbed and not in pristine condition. However, care should be taken to minimise any further degradation of this site. The proposed development has potential to have a greater impact on the aquatic ecosystem of Anzac Creek compared to the Georges River as this area remains in a more 'natural' state. This area also contains an example of the endangered Castlereagh Swampland Community which is likely to be groundwater dependant and consideration should be given to minimise any potential impacts to this community. The development of the rail bridge across the Georges River should consider any additional sedimentation that may result during construction works, but any potential impacts to the aquatic communities at this site are likely to be negligible, both spatially and temporally.

5 Conclusions and Recommendations

The aquatic ecology survey designed by ALS focused on macroinvertebrate and fish communities and a general assessment of the aquatic habitat at each of the sampling sites was made. A summary of findings of this study follow;

- Results of the macroinvertebrate sampling showed both sites to have relatively depauperate macroinvertebrate communities and any further degradation of these sites is likely to influence the macroinvertebrate community on a local scale.
- The Georges River site was rated in Band C by the AUSRIVAS model indicating that was 'severely impaired'.
- Anzac Creek rated slightly better and the overall rating of AUSRIVAS Band B indicates the macroinvertebrate community was 'significantly impaired'.
- The *in-situ* water physico-chemistry showed that pH and dissolved oxygen were below the ANZACC guideline values at both sites. This maybe a factor influencing the macroinvertebrate community composition, but further monitoring would be required to confirm that the low pH and dissolved oxygen values are consistent over time.
- None of the recorded macroinvertebrate taxa are listed in the EPBC Act.
- The assessment of fish communities within the reach of Georges River was limited to the littoral and edge dwelling species only as access to the river prevented most of the proposed sampling methodologies.
- Flathead Gudgeon (*Philypnodon grandiceps*) was the only native fish species recorded and only one specimen was recorded at the Georges River site. This species is not listed in the EPBC Act and is considered common throughout its range.
- The introduced Gambusia (*Gambusia holbrooki)* was caught at both sample sites but was more abundant in the Georges River. Any further increase in the Gambusia population is likely to negatively impact the native Flathead Gudgeon population therefore processes which could potentially reduce aquatic habitat diversity, such as increased siltation during construction works, should be minimised.
- It is possible that other fish species are present in the open waters of the Georges River site but other sampling methods, such as gill netting or boat electrofishing, would be required to confirm this. The proposed development, confined to a small stretch of the Georges River, is likely to have limited impact on the river and any other potential native fish populations.
- The presence/absence of groundwater fauna could not be confirmed due to the lack of monitoring bores on the study site. Any potential fauna are unlikely to be isolated to the vicinity of the proposed developments and while isolated areas of groundwater may be influenced, a significant impact on the wider region is highly unlikely.
- The Castlereagh Swampland Community within the vicinity of Anzac Creek and within the study area could be considered a groundwater dependant ecosystem. Any development within the Anzac Creek CSWL community should thoroughly consider potential impacts on groundwater quality and quantity as any localised pollution or reduction in the groundwater table is likely to influence this endangered community.
- Management of the study area should consider control/removal of Lantana as an offset to any potential impacts that may result from construction works. The aim would be reducing the impact of Lantana on the aquatic ecosystems through reducing the degradation of streamside vegetation.
- While the aquatic ecosystems within the proposed development area are slightly to moderately disturbed, care should be taken to minimise impact and prevent any further degradation.

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Appendix A - Macroinvertebrate Data, May2011

Taxa Code	Class/Order	Family/Sub-family	SIGNAL 2 Value	HYD01Edge1	HYD01Edge2	HYD02Edge1	HYD02Edge2
IF619999	Turbellaria	Dugesiidae	2	3	4	4	
KG059999	Gastropoda	Lymnaeidae	1				1
KG079999	Gastropoda	Planorbidae	2		2	1	
KG089999	Gastropoda	Physidae	1	2			
LO999999	Oligochaeta	Oligochaeta	2	4	2	6	3
MM999999	Acarina	sp.	6	51	22	5	17
QA999999	Collembola	sp.	1			2	5
QC099999	Coleoptera	Dytiscidae	2	1		12	
QC119999	Coleoptera	Hydrophilidae	2			5	
QC139999	Coleoptera	Hydraenidae	3			1	
QC209999	Coleoptera	Scirtidae	6			1	
QD099999	Diptera	Ceratopogonidae	4			8	4
QD249999	Diptera	Stratiomyidae	2				1
QDAE9999	Diptera	s-f Tanypodinae	4	2	1	6	8
QDAJ9999	Diptera	s-f Chironominae	3	1	3	7	4
QE029999	Ephemeroptera	Baetidae	5		5	1	
QH539999	Hemiptera	Hebridae	3				16
QH629999	Hemiptera	Belostomatidae	1		1		
QH689999	Hemiptera	Pleidae	2		1		
QO029999	Odonata	Coenagrionidae	2	45	52	10	5
QO129999	Odonata	Aeshnidae	4			1	1
QO179999	Odonata	Libellulidae	4		5	4	1
QO309999	Odonata	Hemicorduliidae	5		1	4	1
QO999998	Odonata	Epiproctophora	3	2	2		
OG999999	Crustacea	Cladocera	N/A	3	2	1	12
OH999999	Crustacea	Ostracoda	N/A	6	5	3	4
OJ999999	Crustacea	Copepoda	N/A	12	11	13	1

Appendix B - List of Macroinvertebrate Taxa Expected in AUSRIVAS model but not observed in Hyder samples.

Taxa Code	Class/Order	Family	SIGNAL2 Value
IF499999	Turbellaria	Temnocephalidae	0
IJ019999	Nematomorpha	Gordiidae	5
KG029999	Gastropoda	Hydrobiidae	4
KG049999	Gastropoda	Thiaridae	4
KG069999	Gastropoda	Ancylidae	4
KP029999	Gastropoda	Corbiculidae	4
LH019999	Hirudinea	Glossiphoniidae	1
OP029999	Amphipoda	Ceinidae	2
OP039999	Amphipoda	Eusiridae	7
OR129999	Isopoda	Cirolanidae	2
OT019999	Decapoda	Atyidae	3
OT029999	Decapoda	Palaemonidae	4
OV019999	Decapoda	Parastacidae	4
QC069999	Coleoptera	Haliplidae	2
QC089999	Coleoptera	Noteridae	4
QC109999	Coleoptera	Gyrinidae	4
QC189999	Coleoptera	Staphylinidae	3
QC349999	Coleoptera	Elmidae	7
QC379999	Coleoptera	Psephenidae	6
QD019999	Diptera	Tipulidae	5
QD069999	Diptera	Dixidae	7
QD079999	Diptera	Culicidae	1
QD109999	Diptera	Simuliidae	5
QD119999	Diptera	Thaumaleidae	7
QD229999	Diptera	Athericidae	8
QDAD9999	Diptera	Podonominae	6
QDAF9999	Diptera	Orthocladiinae	4
QE039999	Ephemeroptera	Oniscigastridae	8
QE059999	Ephemeroptera	Coloburiscidae	8
QE069999	Ephemeroptera	Leptophlebiidae	8
QE089999	Ephemeroptera	Caenidae	4
QH529999	Hemiptera	Mesoveliidae	2
QH549999	Hemiptera	Hydrometridae	3
QH569999	Hemiptera	Veliidae	3
QH579999	Hemiptera	Gerridae	4
QH649999	Hemiptera	Gelastocoridae	5
QH659999	Hemiptera	Corixidae	2
QH679999	Hemiptera	Notonectidae	1
QL019999	Lepidoptera	Pyralidae	3

Taxa Code	Class/Order	Family	SIGNAL2 Value
QM019999	Megaloptera	Corydalidae	7
QM029999	Megaloptera	Sialidae	5
QO039999	Odonata	Isostictidae	3
QO049999	Odonata	Protoneuridae	4
QO059999	Odonata	Lestidae	1
QO079999	Odonata	Megapodagrionidae	5
QO089999	Odonata	Synlestidae	7
QO139999	Odonata	Gomphidae	5
QO169999	Odonata	Corduliidae	5
QP029999	Odonata	Austroperlidae	10
QP039999	Plectoptera	Gripopterygidae	8
QP049999	Plectoptera	Notonemouridae	6
QT019999	Trichoptera	Hydrobiosidae	8
QT039999	Trichoptera	Hydroptilidae	4
QT049999	Trichoptera	Philopotamidae	8
QT069999	Trichoptera	Hydropsychidae	6
QT079999	Trichoptera	Polycentropodidae	7
QT089999	Trichoptera	Ecnomidae	4
QT139999	Trichoptera	Tasimiidae	8
QT159999	Trichoptera	Conoesucidae	7
QT179999	Trichoptera	Helicopsychidae	8
QT189999	Trichoptera	Calocidae	9
QT219999	Trichoptera	Philorheithridae	8
QT229999	Trichoptera	Odontoceridae	7
QT239999	Trichoptera	Atriplectididae	7
QT249999	Trichoptera	Calamoceratidae	7
QT259999	Trichoptera	Leptoceridae	6

Appendix C -
Fish Data, May 2011

Site Code	Date	Collection Method	Common Name	Scientific Name	Length (mm)
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	25
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	17
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	38
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	29
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	33
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	26
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	21
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	20
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	36
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	32
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	26
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	29
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	34
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	29
HYD01	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	32
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	21
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	24
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	25
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	23
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	26
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	30
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	28
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	32
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	29
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	20
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	24
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	27
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	31
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	28
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	25
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	27
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	26
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	24

Site Code	Date	Collection Method	Common Name	Scientific Name	Length (mm)
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	30
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	28
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	28
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	22
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	25
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	26
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	30
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	23
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	32
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	27
HYD01	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	21
HYD01	12/05/2011	Bait Trap	Flathead Gudgeon	*Philypnodon grandiceps*	32
HYD02	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	22
HYD02	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	22
HYD02	12/05/2011	Bait Trap	Gambusia	*Gambusia holbrooki*	25
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	27
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	26
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	37
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	20
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	22
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	25
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	26
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	32
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	29
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	18
HYD02	12/05/2011	Sweep Net	Gambusia	*Gambusia holbrooki*	19

APPENDIX 2

FLORA SPECIES INVENTORY

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Plant species recorded in the study area

Notes:

* indicates exotic species; † indicates non-local native species; + indicates threatened species.

Columns Q1 to Q6 represent Quadrats 1 to 6. The values for each species are the estimated percentage foliage cover of the species within the 0.04 hectare quadrat.

Columns T1 to T4 represent Transects 1 to 4. The X indicates that the species was observed along the random meander transect.

Species that are not defined as present within a specific sampling location are those that were opportunistically recorded within the study area during surveys.

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
Pteridophytes														
Adiantaceae		*Adiantum aethiopicum*	Common Maidenhair Fern											
		Cheilanthes sieberi	Rock Fern			1						X	X	
Dennstaedtiaceae		*Hypolepis muelleri*						30			X			
		Pteridium esculentum	Bracken											
Dicksoniaceae		*Calochlaena dubia*	Rainbow Fern, False Bracken											
Gleicheniaceae		*Gleichenia dicarpa*	Pouched Coral-fern								X			
Lindsaeaceae		*Lindsaea linearis*	Screw Fern								X			
Salviniaceae	*	*Salvinia molesta*	Salvinia											
Gymnosperms														
Araucariaceae		*Araucaria heterophylla*	Norfolk Island Pine											X
Cupressaceae		*Callitris rhomboidea*	Port Jackson Cypress-pine							X				
	*	*Cupressus sempervirens cv.*	Pencil Pine, Mediterranean Cypress											X

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
		Stricta												
Pinaceae	*	*Pinus sp.*												
Zamiaceae		*Macrozamia spiralis*	Burrawang											

Angiosperms: Dicotyledons

Acanthaceae		*Brunoniella australis*	Blue Trumpet, Blue Yam											
Amaranthaceae		*Alternanthera denticulata*	Common Joyweed			2								
		Alternanthera sp.						1						
Apiaceae		*Centella asiatica*	Indian Pennywort					1		X	X			
	*	*Hydrocotyle bonariensis*	Beach Pennywort					1						
		Hydrocotyle peduncularis						1						
		Platysace ericoides	Heath Platysace	3			1							
		Trachymene incisa		1			1						X	
Apocynaceae	*	*Nerium oleander*	Oleander											X
		Parsonsia straminea	Common Silkpod, Monkey Rope		15									
Araliaceae		*Polyscias sambucifolia*	Elderberry Panax											
Asclepiadaceae	*	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush											
Asteraceae	*	*Aster subulatus*	Wild Aster			1								
	*	*Bidens pilosa*	Cobblers Pegs		1									
		Cassinia uncata	Sticky Cassinia							X		X		
	*	*Chrysanthemoides monilifera* subsp. *rotundata*	Bitou Bush											

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
	*	*Cirsium vulgare*	Black Thistle, Spear Thistle											
	*	*Conyza sp.*	Fleabane							X				
		Coronidium scorpioides	Button Everlasting			1	1						X	
	*	*Delairea odorata*	Cape Ivy											
	*	*Hypochaeris radicata*	Catsear, False Dandelion						1			X		
		Olearia microphylla				1						X		
		Ozothamnus diosmifolius	White Dogwood			2	1			X				
	*	*Senecio madagascariensis*	Fireweed, Madagascar Ragwort							X				
	*	*Tagetes minuta*	Stinking Roger											
		Vernonia cinerea						1						
Bignoniaceae	*	*Jacaranda mimosifolia*	Jacaranda											X
Cactaceae	*	*Opuntia sp.*	Prickly Pear											
Caprifoliaceae	*	*Lonicera japonica*	Japanese Honeysuckle											
Casuarinaceae		*Allocasuarina littoralis*	Black She-Oak									X		
		Casuarina glauca	Swamp Oak, Swamp She-oak											X
Chenopodiaceae		*Einadia nutans* subsp. *linifolia*	Climbing Saltbush											
Clusiaceae		*Hypericum gramineum*	Small St Johns-wort	1					1					
Convolvulaceae		*Dichondra repens*	Kidney-weed, Mercury Bay Weed		1					X				
Dilleniaceae		*Hibbertia obtusifolia*	Guinea-flower	2									X	
		Hibbertia sp.		5			1							
Ericaceae Styphelioideae		*Astroloma humifusum*	Cranberry Heath			1			2					
		Leucopogon ericoides	Beard-heath				1						X	

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
		Lissanthe strigosa	Peach Heath			1								
		Melichrus procumbens					1							
Euphorbiaceae		*Breynia oblongifolia*	Coffee Bush		1			1						
		Micrantheum ericoides				5						X		
	*	*Triadica sebifera*	Chinese Tallow Tree											X
Fabaceae Caesalpinioideae	*	*Senna pendula var. glabrata*	Easter Cassia							X				
Fabaceae Faboideae		*Bossiaea heterophylla*	Variable Bossiaea			1	2		1			X	X	
		Bossiaea scolopendria					1							
		Daviesia ulicifolia	Gorse Bitter-pea			2				X		X		
		Dillwynia parvifolia												
	*	*Erythrina x sykesii*	Coral Tree											X
		Glycine clandestina	Twining Glycine							X			X	
		Gompholobium glabratum	Dainty Wedge Pea	1		1			1					
		Gompholobium pinnatum	Pinnate Wedge Pea	1										
		Hardenbergia violacea	False Sarsaparilla	1		1	1	1			X	X		
		Pultenaea retusa	Notched Bush-pea								X			
		Pultenaea tuberculata		1			1							
		Pultenaea villosa	Hairy Bush-pea	1		50				X	X	X		
	*	*Trifolium repens*	White Clover							X				
	*	*Wisteria sinensis*	Chinese Wisteria											
Fabaceae Mimosoideae		*Acacia binervia*	Coast Myall											X
		Acacia brownii	Golden Prickly Moses	1		1	2		1					

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
		Acacia decurrens	Black Wattle			5		1	2	X				
		Acacia falcata	Sickle Wattle							X	X	X		
		Acacia floribunda	White Sally											
		Acacia implexa	Hickory Wattle		10									
		Acacia longifolia	Sydney Golden Wattle					1			X	X	X	
		Acacia parramattensis	Parramatta Green Wattle			1		5			X			X
Fagaceae	*	*Quercus palustris*	Pin Oak											X
Goodeniaceae		*Dampiera stricta*	Blue Dampiera	1										
		Goodenia hederacea	Ivy Goodenia	1		1						X		
		Goodenia paniculata					1							
Haloragaceae		*Gonocarpus tetragynus*	Common Raspwort	1										
	*	*Myriophyllum aquaticum*	Parrot's Feather, Brazilian Water-milfoil					1						
Hamamelidaceae	*	*Liquidambar styraciflua*	Liquidambar, Sweet Gum											X
Lauraceae		*Cassytha glabella*		1		1	1	1					X	
		Cassytha pubescens	Devil's Twine, Dodder-laurel		2						X			
	*	*Cinnamomum camphora*	Camphor-laurel					1						X
Lobeliaceae		*Pratia purpurascens*	Whiteroot		1			1			X		X	
Loganiaceae		*Mitrasacme polymorpha*	Mitre Weed				1							
Loranthaceae		*Amyema gaudichaudii*	Paperbark Mistletoe											
Malaceae	*	*Cotoneaster sp.*								X				
	*	*Sorbus sp. (unidentified)*												X
Malvaceae	*	*Modiola caroliniana*	Red-flower Mallow											

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
	*	*Sida rhombifolia*	Paddy's Lucerne									X		
Myrtaceae		*Acmena smithii*	Lilly-pilly											
	†	*Agonis flexuosa*	Willow-myrtle, Peppermint Tree											
		Angophora bakeri	Narrow-leaved Apple	1		5	5	2			X	X	X	X
		Angophora costata	Sydney Red Gum, Smooth-barked Apple											X
		Angophora floribunda	Rough-barked Apple											X
		Angophora subvelutina	Broad-leaved Apple								X			
		Callistemon citrinus	Scarlet Bottlebrush											
		Callistemon linearis	Narrow-leaved Bottlebrush			1			1		X		X	
		Callistemon salignus	White Bottlebrush, Pink-tips											X
	†	*Corymbia citriodora*	Lemon-scented Gum											X
		Corymbia eximia	Yellow Bloodwood											X
		Corymbia maculata	Spotted Gum							X				X
		Eucalyptus amplifolia	Cabbage Gum											X
		Eucalyptus botryoides	Bangalay											X
	†	*Eucalyptus camaldulensis*	River Red Gum											X
		Eucalyptus crebra	Narrow-leaved Ironbark											X
		Eucalyptus fibrosa	Red Ironbark											X
		Eucalyptus longifolia	Woollybutt											X
	†	*Eucalyptus microcorys*	Tallowwood											X
		Eucalyptus moluccana	Grey Box											X
		Eucalyptus parramattensis	Parramatta Red Gum	7		5		2		X	X	X		X

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
		Eucalyptus punctata	Grey Gum											X
		Eucalyptus racemosa	Snappy Gum, Scribbly Gum											X
	†	*Eucalyptus saligna*	Sydney Blue Gum							X				X
		Eucalyptus saligna x botryoides			15									
		Eucalyptus sclerophylla	Hard-leaved Scribbly Gum	7		5	10		30	X	X	X		X
		Eucalyptus sideroxylon	Mugga, Red Ironbark											X
		Eucalyptus tereticornis	Forest Red Gum							X				X
		Kunzea ambigua	Tick-bush			5			30	X		X	X	
		Leptospermum juniperinum	Prickly Tea-tree											
		Leptospermum parvifolium	Small-leaved Tea-tree				1						X	
	†	*Leptospermum petersonii*	Lemon-scented Tea-tree											
		Leptospermum polygalifolium	Tantoon								X			
		Leptospermum trinervium	Slender Tea-tree	5			2						X	
	†	*Lophostemon confertus*	Brush Box											X
		Melaleuca armillaris	Bracelet Honey-myrtle							X				
		Melaleuca decora	White Cloud Tree	4						X	X	X		X
		Melaleuca erubescens		1									X	
		Melaleuca linariifolia	Flax-leaved Paperbark			1		40		X	X		X	
		Melaleuca nodosa	Ball Honey-myrtle	6		2	5				X	X	X	
		Melaleuca quinquenervia	Broad-leaved Paperbark							X				
		Melaleuca thymifolia	Thyme Honey-myrtle	1			8							
		Syncarpia glomulifera	Turpentine											X

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
Nyctaginaceae	*	*Bougainvillea cv. (unidentified)*	Bougainvillea											X
Oleaceae	*	*Ligustrum sinense*	Small-Leaved Privet, Chinese Privet		2					X				
		Notelaea longifolia	Mock-olive							X				
	*	*Olea europaea* subsp. *cuspidata*	African Olive		1									
Pittosporaceae		*Billardiera scandens*	Hairy Apple Berry			1						X		
		Bursaria spinosa	Boxthorn			3								
		Pittosporum undulatum	Pittosporum									X		
Plantaginaceae	*	*Plantago lanceolata*	Plantain, Ribwort							X				
Polygonaceae	*	*Acetosa sagittata*	Rambling Dock, Turkey Rhubarb											
		Persicaria decipiens	Slender Knotweed											
		Persicaria praetermissa						1						
Proteaceae		*Banksia ericifolia*	Heath-leaved Banksia											
		Banksia oblongifolia	Fern-leaved Banksia	1			2	2			X		X	
		Banksia serrata	Saw Banksia, Old Man Banksia					1			X			
		Banksia spinulosa var. spinulosa	Hairpin Banksia	8			1				X		X	
	+	*Grevillea parviflora* subsp. *parviflora*		2										
	†	*Grevillea robusta*	Silky Oak											X
		Hakea dactyloides	Finger Hakea	1			2							
		Hakea salicifolia	Willow Hakea							X				
		Hakea sericea	Needlebush, Silky Hakea	5		1	10				X	X	X	

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
		Hakea teretifolia	Needlebush, Dagger Hakea											
		Isopogon anemonifolius	Broad-leaf Drumsticks	1			1						X	
		Lambertia formosa	Mountain Devil			2								
		Lomatia silaifolia	Crinkle Bush									X		
		Persoonia lanceolata	Geebung			1	1						X	
		Persoonia laurina subsp. *laurina*	Laurel Geebung				1						X	
		Persoonia linearis	Narrow-leaf Geebung	1			1		1					
	+	*Persoonia nutans*							1				X	
		Petrophile sessilis				1	10							
Ranunculaceae		*Clematis aristata*	Traveller's Joy, Old Man's Beard		2									
		Clematis glycinoides	Headache Vine, Traveller's Joy								X			
		Ranunculus inundatus	River Buttercup					1				X		
Rhamnaceae		*Pomaderris ferruginea*									X			
Rosaceae	*	*Rubus discolor*	Blackberry					1			X	X		
		Rubus parvifolius	Native Raspberry											
Rubiaceae		*Morinda jasminoides*	Morinda		1									
		Opercularia varia	Variable Stinkweed			1	1		1					
		Pomax umbellata	Pomax			1	1		1					
	*	*Richardia humistrata*												
Rutaceae		*Philotheca salsolifolia*	Philotheca				1							
Santalaceae		*Exocarpos cupressiformis*	Cherry Ballart, Native Cherry		2					X				
Sapindaceae	*	*Cardiospermum grandiflorum*	Balloon Vine											

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
Solanaceae	*	*Lycium ferocissimum*	African Boxthorn											
	*	*Solanum nigrum*	Blackberry Nightshade											
Stylidiaceae		*Stylidium graminifolium*	Grass-leaf Triggerplant	1			1							
Thymelaeaceae		*Pimelea linifolia*	Slender Rice Flower	1			1		1				X	
Verbenaceae	*	*Lantana camara*	Lantana		2									
	*	*Verbena bonariensis*	Purpletop											
	*	*Verbena rigida*	Veined Verbena							X				

Angiosperms: Monocotyledons

Agavaceae	*	*Agave americana*	Century Plant, American Aloe											
Alismataceae		*Alisma plantago-aquatica*	Water-plantain											
Alliaceae	*	*Agapanthus praecox* subsp. *orientalis*	Agapanthus											
Anthericaceae		*Laxmannia gracilis*	Slender Wire Lily											
Asparagaceae	*	*Asparagus aethiopicus*	Asparagus Fern		1									
	*	*Asparagus asparagoides*	Bridal Creeper, Florists' Smilax		2									
Asphodelaceae	*	*Aloe maculata*	Common Soap Aloe											
Colchicaceae		*Burchardia umbellata*	Milkmaids											
Commelinaceae	*	*Tradescantia fluminensis*	Wandering Jew											
Cyperaceae		*Baumea articulata*	Jointed Twig-rush								X			
		Baumea sp.						2						
		Bolboschoenus fluviatilis	Club-rush					1						

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
		Carex appressa	Tall Sedge					1				X		
		Carex breviculmis												
		Chorizandra cymbaria	Heron Bristle-rush							X				
		Cyathochaeta diandra		5		1	5	1				X	X	
		Cyperus brevifolius				1		2						
	*	*Cyperus eragrostis*	Drain Flat-sedge, Umbrella Sedge					1						
		Fimbristylis dichotoma				1								
		Fimbristylis ferruginea												
		Gahnia clarkei	Tall Saw-sedge		1						X			
		Gahnia sp.					1					X	X	
		Isolepis inundata	Water Club-rush					1						
		Lepidosperma laterale	Variable Sword-sedge			1						X		
		Ptilothrix deusta		20			1							
		Schoenus apogon	Fluke Bog-rush, Common Bog-rush											
Iridaceae		*Patersonia sericea*	Native Iris, Silky Purple-flag	5		2								
Juncaceae	*	*Juncus cognatus*	Argentine Rush											
		Juncus continuus	Rush											
		Juncus prismatocarpus	Branching Rush											
		Juncus usitatus	Common Rush			3				X		X		
Lomandraceae		*Lomandra cylindrica*	Needle Mat-rush			1								
		Lomandra longifolia	Spiny-headed Mat-rush	1		1			1			X	X	
		Lomandra multiflora	Many-flowered Mat-rush	1		1								

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
Orchidaceae		*Pterostylis acuminata*	Sharp Greenhood Orchid									X		
Philydraceae		*Philydrum lanuginosum*	Woolly Waterlily, Frogmouth							X				
Phormiaceae		*Dianella caerulea*	Blue Flax-lily	1	1	1	1	1	2		X		X	
		Dianella revoluta	Blue Flax-lily, Spreading Flax-lily						1					
Poaceae	*	*Andropogon virginicus*	Whisky Grass							X				
		Aristida ramosa	Wiregrass	1					5				X	
		Aristida vagans	Threeawn Speargrass			2	1							
		Aristida warburgii	Wiregrass						2					
	*	*Arundo donax*	Giant Reed											
		Austrodanthonia fulva	Wallaby Grass						2			X		
		Austrostipa pubescens	Speargrass	10		2	10							
		Austrostipa ramosissima	Bamboo Speargrass		3									
		Austrostipa rudis							2					
		Bothriochloa macra	Redleg Rass											
	*	*Briza subaristata*												
	*	*Chloris gayana*	Rhodes Grass					1			X			
	*	*Cortaderia selloana*	Pampas Grass											
		Cynodon dactylon	Couch, Bermuda Grass			1				X				
	*	*Dactylis glomerata*	Cocksfoot, Cocksfoot Grass											
	*	*Digitaria sanguinalis*	A Summer Grass, Crab Grass											
		Digitaria sp.							1					
		Echinopogon ovatus	Forest Hedgehog Grass			1					X			

Family		Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
	*	*Ehrharta erecta*	Panic Veld-grass		30									
		Entolasia marginata	Bordered Panic		1									
		Entolasia stricta	Wiry Panic	2		2	1	1	2		X	X	X	
		Eragrostis brownii	Brown's Lovegrass						1	X				
	*	*Eragrostis curvula*	African Lovegrass		1	1			1	X	X		X	
		Eragrostis leptostachya	Paddock Lovegrass	1		2								
		Hemarthria uncinata	Mat Grass					2		X				
		Imperata cylindrica	Blady Grass					10			X			
		Microlaena stipoides	Weeping Grass, Meadow Rice-grass	1	20	1		15	5		X	X	X	
		Oplismenus aemulus	Broad-leaved Basket Grass		1									
		Panicum simile	Two-colour Panic	2		1	1					X		
		Paspalidium distans								X	X			
	*	*Paspalum dilatatum*	Paspalum											
	*	*Paspalum urvillei*	Vasey Grass							X				
	*	*Pennisetum clandestinum*	Kikuyu Grass											
	*	*Phyllostachys aurea*	Yellow Bamboo											
		Poa sp.		1						X				
	*	*Setaria gracilis*	Slender Pigeon Grass			3		10		X	X			
	*	*Setaria parviflora*												
	*	*Sporobolus africanus*	Rat-tail Grass, Parramatta Grass											
		Themeda australis	Kangaroo Grass	10		2	5				X		X	
Restionaceae		*Leptocarpus tenax*					1	2			X			

Family	Botanical name	Common name	Q1	Q2	Q3	Q4	Q5	Q6	T1	T2	T3	T4	SIMTA trees
	Lepyrodia scariosa					1							
Typhaceae	*Typha orientalis*	Broad-leaf Cumbungi, Bulrush					2		X				
Xanthorrhoeaceae	*Xanthorrhoea media*	Grass Tree	5		1	1	1				X	X	

APPENDIX 3

FAUNA SPECIES INVENTORY

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General Status	
*	Exotic/introduced species
(?)	Uncertain identification
P	Protected
U	Unprotected

Conservation Status	
CE	Critically Endangered - listed under Schedule 1A of the TSC Act
E	Endangered - listed under Schedule 1 of the TSC Act
V	Vulnerable - listed under Schedule 2 of the TSC Act

Observation Type			
Fl	Flying over the site	Hp	Harp
Vi	Visual observation	El	Elliot
Au	Aural (call recognition)	An	Anabat
Ul	Ultrasonic call recognition (Anabat)	Cg	Cage
Sc	Scat or scent	CP	Call Playback
T	Tracks	Pt	Pittfalls
Scr	Scratch marks on tree trunks or other	A	Anecdotal
D	Diggings	E	Eggs or juvenille morphs
N	Nest	F	Fur or feathers
B	Burrow	H	Hollows (in trees, trunks or other)

Status	Group	Scientific Name	Common Name	Obs Type	Certainty
P	Amphibian	*Crinia signifera*	Common Eastern Froglet	Au	
P	Amphibian	*Litoria fallax*	Dwarf Tree Frog	Au	
*	Bird	*Acridotheres tristis*	Indian Myna	Vi	
P	Bird	*Anas superciliosa*	Pacific Black Duck	Vi	
P	Bird	*Anthochaera carunculata*	Red Wattlebird	Au	
P	Bird	*Cacatua galerita*	Sulphur-crested Cockatoo	Au	
P	Bird	*Cacatua roseicapilla*	Galah	Vi	

P	Bird	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	Au	
P	Bird	*Calyptorhynchus funereus*	Yellow-tailed Black Cockatoo	Vi	
P	Bird	*Chenonetta jubata*	Australian Wood Duck	Vi	
P	Bird	*Coracina novaehollandiae*	Black-faced Cuckoo Shrike	Au	
P	Bird	*Corcorax melanorhamphos*	White-winged Chough	Vi	
P	Bird	*Corvus coronoides*	Australian Raven	Vi	
P	Bird	*Cracticus torquatus*	Grey Butcherbird	Au	
P	Bird	*Dacelo novaeguineae*	Laughing Kookaburra	Au	
P	Bird	*Egretta novaehollandiae*	White-faced Heron	Vi	
P	Bird	*Eopsaltria australis*	Eastern Yellow Robin	Au	
P	Bird	*Gallinula tenebrosa*	Dusky Moorhen	Vi	
P	Bird	*Gerygone mouki*	Brown Gerygone	Au	
P	Bird	*Grallina cyanoleuca*	Magpie Lark	Vi	
P	Bird	*Gymnorhina tibicen*	Australian Magpie	Vi	
P	Bird	*Hirundo neoxena*	Welcome Swallow	Vi	
P	Bird	*Malurus cyaneus*	Superb Fairy Wren	Vi	
P	Bird	*Manorina melanocephala*	Noisy Miner	Vi	
P	Bird	*Manorina melanophrys*	Bell Miner	Au	
P	Bird	*Neochmia temporalis*	Red-browed Finch	Vi	
P	Bird	*Ocyphaps lophotes*	Crested Pigeon	Vi	
P	Bird	*Pachycephala pectoralis*	Golden Whistler	Au	
P	Bird	*Pardalotus punctatus*	Spotted Pardelote	Au	
P	Bird	*Phalacrocorax melanoleucos*	Little Pied Comorant	Vi	
P	Bird	*Platycercus elegans*	Crimson Rosella	Vi	
P	Bird	*Platycercus eximius*	Eastern Rosella	Vi	
P	Bird	*Porphyrio porphyrio*	Purple Swamphen	Vi	
P	Bird	*Psephotus haematonotus*	Red-rumped Parrot	Vi	
P	Bird	*Psophodes olivaceus*	Eastern Whipbird	Au	
P	Bird	*Pycnonotus jocosus*	Red-whiskered Bulbul	Vi	
P	Bird	*Rhipidura leucophrys*	Willie Wagtail	Vi	
P	Bird	*Strepera graculina*	Pied Currawong	Au	
P	Bird	*Trichoglossus haematodus*	Rainbow Lorikeet	Vi	
P	Bird	*Vanellus miles*	Masked Lapwing	Vi	
*	Mammal	*Canis lupus familiaris*	Dog	T	
P	Mammal	*Chalinolobus gouldii*	Gould’s Wattled Bat	An	C
P	Mammal	*Chalinolobus morio*	Chocolate Wattled Bat	An	C

*	Mammal	*Felis catus*	Cat	Vi	
*	Mammal	*Lepus capensis*	Brown Hare	Vi	
P	Mammal	*Macropus sp.*	Kangaroo	T	
V	Mammal	*Miniopterus schreibersii oceanensis*	Eastern Bent-wing Bat*	An	C
P	Mammal	*Mormopterus sp.*	Free-tail Bat	An	C
V	Mammal	*Myotis macropus*	Southern Myotis*	An	Po
P	Mammal	*Nyctophilus sp.*	Unidentified Long-eared Bat	An	Po
P	Mammal	*Pseudocheirus peregrinus*	Ringtail Possum	Vi	
V	Mammal	*Pteropus poliocephalus*	Grey-headed Flying Fox	Vi	
P	Mammal	*Tachyglossus aculeatus*	Echidna	Vi	
P	Mammal	*Tadarida australis*	White-striped Mastiff Bat	An	C
P	Mammal	*Vespadelus vulturnus*	Little Forest Bat	An	C
*	Mammal	*Vulpes vulpes*	Fox	Vi	
P	Reptile	*Lampropholis sp.*	Skink	Vi	
P	Reptile	*Pseudechis porphyriacus*	Red-bellied Black Snake	Vi	
P	Reptile	*Pseudonaja textilis*	Eastern Brown Snake	Vi	
P	Fish	*Anguilla australis*	Short-finned Eel	Vi	
*	Fish	*Gambusia holbrooki*	Gambusia	Vi	
P	Fish	*Philypnodon grandiceps*	Flathead Gudgeon	Vi	

APPENDIX 4

EPBC ACT PROTECTED MATTERS REPORT

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 17/07/12 12:53:54

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	4
Threatened Species:	44
Migratory Species:	16

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	16
Commonwealth Heritage Places:	6
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

Place on the RNE:	26
State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	18
Nationally Important Wetlands:	2

Details

Matters of National Environmental Significance

Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered	Community likely to occur within area
Shale/Sandstone Transition Forest	Endangered	Community likely to

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
		occur within area
Turpentine-Ironbark Forest in the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community may occur within area

Threatened Species [Resource Information]

Name	Status	Type of Presence
BIRDS		
Anthochaera phrygia Regent Honeyeater [82338]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Vulnerable	Species or species habitat likely to occur within area
Sternula nereis nereis Fairy Tern (Australian) [82950]	Vulnerable	Species or species habitat may occur within area
FISH		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
FROGS		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog [1828]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Mixophyes balbus		
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
MAMMALS		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Isoodon obesulus obesulus		
Southern Brown Bandicoot (Eastern) [68050]	Endangered	Species or species habitat may occur within area
Petrogale penicillata		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pseudomys novaehollandiae		
New Holland Mouse [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
PLANTS		
Acacia pubescens		
Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat likely to occur within area
Asterolasia elegans		
[56780]	Endangered	Species or species habitat likely to occur within area
Caladenia tessellata		
Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cynanchum elegans		
White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Deyeuxia appressa		
[7438]	Endangered	Species or species habitat likely to occur within area
Grevillea parviflora subsp. parviflora		
Small-flower Grevillea [64910]	Vulnerable	Species or species habitat likely to occur within area
Hibbertia sp. Bankstown (R.T.Miller & C.P.Gibson s.n. 18/10/06)		
[81969]	Critically Endangered	Species or species habitat likely to occur within area
Melaleuca biconvexa		
Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Melaleuca deanei		
Deane's Melaleuca [5818]	Vulnerable	Species or species habitat likely to occur within area
Pelargonium sp. Striatellum (G.W.Carr 10345)		
Omeo Stork's-bill [84065]	Endangered	Species or species habitat may occur within area
Persoonia nutans		
Nodding Geebung [18119]	Endangered	Species or species habitat likely to occur within area
Pimelea curviflora var. curviflora		
[4182]	Vulnerable	Species or species habitat likely to occur within area
Pimelea spicata		
[20834]	Endangered	Species or species habitat known to occur within area
Pomaderris brunnea		
Rufous Pomaderris [16845]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis gibbosa		
Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat known to occur within area
Pterostylis saxicola		
Sydney Plains Greenhood [64537]	Endangered	Species or species habitat known to occur within area
Pultenaea parviflora		
[19380]	Vulnerable	Species or species habitat likely to occur within area
Streblus pendulinus		
Siah's Backbone, Sia's Backbone, Isaac Wood [21618]	Endangered	Species or species habitat likely to occur within area
Thelymitra sp. Kangaloon (D.L.Jones 18108)		
Kangaloon Sun-orchid [81971]	Critically Endangered	Species or species habitat may occur within area
REPTILES		
Hoplocephalus bungaroides		
Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area

Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Marine Species		
Lamna nasus		
Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		

Name	Threatened	Type of Presence
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus		
White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Breeding likely to occur within area
Neophema chrysogaster		
Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Breeding may occur within area
Xanthomyza phrygia		
Regent Honeyeater [430]	Endangered*	Species or species habitat likely to occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands	[Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Australian Telecommunications Corporation
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Director of War Service Homes
Commonwealth Land - Telstra Corporation Limited
Defence - CAMP SAPPER-EAST HILLS (Lot 2) : CAMP SAPPER TRAINING AREA (Lot 1)
Defence - EAST HILLS BARRACKS - OP SAFE HAVEN
Defence - INGLEBURN AREA (Bardia Barracks)
Defence - MOOREBANK AREA INC SME
Defence - Suite 8, Library Plaza

Name
Defence - VILLAWOOD - MOTOR REPAIR W/SHP (VILLAWOOD GEMS BASE)
Defence - WET BRIDGING SITE - CASULA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Indigenous		
Cubbitch Barta National Estate Area	NSW	Listed place
Historic		
Defence National Storage and Distribution Centre	NSW	Listed place
Ingleburn Army Camp	NSW	Listed place
Old Army / Internment Camp Group Holsworthy	NSW	Listed place
Prefabricated Cottages Ingleburn Village	NSW	Listed place
Bankstown Airport Air Traffic Control Tower	NSW	Nominated place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Breeding may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Georges River Wetlands	NSW	Indicative Place
Voyager Point	NSW	Registered
Indigenous		
Cubbitch Barta National Estate Area	NSW	Registered
Historic		
Bankstown Airport	NSW	Indicative Place
Fairfield Fire Station	NSW	Indicative Place
Liverpool Fire Station	NSW	Indicative Place
Defence National Storage and Distribution Centre	NSW	Interim List
Bernera including Site and Knoll	NSW	Registered
Collingwood	NSW	Registered
Denham Court and St Marys Anglican Chapel	NSW	Registered
Glenfield Farm	NSW	Registered
Horningsea Park	NSW	Registered
Hoxton Park Airport	NSW	Registered
Ingleburn Army Camp	NSW	Registered
Kitchener House	NSW	Registered
Lansdowne Bridge	NSW	Registered
Liverpool Courthouse (former)	NSW	Registered
Liverpool Dam	NSW	Registered
Liverpool Hospital (former)	NSW	Registered
Macquarie Field Garden	NSW	Registered
Macquarie Field House	NSW	Registered
Old Army / Internment Camp Group Holsworthy	NSW	Registered
Prefabricated Cottages Ingleburn Village	NSW	Registered
St Lukes Anglican Church	NSW	Registered
The Homestead	NSW	Registered
The Homestead	NSW	Registered

State and Territory Reserves [Resource Information]

Name	State
Georges River	NSW
Leacock	NSW

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit,

Name	Status	Type of Presence
Frogs		
Bufo marinus		
Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		

Name	Status	Type of Presence
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat may occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Liverpool Military Training Area	NSW
Voyager Point	NSW

Coordinates

-33.95444 150.9263

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX 5

COMMONWEALTH SPECIES AND COMMUNITIES OF CONCERN

Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest

Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest is listed as a critically endangered ecological community under the EPBC Act.

- **information on the abundance, distribution, ecology and habitat preferences of the species or communities**

Cumberland Plain Woodland and Shale-Gravel Transition Forest occurs in the Sydney Basin bioregion and is restricted to the Cumberland Plain. The community is associated with clay soils derived from Wianamatta Group geology.

Cumberland Plain Woodland and Shale-Gravel Transition Forest incorporates grassy eucalypt shale hills and plains woodlands and shale-gravel transition forests. The tree canopy is typically dominated by *Eucalyptus moluccana* (Grey Box), *E. tereticornis* (Forest Red Gum) and/or *E. fibrosa* (Red Ironbark). Ground layer vegetation consists of a mixture of native grasses and herbs.

The community is currently known to occur across western Sydney, within the local government areas of Auburn, Bankstown, Baulkham Hills, Blacktown, Camden, Campbelltown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta, Penrith and Wollondilly. In 2009, the ecological community occupied a maximum area of approximately 12 300 hectares (ha) but is highly fragmented across its distribution, with most occurrences small remnants, mostly under 10 ha in size (Threatened Species Scientific Committee, 2008).

- **discussion of the known threats to the species or communities with reference to threats posed by the proposed action**

The conservation advice for Cumberland Plain Woodland and Shale-Gravel Transition Forest identifies the main and ongoing threats to Cumberland Plain Woodland as clearing for industrial or rural development, consequent fragmentation of remnants, inappropriate grazing and fire regimes, weed invasion and low level of protection in reserves. Vegetation clearance is considered to be the major contributor to the loss and fragmentation of native vegetation across the Cumberland Plain. The proposed action will require clearing of native vegetation; none of the vegetation to be cleared was identified as Cumberland Plain Woodland and Shale-Gravel Transition Forest.

- **details of surveys for these species and communities and their habitat in the proposed action area or surrounding areas. This should include details of survey effort, timing, location and methodologies for studies and surveys undertaken and the regional status, population size and distribution within the area surrounding the proposed action identified for these species and communities. Survey methodology must have regard to any relevant publicly available guidance issued by the department;**

There have been numerous vegetation surveys and regional mapping projects on the Cumberland Plain (Benson 1992, NPWS 2002, Tozer 2003, DECCW 2009). NPWS (2002)/Tozer (2003) mapped the native vegetation of the Cumberland Plain at a 1:16 000 scale, based on aerial photograph interpretation, mapped geological boundaries and field sampling. Three of the mapped communities are equivalent to Cumberland Plain Woodland and Shale-Gravel Transition Forest: Shale Plains Woodland, Shale Hills Woodland and Shale-Gravel Transition Forest. The communities are mapped in the locality (within 5 kilometres) of the study area (Table 40), but none were mapped within the study area.

Table 40: Cumberland Plain Woodland mapped in the locality of the study area

Vegetation Communities equivalent to CPW	Total area (>10% canopy cover) mapped on Cumberland Plain (ha)	Total area (>10% canopy cover) mapped within 5km of study area (ha)
Shale Plains Woodland	6732	266
Shale Hills Woodland	4309	4
Shale-Gravel Transition Forest	1721	358
Total	**12762**	**628**

A comprehensive vegetation assessment was undertaken as part of terrestrial flora and fauna surveys in the study area. The structure and floristics of the plant communities present in the study area were sampled using eight 400 m^2 quadrats. Vegetation communities were mapped based on desktop analysis and ground truthing of published soil, geology and vegetation maps, interpretation of aerial photographs, data on vegetation structure and floristics collected in vegetation quadrats and site observations. Comparison of vegetation data with the Tozer (2003) diagnostic species for each vegetation unit was also undertaken. Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest was not identified within the study area; vegetation communities were more typical of soils derived from Tertiary Alluvium, with Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland recorded in the rail corridor.

- **an assessment of the quality and importance or potential habitat for these species and communities in the proposed action area and surrounding areas;**

There is no potential habitat for Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest within the proposed action area. There are mapped areas of equivalent communities in the locality, with large contiguous patches to the south of the study area in the Holsworthy Training Area and smaller fragmented patches in the more developed areas west of the Glenfield Waste Disposal site.

- **the presence of formal or informal conservation reserves for these species or communities within the proposed action area or surrounding areas;**

Approximately 10 hectares of Shale Plains Woodland were mapped within Leacock Regional Park, adjoining the Main Southern railway line to the west of the study area.

Large areas of Shale-Gravel Transition Forest and Shale Hills Woodlands have been mapped to the south of the study area in the Holsworthy Training Area, which functions as an informal conservation area. This area has been identified as part of the Priority Conservation Lands in the Cumberland Plain Recovery Plan (DECCW 2011).

- **for all species and communities that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate impacts of the species are unlikely to occur;**

There is no potential habitat for Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest within the proposed action area. The community occurs on shale-derived soils, which do not underlie the study area. Mapped areas of the community to the west and south of the study area will not be impacted by the proposed action.

- **discussion of the potential impacts on the above species and communities of pest species, disease and fire outbreaks generated by the proposed action;**

Weed invasion is considered a threat to Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest, with a range of weed species occurring in the community including perennial

grasses, pasture weeds, vines and scramblers and woody shrubs. African Olive (*Olea europaea* subsp. *cuspidata*) and Bridal Creeper (*Asparagus asparagoides*) have been identified as particularly significant weeds as they appear able to suppress understorey species. African Olive was observed to be widespread in the River-flat Eucalypt Forest adjoining the Georges River in the study area, but it is considered unlikely that the SIMTA proposal will encourage the spread of this species, particularly to areas of Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest which are not contiguous with the vegetation in the study area.

Fire and its frequency can affect the structure and composition of the ecological community, particularly the understorey component. The proposed action is unlikely increase the frequency of fire in the locality.

- **consideration of each species or community must have regard to any recovery plan prepared by the Commonwealth, NSW or other State government, in relation to the species and any publically available policy statement or conservation advice approved by the minister in relation to the species or community**

DECCW (2011) prepared the Cumberland Plain Recovery Plan, focusing on the threatened species, populations and ecological communities that are endemic to or primarily distributed on the Cumberland Plain. Cumberland Plain Woodland is one of the threatened ecological communities addressed in the recovery plan.

DECCW (2011) has identified approximately 25,566 hectares of Priority Conservation Lands (PCLs), representing the best opportunities in the region to secure long-term viable conservation outcomes. The recovery plan identifies the current extent Cumberland Plains Shale Woodlands and Shale-Gravel Transition Forest consistent with the EPBC Act listing for the community as approximately 10,726 hectares, of which 5,045 hectares is located within the Priority Conservation Lands.

The native vegetation in and to the south of the study area has been mapped as part of the Cumberland Plain Priority Conservation Lands, a 2,314 hectare area extending across the Holsworthy Military Area.

Green and Gold Bell Frog (*Litoria aurea*)

The Green and Golden Bell Frog (*Litorea aurea*) is listed as an Endangered species under the TSC Act, and a Vulnerable species under the EPBC Act.

- **information on the abundance, distribution, ecology and habitat preferences of the species or communities**

The Green and Golden Bell Frog is found along coastal lowland areas of eastern NSW and Victoria, from Yuraygir National Park near Grafton in northern NSW to Lake Wellington, in south-eastern Victoria, to the south. Green and Golden Bell Frog populations are also known from three offshore islands: Bowen Island in Jervis Bay; Kooragang Island and Broughton Island north of Port Stephens (DSEWPC 2012a). The former distribution of the species has contracted to eight known locations in the Sydney Region: Homebush Bay/Sydney Olympic Park; Kurnell; Greenacre (Upper Cooks River); Clyde/Rosehill (Parramatta River); Merrylands (Parramatta River); St Marys/Mt Druitt/Riverstone; Arncliffe/Lower Cooks River and Hammondville (Georges River) (DECC 2008b).

In NSW, the Green and Golden Bell Frog has been found in a wide range of water bodies that are still, shallow, ephemeral, unpolluted; however, the species has been found in polluted habitats. This includes marshes, dams, stream sides and disturbed sites, including abandoned mines and quarries. The species is not found in fast flowing streams. Optimum habitat includes water bodies which are unshaded with emergent aquatic vegetation (bullrushes *Typha spp.* or spikerushes *Eleocharis spp*), that are free of predatory Mosquito Fish (*Gambusia holbrooki*). Diurnal sheltering and foraging sites comprise of grasses, tussock vegetation and emergent sedges, rock piles, ground timber, crevices in the ground, plant root systems and ground debris adjacent to the water body (NPWS 1999b, DSEWPC 2012a).

The Green and Golden Bell Frog is known to breed during late winter to early autumn, but generally during September–February with a peak around January–February after heavy rain or storms. Breeding habitat in NSW includes water bodies that are still, shallow, ephemeral, unpolluted. Spawn is laid among aquatic vegetation (DSEWPC 2012a). Ephemeral swale habitat that supports plant species such as *Juncus spp., Schoenoplectus spp., Isolepis spp.* and *Baumea spp*, may also provide breeding habitat (DECC 2008b).

The Green and Golden Bell Frog is highly mobile and may move between breeding sites, however, dispersal patterns can vary between populations. The species is capable of moving long distances in a single day or night of up to one kilometre; some individuals have been recorded travelling up to three kilometres on one night. Movements of up to five kilometres may be common, and the frog may possibly disperse as far as 10 kilometres, and may occasionally be found several hundred metres from major drainage lines or other waterbodies (NPWS 1999b, DSEWPC 2012a).

- **discussion of the known threats to the species or communities with reference to threats posed by the proposed action**

Known threats to the Green and Golden Bell Frog (DSEWPC 2012a) include:

- habitat removal
- habitat degradation (which includes siltation, changes to aquatic vegetation diversity or structure reducing shelter, increased light and noise, grazing, mowing, fire)
- habitat fragmentation
- reduction in water quality and hydrological changes (for example, pollution, siltation erosion and changes to timing, duration or frequency of flood events)
- disease (for example, infection of the frog with chytrid fungus (*Batrachochytrium dendrobatidis*) resulting in chytridiomycosis)

- predation (for example, by the introduced Mosquito Fish (*Gambusia holbrooki*), Cats (*Felis catus*) or Foxes (*Vulpes vulpes*))
- introduction or intensification of public access to Green and Golden Bell Frog habitats
- **details of surveys for these species and communities and their habitat in the proposed action area or surrounding areas. This should include details of survey effort, timing, location and methodologies for studies and surveys undertaken and the regional status, population size and distribution within the area surrounding the proposed action identified for these species and communities. Survey methodology must have regard to any relevant publicly available guidance issued by the department;**

Targeted diurnal and nocturnal surveys for this species, including habitat searches, spotlighting and call-playback, did not identify Green and Golden Bell Frogs within the study area.

There are 30 records of the Green and Golden Bell Frog within 10 kilometres of the study area (OEH 2012a), dated between 1963 and 1999, including the Georges River population at Hammondville (Table 41). This population is located approximately 3.5 kilometres east of the study area and is known to occupy the wetlands associated with the lower Georges River floodplain. The species has been found to inhabit the wetlands, water bodies and ponds that are interspersed amongst green space (such as golf courses and playing fields), residential development and major transport and infrastructure routes (DECC 2008b). This population was considered extant in 2009 (DSEWPC 2012a); however, this population has apparently undergone severe declines in recent years and its current status is likely precarious (DEC 2005e).

Table 41: Locations and status of Georges River populations of Green and Golden Bell Frog

Population	Location	Status
Georges River	Hammondville	Extant
Georges River	Holsworthy	Probably Extinct
Georges River	Liverpool	Probably Extinct

Parsons Brinckerhoff (2006) undertook targeted diurnal and nocturnal surveys for this species at the end of the summer breeding season during periods of rain at Glenfield Creek. Glenfield Creek flows into the Georges River approximately 200 metres north of the study area. These surveys did not find any evidence of the species, and it was stated in the assessment that there were no recent records of Green and Golden Bell Frog near Leacock Regional Park. Parsons Brinckerhoff (2006) also recorded Mosquito fish in Glenfield Creek. The likelihood of the species to occur in the study area for the proposed Moorebank Intermodal Freight Terminal was assessed in August 2011. This area consists of the Moorebank and Steele Barracks, adjacent to the SIMTA proposal. The assessment concluded that “Marginal habitat and local records in Holsworthy area however local population considered likely to be extinct (White & Pyke 2010). Not detected despite targeted surveys conducted in ideal conditions” (Parson Brinckerhoff 2011).

- **an assessment of the quality and importance or potential habitat for these species and communities in the proposed action area and surrounding areas;**

The study area supports marginal habitat for the species; water in Anzac Creek is static and shallow; small pools were heavily vegetated with floating and emergent macrophytes such as

Typha sp. and *Salvinia molesta*; the creek is mostly unshaded; and potential sheltering and foraging sites such as grasses, ground timber and ground debris occur in proximity to the creek banks. Formalised drainage channels in the south-east of the SIMTA site that support aquatic and fringing vegetation, such as *Typha* may also provide potential habitat. While the study area supports some preferred habitat features, Mosquito fish (*Gambusia holbrooki*), a predator of tadpoles, was recorded in Anzac Creek.

- **the presence of formal or informal conservation reserves for these species or communities within the proposed action area or surrounding areas;**

There are no formal conservation reserves for the Green and Golden Bell Frog in the proposed action area or surrounding areas. The Georges River key population is located nine kilometres west southwest of the Sydney central business district and approximately 3.5 kilometres east of the study are. This population on the lower Georges River occurs in several locations, including in proximity to the wetlands at Hammondville, at Holsworthy and East Hills, and along Prospect Creek and Orphan School Creek. The population occurs on public and privately-owned land, including council reserves, Commonwealth lands (military areas) and some golf courses (DECC 2008b).

- **for all species and communities that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate impacts of the species are unlikely to occur;**

While the SIMTA proposal study area supports some preferred habitat features, the presence of Mosquito fish reduces the likelihood of the species to occur in the study area. Habitat connectivity between potential habitat of the study area and known habitat of the population at Hammondville is low, reducing the likelihood of Hammondville frogs to colonise the study area. As a result, the probability of occurrence of the species in the study area was assessed as being Unlikely and further consideration of this species is not required.

Downy Wattle (*Acacia pubescens*)

- **information on the abundance, distribution, ecology and habitat preferences of the species or communities**

Acacia pubescens is restricted to the Sydney region; populations of the species have been recorded in the Bankstown, Fairfield and Rookwood area, however, the species is also known to occur within the Baulkham Hills, Hawkesbury and Liverpool LGAs.

A. pubescens typically occurs on alluviums, shales and the intergrade between shale and sandstone soil, in association with open woodland and forest communities including Cooks River Castlereagh Ironbark Forest, Shale/Sandstone Transition Forest and Cumberland Plain Woodland Endangered Ecological Communities.

The species is clonal and more commonly recruits from suckers of a parent plant rather than seed, resulting in dense patches of the species formed from one individual. Acacia species generally have high seed dormancy, however Downy Wattle may require a fire-free period of up to seven years in order to allow an adequate soil seedbank to develop.

- **discussion of the known threats to the species or communities with reference to threats posed by the proposed action**

The recovery plan for *Acacia pubescens* (NPWS 2003) identifies the following threats to the species: habitat loss due to clearing, and habitat degradation as a result of weed invasion, mechanical damage, rubbish dumping, illegal track creation, arson, horses and hybridisation.

- **details of surveys for these species and communities and their habitat in the proposed action area or surrounding areas. This should include details of survey effort, timing, location and methodologies for studies and surveys undertaken and the regional status, population size and distribution within the area surrounding the proposed action identified for these species and communities. Survey methodology must have regard to any relevant publicly available guidance issued by the department;**

Acacia pubescens was identified at 75 sites in the Urban Bushland Biodiversity Survey (UBBS) undertaken by the NPWS in 1996. An inventory of all records of *A. pubescens* was compiled prior to preparation of the recovery plan (NPWS 2003) and sites not previously surveyed for UBBS were surveyed by NPWS in 1997 to 1998. In 2003 *A. pubescens* was known from 151 sites.

A. pubescens was targeted in threatened plant searches in the study area. The species is distinctive in appearance and surveys can be conducted at any time of year (NPWS 2003). The species was not recorded in the study area; two individuals were recorded at the edge of bushland to the east of the study area.

- **an assessment of the quality and importance or potential habitat for these species and communities in the proposed action area and surrounding areas;**

The vegetation in the study area forms potential habitat for *Acacia pubescens,* however the species was not recorded here despite intensive targeted searches. The species was recorded at the edge of bushland to the east of the SIMTA site and may occur further east.

- **the presence of formal or informal conservation reserves for these species or communities within the proposed action area or surrounding areas;**

Acacia pubescens is not formally conserved at any reserves within the locality. The species is conserved at four sites in Scheyville National Park and at one site in Windsor Downs Nature Reserve in north-west Sydney.

There are few records of the species in the northern parts of Holsworthy Training Area, registered as the Cubbitch Barta National Estate Area on the Register of the National Estate, which could function as an informal conservation area for the species.

- **for all species and communities that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate impacts of the species are unlikely to occur;**

The two *A. pubescens* located to the east of the study area are separated from the proposed action by a boundary fence and powerline easement. The *A. pubescens* occur at the cleared edge of bushland and it is possible that the species occurs further east; this potential habitat will be protected from impacts by the buffer that the managed powerline easement represents.

- **discussion of the potential impacts on the above species and communities of pest species, disease and fire outbreaks generated by the proposed action;**

A. pubescens adjacent to the study area occurs on the disturbed edge of woodland habitat that adjoins cleared land containing an electricity transmission line. *A. pubescens* has been recorded in open and disturbed areas, in association with exotic species, and as a result, appears to tolerate some levels of disturbance (NPWS 2003). *E. curvula* was observed growing in proximity to *A. pubescens* where it occurs adjacent to the study area. As the species occurs outside and upslope of the study area, the species is unlikely to be adversely affected by any potential introduction and spread weeds that may result from the proposed action.

A. pubescens has been identified as a species that may be adversely affected by *Phytophthora cinnamomi,* a soil borne pathogen that infects roots and is associated with plant damage and death. *P. cinnamomi* may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of *P. cinnamomi* may also be dispersed by vehicles (e.g. cars and earth moving equipment), animals, walkers and movement of soil. No evidence of. *P. cinnamomi* was observed in the study area, but there is an increased risk of *P. cinnamomi* dispersal as a result of the proposed action. As *A. pubescens* occurs outside and upslope of the study area, the likelihood that *P. cinnamomi* could be dispersed from the study area to *A. pubescens* is low.

A. pubescens may require a fire-free period of up to seven years in order to allow an adequate soil seedbank to develop. A fire interval of less than seven years may adversely affect the soil seed bank of the species. However, the proposed action is unlikely to result in an increase in the frequency or intensity of fire.

- **consideration of each species or community must have regard to any recovery plan prepared by the Commonwealth, NSW or other State government, in relation to the species and any publically available policy statement or conservation advice approved by the minister in relation to the species or community**

NPWS (2003) prepared a recovery plan for *Acacia pubescens.* The recovery plan has been reviewed for information to support the assessment of this species.

Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)

- **information on the abundance, distribution, ecology and habitat preferences of the species or communities**

Grevillea parviflora subsp. *parviflora* is a spindly shrub varying from prostrate to erect, usually 0.3–1 m high but growing up to 1.5 to 2 m. The species has a widespread but sporadic distribution, with the main occurrence centred south of Sydney in the Appin-Wedderburn-Picton-Bargo districts, disjunct northern populations at Kurri Kurri and Heddon Greta and on the western shores of Lake Macquarie, and small populations in western Sydney at Kemps Creek and Voyager Point (NPWS 2002c).

G. parviflora subsp. *parviflora* occurs on sandy clay loam soils, often with lateritic ironstone gravels, mostly derived from Tertiary sands or alluvium and from the Mittagong Formation (NPWS 2002c).

The recorded populations of *G. parviflora* subsp. *parviflora* vary in size from single individuals to over 2000 plants. There are only four populations recorded from the Liverpool and Campbelltown LGAs; these are listed as follows in the SPRAT profile for the species (DSEWPC 2012b)(Table 36).

Table 42: *Grevillea parviflora* subsp. *parviflora* populations in the Liverpool and Campbelltown LGAs

Locality	Number of Plants
Kemps Creek, Liverpool LGA	1 (note: Wildlife Atlas records in this area from 2006 suggest there are at least 90 plants in this location)
Voyager Point, Liverpool LGA	Small
Upper Georges River, Liverpool LGA	Large
Wedderburn, Campbelltown LGA	

- **discussion of the known threats to the species or communities with reference to threats posed by the proposed action;**

The SPRAT profile for *G. parviflora* subsp. *parviflora* (DSEWPC 2012b) list six threats to the survival of the species:

1. Land clearing

Clearing for urban and agricultural development has resulted in the loss of individuals of *G. parviflora* subsp. *parviflora* as well as habitat modification including overshading, altered hydrology, grazing, mowing, dumping of fill and waste and increased soil nutrients.

The proposed action will result in the clearing of habitat and loss of individuals of *G. parviflora* subsp. *parviflora.* The proposed rail link is unlikely to have any significant overshading effect on the *G. parviflora* subsp. *parviflora* habitat; although).h the rail link will be raised above the existing ground level, it will not be high enough to cast a large shadow. It is expected that soil and water management actions will be implemented during the construction and operation of the rail corridor to prevent changes in hydrology and increases in soil nutrients in adjoining areas. The proposed action will not result in dumping of fill and waste; the population is in an area that has restricted public access and this will be maintained following construction of the project.

2. Fire control activities

G. parviflora subsp. *parviflora* is fire-killed, but can regenerate from underground rhizomes and germination of seed in the soil seed bank. High frequency fire may result in a decline in the soil seed bank and limited seedling recruitment, whereas low frequency fire may result in poor germination rates and dense growth of the shrub layer, which shades out *G. parviflora* subsp. *parviflora.*

The proposed action is unlikely increase the frequency of fire. Fire prevention and control measures undertaken as part of the operation of the intermodal terminal are more likely to decrease the frequency of fires, which could have impacts on the habitat of the *G. parviflora* subsp. *parviflora* population in the study area.

3. Habitat fragmentation

Isolation of populations through habitat fragmentation can result in reduced gene flow and low genetic diversity, which may affect the long-term viability of populations.

The proposed rail link will fragment *G. parviflora* subsp. *parviflora* habitat; a fenced gap of 35 metres will intersect areas of occupied and potential habitat to the south of Anzac Creek. Most of the population of *G. parviflora* subsp. *parviflora* recorded in the study area occurs to the east of the proposed rail link; there are only an estimated 48 stems occurring as scattered plants to the west of the rail link, compared with an estimated 2875 stems to the east of the rail link.

G. parviflora subsp. *parviflora* is considered to be gravity dispersed (Benson and McDougall 2000) and have limited natural seed dispersal (probably less than two metres) (NPWS 2002d), so even minimal clearing may act as an effective barrier to gene flow. Given that the existing disused rail line adjoining the eastern edge of the rail corridor is at least five metres in width and raised above the ground level, there is already an existing barrier within the population in the study area.

4. Weed invasion

The weedy native species *Imperata cylindrica* (Blady Grass) and *Kunzea ambigua* (Tick Bush) are considered to be a threat to *G. parviflora* subsp. *parviflora* as they can aggressively colonise disturbed areas, especially following fire, thus reducing available habitat and create barriers for the species.

Kunzea ambigua was recorded in the study area and, although locally abundant in some parts of the Castlereagh Scribbly Gum Woodland, was not dominating the shrub layer in the vicinity of the *G. parviflora* subsp. *parviflora* population. This species could aggressively colonise any areas cleared for construction operations following completion of the project.

5. Disturbance

Disturbance of habitat through clearing of edges for road widening and maintenance, slashing or mowing of easements, trail bike riding, rubbish dumping and grazing by domesticated animals can all threaten adjacent populations of *G. parviflora* subsp. *parviflora.* Any activity that impacts on the accumulation of seed in the soil seed bank, seedling germination or seedling recruitment is likely to reduce numbers.

6. Recruitment

G. parviflora subsp. *parviflora* populations appear to have low levels of seedling recruitment; most populations are large due to suckering, but the health and viability of populations is likely to be dependent on seedling recruitment, so that genetic diversity can be maintained.

- **details of surveys for these species and communities and their habitat in the proposed action area or surrounding areas. This should include details of survey effort, timing, location and methodologies for studies and surveys undertaken and the regional status, population size and distribution within the area surrounding the proposed action identified for these species and communities. Survey methodology must have regard to any relevant publicly available guidance issued by the department;**

Targeted surveys for *G. parviflora* subsp. *parviflora* in the study area were undertaken in May 2011 and July 2012. The areas of identified habitat for the species, south of Anzac Creek, were surveyed using north-south transects four metres wide, spaced 10 metres apart. GPS waypoints were recorded at points where the species occurred and the number of stems within four metre x four metre quadrats was recorded. Potential *G. parviflora* subsp. *parviflora* habitat north of Anzac Creek and adjoining the western side of Moorebank Avenue was also searched intensively, with no individuals recorded.

The Environmental Impact Assessment Guidelines for *G. parviflora* subsp. *parviflora* (NPWS 2002d) recommend that the species is best surveyed during the main flowering period between July and December, when it is easier to identify. The species was considered to be easy to detect during surveys in May and July due to its distinctive foliage and habit; there were no similar *Grevillea* species in the study area that it could be confused with. *G. parviflora* subsp. *parviflora* was recorded in high densities in some parts of the study area, and was considered highly likely to be suckering; rhizomes could not easily be seen from above ground due to soil and vegetation cover, and given the large number of stems present, no attempt was made to estimate the number of individuals in the population. The number of stems in the population in the study area was estimated based on extrapolation from the number of stems recorded in transects.

Most of the survey effort for this species detailed on the SPRAT profile has been in the Lake Macquarie and Lower Hunter Valley populations (DSEWPC 2012b). The only western Sydney survey referred to, at Kemps Creek, did not record any *G. parviflora* subsp. *parviflora.*

Parsons Brinckerhoff (2011) recorded *G. parviflora* subsp. *parviflora* on the MICL site to the north and west of the study area. The total number of individuals on the MICL site is not specified, but it is stated that at least 16 individuals with many suckers, and approximately 6.5 hectares of potential habitat, will be removed for the MICL intermodal terminal project development. This population is not included in the recovery plan.

- **an assessment of the quality and importance or potential habitat for these species and communities in the proposed action area and surrounding areas;**

Grevillea parviflora subsp. parviflora recorded in Castlereagh Scribbly Gum Woodland south of Anzac Creek in the rail corridor lands and adjoining areas to the east of the existing rail spur. A total of 1644 stems of *G. parviflora* subsp. *parviflora* were recorded from 4 metre wide transects spaced 10 metres apart; as the survey method sampled 40% of the survey area, the population estimate within the study area is approximately 4,110 stems.

The number of genetically distinct individuals is likely to be lower than this estimate given the suckering habit of this species and the localised high density of plant stems observed. The species was more widespread within the more open, grassy areas of bushland, with few plants recorded from the western parts of the rail corridor where there was a dense shrubby midlayer. The *G. parviflora* subsp. *parviflora* habitat in the study area was in relatively good condition.

The population of *G. parviflora* subsp. *parviflora* in Castlereagh Scribbly Gum Woodland to the south of Anzac Creek is considered highly significant as the population size is relatively large and there is a very low occurrence of this species in the western Sydney region.

- **the presence of formal or informal conservation reserves for these species or communities within the proposed action area or surrounding areas;**

There are no formal conservation reserves containing known records of the species in the western Sydney distribution of the species. The Holsworthy Training Area, registered as the Cubbitch Barta National Estate Area on the Register of the National Estate, also functions as an informal conservation area for *G. parviflora* subsp*. parviflora* habitat, although few records occur on these lands to date.

- **for all species and communities that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate impacts of the species are unlikely to occur;**

Not applicable. *G. parviflora* subsp*. parviflora* is expected to be impacted by the proposed action.

- **discussion of the potential impacts on the above species and communities of pest species, disease and fire outbreaks generated by the proposed action;**

The vegetation communities that constitute habitat for *P. nutans* grow on acidic, nutrient poor soil which is not highly susceptible to weed invasion, so weed invasion is not considered a major threat to populations; however a number of weed species have been observed growing in proximity to individuals, including *Opuntia* sp. (Prickly Pear), *Eragrostis curvula* (African Lovegrass) and *Andropogon virginicus* (Whiskey Grass). All three of these species were recorded in the study area and *E. curvula* was observed growing in abundance at the cleared edge of *P. nutans* habitat in the rail corridor.

Grevillea parviflora subsp. *parviflora* has been identified as a species that may be adversely affected by *Phytophthora cinnamomi,* a soil borne pathogen that infects roots and is associated with plant damage and death. *P. cinnamomi* may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of *P. cinnamomi* may also be dispersed by vehicles (e.g. cars and earth moving equipment), animals, walkers and movement of soil. No evidence of. *P. cinnamomi* was observed in the study area, but there is an increased risk of *P. cinnamomi* dispersal as a result of the proposed action. Precautionary measures are recommended during construction of the rail corridor.

The fire sensitivity of *P. nutans* is discussed above. The proposed action is unlikely to result in an increase in the frequency or intensity of fire.

- **consideration of each species or community must have regard to any recovery plan prepared by the Commonwealth, NSW or other State government, in relation to the species and any publically available policy statement or conservation advice approved by the minister in relation to the species or community**

No recovery plan has been prepared for *Grevillea parviflora* subsp. *parviflora.* OEH (2012b) has specified four priority actions to assist the recovery of this species. The listed actions are aimed at threatened species management from a conservation agency perspective and are not directly relevant to the planning and design stage of the SIMTA proposal. The priority actions are discussed in the Assessment of Significance for this species (Appendix 6).

Nodding Geebung (*Persoonia nutans*)

- **information on the abundance, distribution, ecology and habitat preferences of the species or communities;**

Persoonia nutans is an erect to spreading shrub 0.5–1.5m high, with linear leaves and hairy young branches. *P. nutans* is endemic to the Cumberland Plain where it is confined to aeolian and alluvial sediments. The species has a disjunct distribution, with the majority of the population occurring in the north of the range around Agnes Banks, Londonderry, Castlereagh and Windsor Downs, and isolated and relatively small populations found at Kemps Creek, Moorebank, Holsworthy and Voyager Point and Villawood (DEC 2006b).

Robertson *et al.* (1996) estimated the total population size at approximately 6278 plants based on counts from nine different populations. DEC (2006b) identify 25 populations (populations being distinguished on the basis of a geographic discontinuity of more than one kilometre) and state that the total number of mature individuals is likely to be greater than 5500.

As *P. nutans* is a fire sensitive obligate seeder, the species will exhibit considerable fluctuations in the number of mature individuals over time, depending upon time since fire. Recorded population sizes vary from only a few individuals to thousands of plants, although the majority of populations support a low number of plants; 64% of populations consist of less than ten mature individuals. Less than 1% of individuals occur within the southern part of the species range.

Parsons Brinckerhoff (2011) recorded *Persoonia nutans* on the MICL site to the north and west of the study area. The total number of individuals on the MICL site is not specified, but it is stated that at least 10 individuals will be removed for the MICL intermodal terminal project.

An analysis of the populations within five kilometres of the study area was undertaken with reference to information in the recovery plan, SPRAT profile and Wildlife Atlas records (Table 43)

Table 43: *Persoonia nutans* populations within five kilometres of the study area

Site code (DEC 2006b)	Location	Population size (if known)
C1a	Simmos Beach Reserve	11-50
L1a	North Holsworthy Military Area	Not stated
L2a	Pleasure Point, on track parallel and north of Heathcote Road	? – potentially extinct
L3a	Western side of Georges River at Voyager Point, north of footbridge	<10
L3b	North of East Hills military barracks at Voyager Point	<10
n/a	MICL site: patches of CSGW to west of Moorebank Road	Not known, but at least 10

The species also occurs at Kemps Creek and Villawood, in small populations (<10 individuals). All known populations of *Persoonia nutans* in the south of the species range are small in size, with no recorded populations of over 50 individuals.

P. nutans is often found at the disturbed edge of bushland and Robertson *et al.* (1996) suggested that the species requires disturbance to persist and is capable of surviving extreme disturbance; fire was probably the primary agent of disturbance in the past.

In the study area, *Persoonia nutans* was recorded in the Castlereagh Scribbly Gum Woodland north of Anzac Creek, in the rail corridor lands. A targeted search for this species recorded 126 individual plants, of which 110 occurred within the rail corridor, with 17 of those occuring within the construction footprint of the rail link. 16 occurred in adjoining lands to the east. There were two distinct sub-populations in the study area, separated by an approximately 170 metre gap. Plants ranged from 20cm to about 1.8m in height, and many individuals were observed to be flowering and/or fruiting.

The areas supporting *P. nutans* appeared to have been disturbed, with mounded earth bunds running roughly east-west. Based on observations of the historical aerial photographs, this disturbance occurred between 1950 and 1960. There was a higher density of individuals recorded at the edge of the bushland. There were also individuals of *P. nutans* observed regenerating in the transmission line easement, which is regularly slashed.

The population of *P. nutans* in the study area is considered to be significant as it is the largest population recorded in the south of the species' range, and one of only 15 known populations with over 50 mature individuals.

- **discussion of the known threats to the species or communities with reference to threats posed by the proposed action;**

The recovery plan for *P. nutans* (DEC 2006b) lists three main threats to the survival of the species:

1. Habitat loss and fragmentation

Clearing and fragmentation of habitat for *P. nutans* is one of the major threats to the survival of the species. Extensive clearing of habitat has occurred for sand and gravel extraction and for industrial and residential development. Loss of habitat has direct impacts to *P. nutans* populations through loss of individuals and indirect impacts through fragmentation of populations; habitat fragmentation can reduce the long-term viability of populations as the species is dependent on recolonisation via seed dispersal.

The proposed action will include clearing of occupied and potential habitat for *P. nutans,* resulting in the loss of individual plants and fragmentation of the remaining population as well as areas of potential habitat.

2. Inappropriate fire regimes

P. nutans is an obligate seed regenerator; plants are killed by fire and regeneration is dependent upon recruitment from a soil stored seed bank. If fires occur too frequently to allow re-establishment of the soil stored seed bank, local extinction of the species may occur. The critical fire frequencies for *P. nutans* have not been determined, but an interval of at least 7 to 10 years between fires has been recommended (DEC 2006b).A long-term absence of fire or other disturbance may also be detrimental to the persistence of *P. nutans* populations, however frequent rather than infrequent fires pose the greater threat.

The proposed action is unlikely to result in an increase in the frequency or intensity of fire. Fire prevention and control measures undertaken as part of the operation of the intermodal terminal are more likely to decrease the frequency of fires.

3. Habitat degradation and rubbish dumping related to unrestricted access

The majority of populations of *P. nutans* outside of nature reserves are subject to high levels of disturbance associated with unrestricted access. The habitat is commonly dissected by tracks, and populations have been damaged by vehicles and smothered by large quantities of rubbish (DEC 2006b).

The *P. nutans* habitat in the study area is currently fenced with no public access, and this restricted access will continue during the construction and operation of the SIMTA proposal.

- **details of surveys for these species and communities and their habitat in the proposed action area or surrounding areas. This should include details of survey effort, timing, location and methodologies for studies and surveys undertaken and the regional status, population size and distribution within the area surrounding the proposed action identified for these species and communities. Survey methodology must have regard to any relevant publicly available guidance issued by the department;**

Targeted surveys for *P. nutans* in the study area were undertaken in May 2011 and July 2012. Survey methods included detailed targeted searches of areas of potential habitat: the main areas of occupied habitat identified in general site inspections, north of Anzac Creek, were intensively searched by two ecologists walking in east-west aligned transects spaced no more than two metres apart. GPS waypoints were recorded at points where the species occurred. The species was also targeted in north-south transects spaced 10 metres apart in potential habitat south of Anzac Creek, but only one individual of the species was found in this area. The strip of potential *P. nutans* habitat adjoining the western side of Moorebank Avenue was searched intensively, with no individuals recorded.

The Environmental Impact Assessment Guidelines for *P. nutans* (DEC 2005a) recommend targeted survey should be conducted during peak flowering in summer, as the species is most easily detected when in flower. The species was considered to be easy to detect during surveys in May due to its distinctive foliage; many individuals were observed to be in flower or fruit. The guidelines also recommend that surveys of potential habitat at recently burnt or long unburnt sites may not detect the species, as it may only occur in the soil stored seed bank or as young seedlings.

P. nutans populations were surveyed in detail in 1996 during preparation of the first recovery plan for the species (Robertson *et al.* 1996). No further formal surveys of *P. nutans* populations have been undertaken; previously unrecorded populations have been located by consultants on an ad hoc basis and recorded in the NSW Wildlife Atlas, and brief surveys were conducted by DEC prior to preparation of the most recent recovery plan in 2005.

There are large areas of potential habitat for *P. nutans* mapped in the Holsworthy lands, but few records of the species in this area. One individual was recorded to the south of the study area in 1996 and there is another record in the east of the Holsworthy lands near Voyager Point from 1998. This lack of records reflects the limited targeted survey for the species in the area and the possibility that the species may not be detected by targeted survey even if present at a site given that it is an obligate seeder and the number of above ground individuals will fluctuate in space and time (DEC 2006b).

Parsons Brinckerhoff (2011) recorded *Persoonia nutans* on the MICL site to the north and west of the study area. The total number of individuals on the MICL site is not specified, but it is stated that at least 10 individuals will be removed for the IMT development. This population is not included in the recovery plan.

- **an assessment of the quality and importance or potential habitat for these species and communities in the proposed action area and surrounding areas;**

The recorded populations of *P. nutans* vary in size from a few individuals to thousands of plants, but the majority of populations support a low number of plants. Less than 1% of individuals occur within the southern part of the species range.

Persoonia nutans was recorded in the Castlereagh Scribbly Gum Woodland north of Anzac Creek in the study area. A targeted search for this species recorded 126 individual plants, of which two occurred in the cleared lands south of the SIMTA site, 106 occurred within the rail corridor north of Anzac Creek, one occurred in the rail corridor south of Anzac Creek. Seventeen of these plants occurred within the construction footprint of the rail link. Seventeen

occurred in adjoining lands to the east. Plants ranged from 20cm to about 1.8m in height, and many individuals were observed to be flowering and/or fruiting.

The areas supporting *P. nutans* appeared to have been disturbed, with mounded earth bunds running roughly east-west. Based on observations of the historical aerial photographs, this disturbance occurred between 1950 and 1960. There was a higher density of individuals recorded at the edge of the bushland. There were also individuals of *P. nutans* observed regenerating in the transmission line easement, which is regularly slashed. It is considered likely that soil and vegetation disturbance in and adjoining the habitat has encouraged germination of *P. nutans*. The habitat for *P. nutans* in the rail corridor is generally in good condition, with low incidence of exotic species.

The population of *P. nutans* in the study area is considered to be very important as it is the largest population recorded in the south of the species' range, and one of only 15 known populations with over 50 mature individuals.

- **the presence of formal or informal conservation reserves for these species or communities within the proposed action area or surrounding areas;**

There are no formal conservation reserves in the southern part of the species range. The southernmost population of *P. nutans* at Macquarie Fields is relatively protected within Simmos Beach Recreation Reserve, managed by Campbelltown City Council. The Holsworthy Training Area, registered as the Cubbitch Barta National Estate Area on the Register of the National Estate, also functions as an informal conservation area for *P. nutans* habitat, although few populations have been recorded on these lands to date.

- **for all species and communities that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate impacts of the species are unlikely to occur;**

Not applicable. *P. nutans* is expected to be impacted by the proposed action.

- **discussion of the potential impacts on the above species and communities of pest species, disease and fire outbreaks generated by the proposed action;**

The vegetation communities that constitute habitat for *P. nutans* grow on acidic, nutrient poor soil which is not highly susceptible to weed invasion, so weed invasion is not considered a major threat to populations; however a number of weed species have been observed growing in proximity to individuals, including *Opuntia* sp. (Prickly Pear), *Eragrostis curvula* (African Lovegrass) and *Andropogon virginicus* (Whiskey Grass). All three of these species were recorded in the study area and *E. curvula* was observed growing in abundance at the cleared edge of *P. nutans* habitat in the rail corridor.

Persoonia nutans has been identified as a species that may be adversely affected by *Phytophthora cinnamomi,*a soil borne pathogen that infects roots and is associated with plant damage and death. *P. cinnamomi* may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of *P. cinnamomi* may also be dispersed by vehicles (e.g. cars and earth moving equipment), animals, walkers and movement of soil. No evidence of. *P. cinnamomi* was observed in the study area, but there is an increased risk of *P. cinnamomi* dispersal as a result of the proposed action. Precautionary measures are recommended during construction of the rail corridor.

The fire sensitivity of *P. nutans* is discussed above. The proposed action is unlikely to result in an increase in the frequency or intensity of fire.

- **consideration of each species or community must have regard to any recovery plan prepared by the Commonwealth, NSW or other State government, in relation to the**

species and any publically available policy statement or conservation advice approved by the minister in relation to the species or community

A recovery plan has been prepared for *Persoonia nutans* (DEC 2006b). The overall objective of the recovery plan is "to ensure the continued and long-term survival of *P. nutans* in the wild by promoting the in situ conservation of the species across its natural range". The recovery plan has been reviewed and is the major reference source for this assessment of *P. nutans.* The SIMTA proposal is being assessed with reference to the recovery plan, environmental impact assessment guidelines and all publicly available information regarding the species. Specific recovery objectives for *P. nutans* are discussed in the Assessment of Significance for this species (Appendix 6).

Macquarie Perch (*Macquaria australasica*)

Macquarie Perch (*Macquaria australasica*) is listed as Endangered under the EPBC Act and the NSW Fisheries Management Act 1994 (FM Act).

- **information on the abundance, distribution, ecology and habitat preferences of the species or communities**

The distribution of Macquarie Perch is restricted to the headwaters of the Lachlan, Murrumbidgee, Murray, Kiewa, Ovens, Goulburn-Broken and Campaspe Rivers in the Murray-Darling Basin to the west of the Great Dividing Range, and the Hawkesbury-Nepean, Georges River and Shoalhaven basins on the east. The species was recorded in 2008 in the Georges River near Campbelltown, approximately 15 kilometres upstream of the study area, the first record from the river since 1894. The species persists in the Burrinjuck, Cotter (Murrumbidgee) and Wyangala impoundments (ALS 2011, Faulks *et al.* 2011, DSEWPC 2012c).

The Macquarie Perch is a riverine, schooling species. It prefers clear water of upper reaches of river catchments where siltation loads are reduced and undisturbed. Habitat requirements are deep, rocky holes interspersed with shallow riffles with lots of cover, such as aquatic vegetation, large boulders, debris and overhanging banks. The area of riffles within a reach was found to be one of the best predictors of the species presence; species-habitat association modelling indicates that at least one hectare and an optimum of three hectares of riffle habitat per kilometre of stream are required for *M. australasica* to be present (Faulks *et al.* 2011, DSEWPC 2012c).

The Macquarie Perch feeds mainly on insects and larvae. The diet of the Macquarie Perch may also include custaceans, bugs, damselflies and molluscs. This species is generally a bottom feeder and only takes a small proportion of its food at the water surface (DSEWPC 2012c, DPI 2012).

Females do not spawn until three years of age, at approximately 300 millimetres in length. Spawning generally occurs in spring to early summer when the water temperature reaches approximately 15°C. The timing of spawning migration and spawning most likely differs from river to river due to difference in temperature regimes.

The species spawns just above riffles in shallow, fast-flowing water over gravel beds, in shallow upland streams or flowing parts of rivers. Downstream reaches of rivers or still or stagnant stretches are generally not favourable for spawning, as any silt present typically fills deep holes and settles on the river bottom, covering rocky substrates and filling small spaces between the gravel and cobbles. This prevents the eggs from settling among stones and gravel of the stream or river bed. The Macquarie Perch may undertake small-scale migrations from pools to riffles to spawn; migration may not be necessary in stream-dwelling fish. Recaptures of tagged fish suggest some fish use the same river each year for spawning (Faulks *et al.* 2011, DSEWPC 2012c, DPI 2012).

- **discussion of the known threats to the species or communities with reference to threats posed by the proposed action**

Known threats to the species (Faulks *et al.* 2011, DSEWPC 2012c, DPI 2012) include:

- Changes in water quality associated with agricultural and forestry practices. For example, siltation (as a result of clearing) can destroy the deep rock pools used by adults as well as smothering spawning areas.
- Loss of riparian vegetation causes riverbanks to become unstable and to erode, causing siltation of the riverbed. The cumulative effect of these changes is habitat degradation and a reduction of the stream's capacity to support its natural fish community (DIPNR 2004).