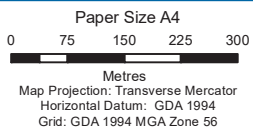
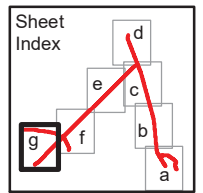


**LEGEND**

- ▭ Subject site
- Study Area
- ⊗ Large-eared Pied Bat
- ⊗ Southern Myotis
- ⊗ Curlew Sandpiper, Terek Sandpiper, Black-tailed Godwit
- ⊗ Green and Golden Bell Frog



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**Species polygons**

**Figure 6-1g**



## 6.2 Threatened biota survey results (BC Act)

### 6.2.1 Threatened species

No BC Act-listed threatened flora species, or potential habitat for threatened flora species, was recorded during field surveys.

Twelve threatened fauna species listed under the BC Act were recorded within the study area during field surveys (Table 6-5).

Table 6-5 Threatened species (BC Act) recorded within the study area during field survey

Scientific name	Common name	BC Act
<b>Birds</b>		
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper	V
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E
<i>Epthianura albifrons</i>	White-fronted Chat	V
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V
<i>Hieraaetus morphnoides</i>	Little Eagle	V
<i>Ninox connivens</i>	Barking Owl	V
<b>Mammals - bats</b>		
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V
<i>Miniopterus australis</i>	Little Bentwing-bat	V
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V
<i>Myotis macropus</i>	Southern Myotis	V
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V

V=Vulnerable, E=Endangered

#### Threatened birds

Of the six threatened bird species recorded, three are predatory birds that are likely to fly over the subject site during foraging activities (White-bellied Sea-Eagle, Little Eagle and Barking Owl). Two are wetland or saltmarsh species (Black-necked Stork and White-fronted Chat) and one is a woodland bird (Brown Treecreeper).

The White-bellied Sea-Eagle (*Haliaeetus leucogaster*) and Little Eagle (*Hieraaetus morphnoides*) were recorded foraging over the study area. Both species are unlikely to breed within the study area as no suitable nests were recorded during field survey. The absence of suitable breeding habitat determined that these species were excluded as candidate threatened species in Table 6-4.

The Barking Owl (*Ninox connivens*) was recorded foraging over the study area. There was only one suitable habitat tree with a sufficiently large hollow entrance for forest owl species, but this hollow was not being utilised by the Barking Owl during targeted stag-watching surveys.

The Black-necked Stork (*Ephippiorhynchus asiaticus*) was recorded foraging within wetland habitats in the study area. This species breeds in stick nests in tall trees standing in water or close to water, where there is a clear view of surroundings and predators. No stick nests were recorded within the study area during field surveys. This species is associated with ecosystem credits and is a 'confirmed' predicted threatened species in Table 6-1.

The White-fronted Chat (*Epthianura albifrons*) was recorded foraging in estuarine habitats in the study area. This species builds open cup nests in low vegetation, including low, isolated mangrove trees. There is suitable habitat within the study area for foraging and nesting; however, no nests were recorded within the subject site during field surveys. This species is associated with ecosystem credits and is a 'confirmed' predicted threatened species in Table 6-1.

The Brown Treecreeper (*Climacteris picumnus victoriae*) was recorded within forest habitats at the Minmi/Stockrington end of the study area. This species would forage and nest within the forested habitats in the study area; however, no nests were observed within the subject site at the time of survey.

### **Threatened microbats**

Of the six threatened microbat species recorded, three are cave-obligate species (*Chalinolobus dwyeri*, *Miniopterus schreibersii oceanensis* and *Miniopterus australis*) meaning that they rely upon cave or cave-like habitats for all of their lifecycle (e.g. for diurnal roosting and breeding). The remaining are hollow-roosting bats that typically roost in forest and woodland habitats.

The species specifically associated with the tunnel roost include Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Southern Myotis (*Myotis macropus*) and Little Bentwing-bat (*Miniopterus australis*). Of these, the Southern Myotis and Eastern Freetail-bat are not a cave-obligate species and are known to utilise habitat trees as well as a range of artificial roost structures. The tunnel is likely to provide year round roosting for the Southern Myotis (*Myotis macropus*). The tunnel may provide suitable breeding habitat for Southern Myotis, however further surveys are required to understand species usage and roost type.

Call data for the remaining two species, Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*), indicated that these species were not roosting within the tunnel.

### **Southern Myotis**

The M1 tunnel is confirmed to be a roost site for this species, as evidenced by sightings of individuals and corroborated by call data. The M1 tunnel is suitably located within proximity of the wetlands at Pambalong Nature Reserve where Southern Myotis have previously been recorded to forage over (OEH, 2018c).

### **Little Bentwing-bat**

The Little Bentwing-bat (*Miniopterus australis*) is a cave-obligate species that is known to congregate in the summer months into maternity colonies and disperse during winter. The Little Bentwing-bat was the most commonly recorded species during anabat surveys, with high call activity and consistent calls. The species was highly likely to be roosting in the tunnel at the time of survey. This species has a strong preference for a wide variety of well-timbered areas, including rainforests, wet and dry sclerophyll forests, *Melaleuca* swamps and coastal forests (Churchill, 2008). As such, it is assessed as an ecosystem credit species under the BAM.

However, the M1 tunnel is unlikely to be a suitable breeding site for the species. This species has specific maternity roost requirements, including a need for high roost temperatures (up to 39°C, Churchill, 2008). The Little Bentwing-bat is known to share roosts with the sympatric species, the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), benefitting from the latter species' ability to boost roost temperatures using metabolic heat. The Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) is unlikely to be roosting within the M1 tunnel (see below), and the M1 tunnel is unlikely to provide the necessary roost conditions to support breeding as it is unlikely to be able to produce and maintain the high temperatures required.

### Large-eared Pied Bat

The cave-obligate Large-eared Pied Bat (*Chalinolobus dwyeri*) has very particular maternity roost requirements in terms of specific humidity and temperature microclimates. The tunnel structure is unlikely to support stable microclimates required as maternity roost for the Large-eared Pied Bat (*Chalinolobus dwyeri*), as such it is assumed to be utilising the tunnel as a diurnal roost but not as a maternity roost.

### Eastern Freetail-bat

The Eastern Freetail-bat (*Mormopterus norfolkensis*) is not typically associated with artificial roost structures and most records are from tree hollow roosts. Call data near the M1 tunnel is probably from individuals foraging in the vicinity of the tunnel.

### Eastern Bentwing-bat

The small number of calls and the timing of calls for the remaining cave-obligate species detected, the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), indicates that the species was not roosting in the tunnel at the time of survey. Notwithstanding, the species has specific temperature and humidity regimes for maternity roosts, typically requiring very high humidity levels (up to 95% humidity, Churchill, 2008). The M1 tunnel is highly unlikely to be a suitable breeding roost as it does not have the depth to support stable temperatures or high humidity levels.

### Yellow-bellied Sheathtail-bat

The small number of calls and the timing of calls for the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) indicates that the species was not roosting in the tunnel at the time of survey but is likely to be foraging within the vicinity of the tunnel.

## 6.2.2 Threatened ecological communities

The majority of the vegetation types present within the subject site conform to TECs listed under either the BC Act or the EPBC Act. Their threatened status under legislation reflects the historical and ongoing risks to coastal floodplain communities, due to land clearing and hydrological modification for agricultural, industrial and urban development.

There are six BC Act listed TECs associated with the PCTs in the subject site; these are summarised in Table 6-6 below and displayed on Figure 6-2 and comprises approximately 94.4 ha of native vegetation within the study area. Approximately 2.8 ha of native vegetation conforming to TECs would be disturbed within the subject site.

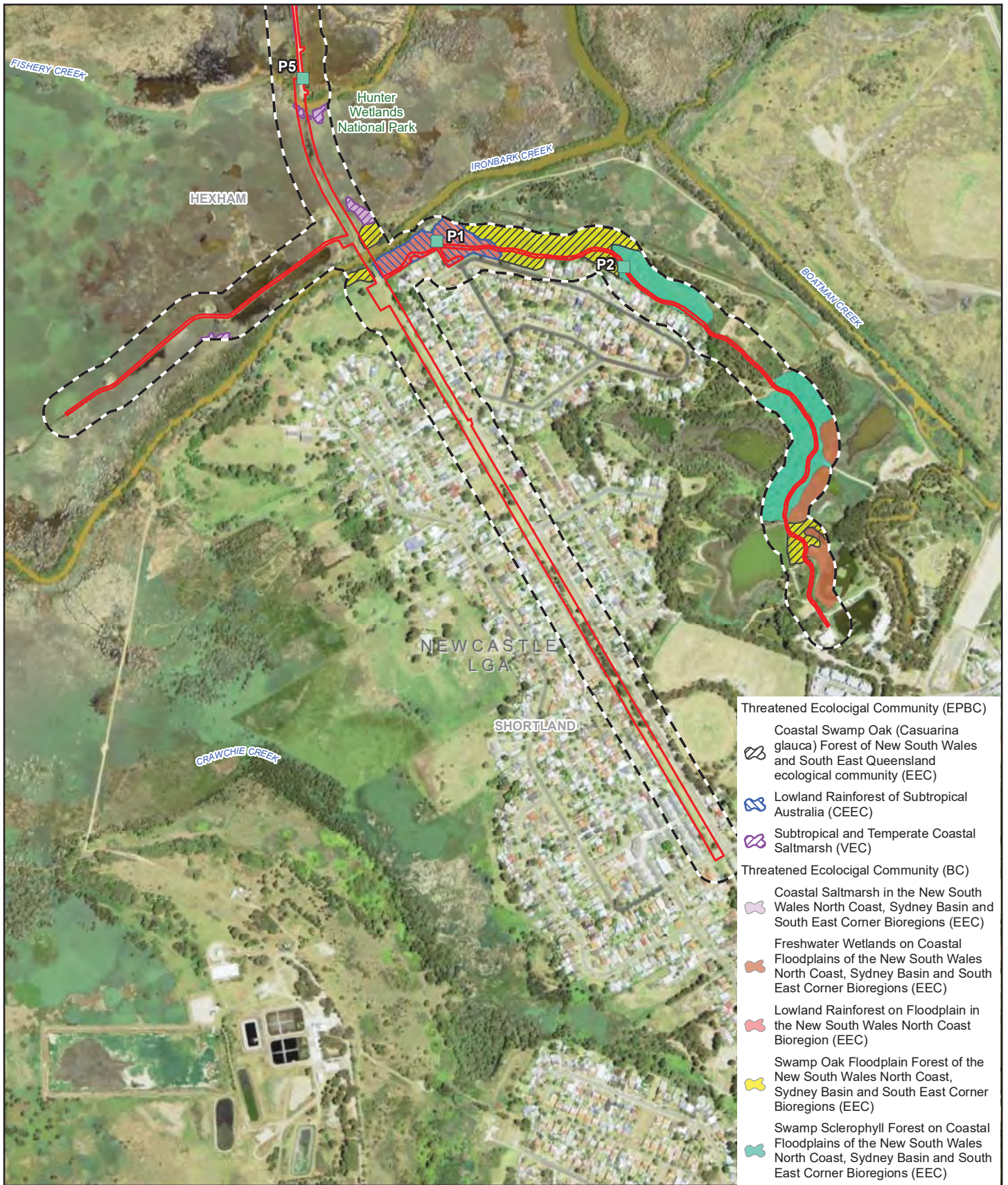
Table 6-6 Threatened ecological communities within the study area and subject site

Plant Community Type (PCT)	BC Act status	EPBC Act status	Extent in subject site (ha)	Extent in study area (ha)
PCT 1528 - Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast.	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (EEC)	Lowland Rainforest of Subtropical Australia (CEEC)	0.18	1.11
PCT 1598- Forest Red Gum grassy open forest on floodplains of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (EEC)	Not listed	0.76	3.47
PCT 1718- Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)	Not listed	0.41	4.83
PCT 1727 - Swamp Oak - Sea Rush - <i>Baumea juncea</i> swamp forest on coastal lowlands of the Central Coast and Lower North Coast	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)	Coastal Swamp Oak ( <i>Casuarina glauca</i> ) Forest of New South Wales and South East Queensland (EEC)	0.60	9.86
PCT 1746- Saltmarsh Estuarine Complex	Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)	Subtropical and Temperate Coastal Saltmarsh (VEC)	0.02	0.62
PCT 1737- Typha Rushland	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)	Not listed	0.85	45.34
PCT 1808- Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)*	Not listed	0.01	29.21
<b>Total</b>			<b>2.8</b>	<b>94.4</b>

EEC = endangered ecological community, VEC = vulnerable ecological community, CEEC = critically endangered ecological community

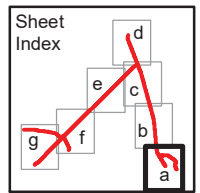
\* Note that the BAM credit calculator will only allow Swamp Oak Floodplain Forest TEC to be selected for this PCT.





- Threatened Ecological Community (EPBC)**
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (EEC)
  - Lowland Rainforest of Subtropical Australia (CEEC)
  - Subtropical and Temperate Coastal Saltmarsh (VEC)
- Threatened Ecological Community (BC)**
- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion (EEC)
  - Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)

- LEGEND**
- Subject site
  - Study Area
  - BAM plot surveys (2019)



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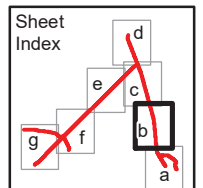
**Figure 6-2a**





- LEGEND**
- Subject site
  - Study Area
  - BAM plot surveys (2019)

- Threatened Ecological Community (EPBC)**
- ⌘ Subtropical and Temperate Coastal Saltmarsh (VEC)
- Threatened Ecological Community (BC)**
- ⌘ Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - ⌘ Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)



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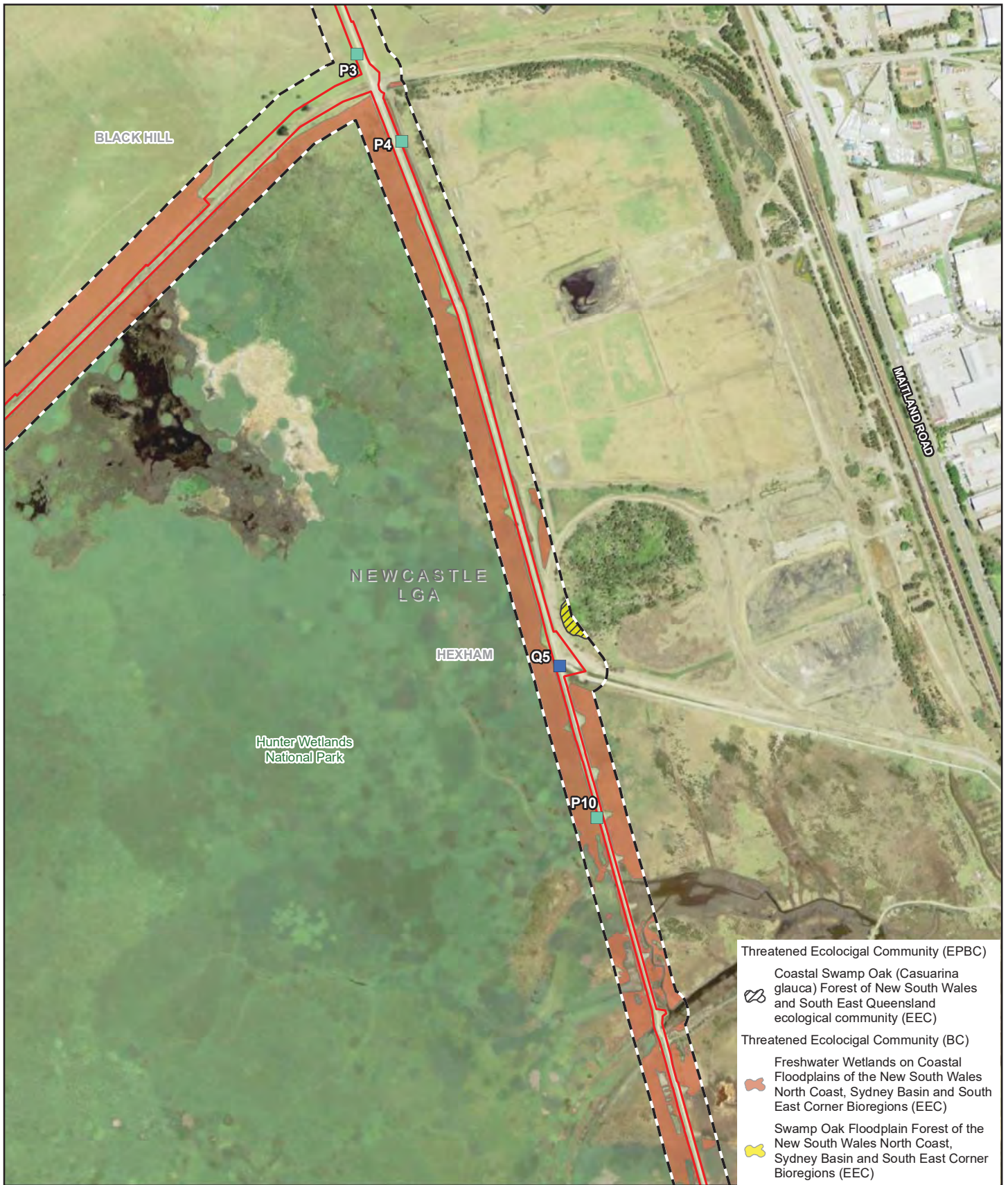


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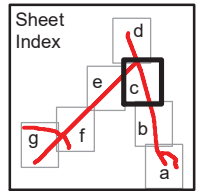
**Figure 6-2b**





- Threatened Ecological Community (EPBC)**
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (EEC)
- Threatened Ecological Community (BC)**
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)

- LEGEND**
- Subject site
  - Study Area
  - BAM plot surveys (2016)
  - BAM plot surveys (2019)



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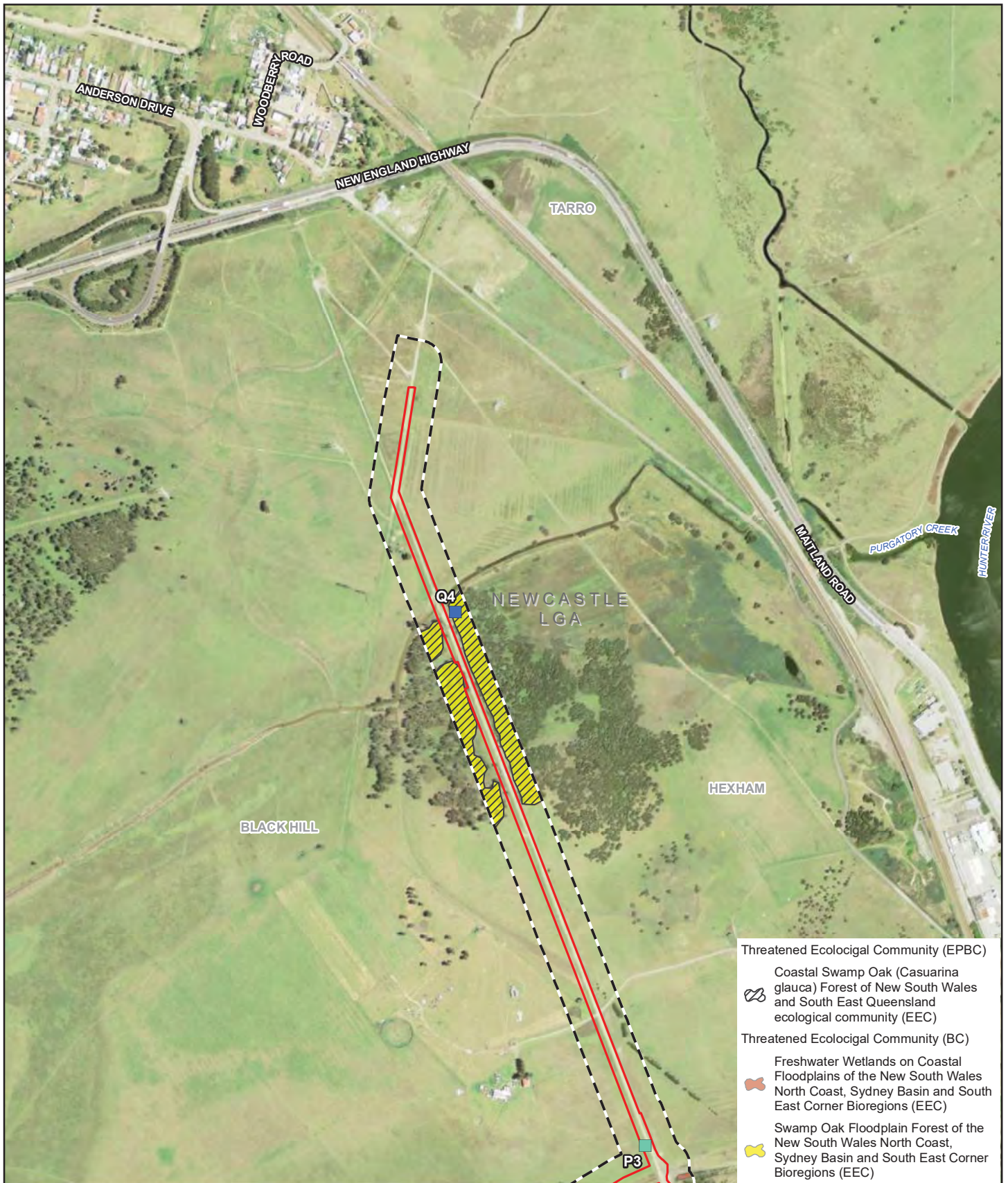


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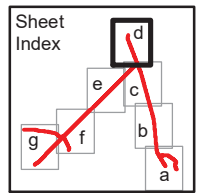
**Figure 6-2c**





- Threatened Ecological Community (EPBC)**
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (EEC)
- Threatened Ecological Community (BC)**
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)

- LEGEND**
- Subject site
  - Study Area
  - BAM plot surveys (2016)
  - BAM plot surveys (2019)



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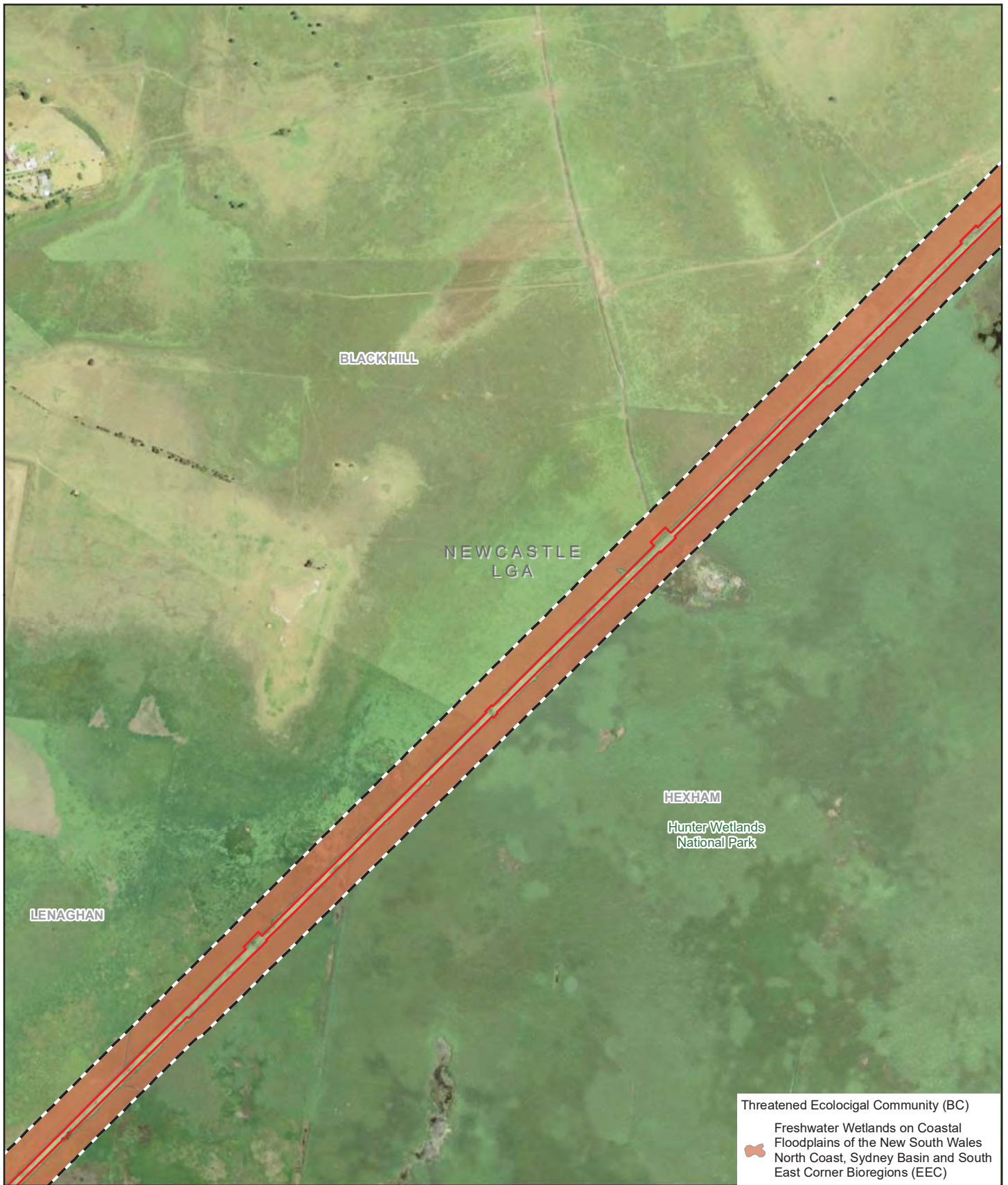


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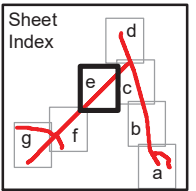
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**Figure 6-2d**





**LEGEND**  
 Subject site  
 Study Area



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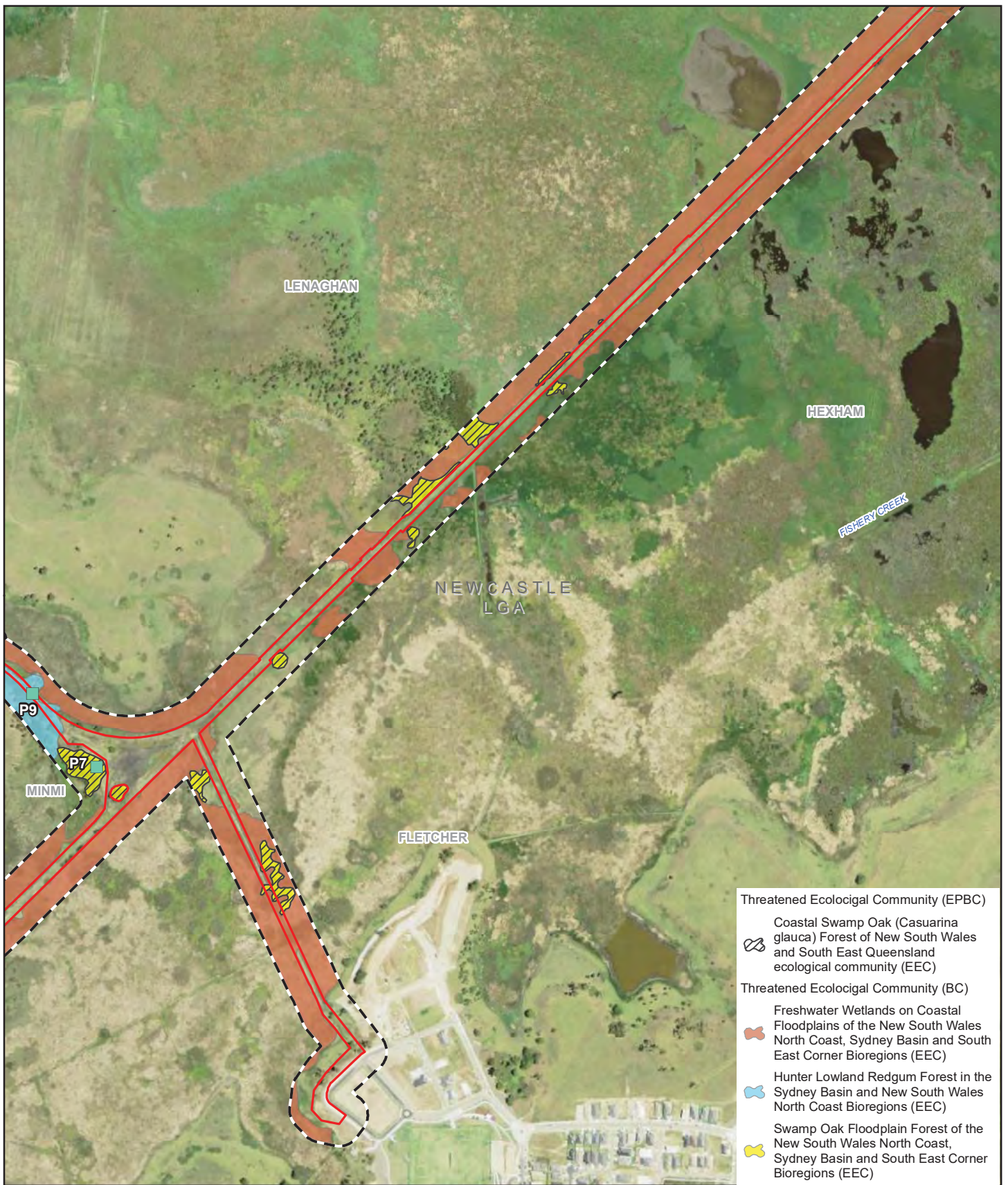


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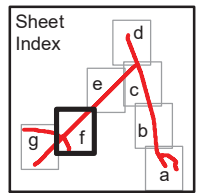
**Figure 6-2e**





- Threatened Ecological Community (EPBC)**
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (EEC)
- Threatened Ecological Community (BC)**
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Hunter Lowland Redgum Forest of the Sydney Basin and New South Wales North Coast Bioregions (EEC)
  - Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)

- LEGEND**
- Subject site
  - Study Area
  - BAM plot surveys (2019)



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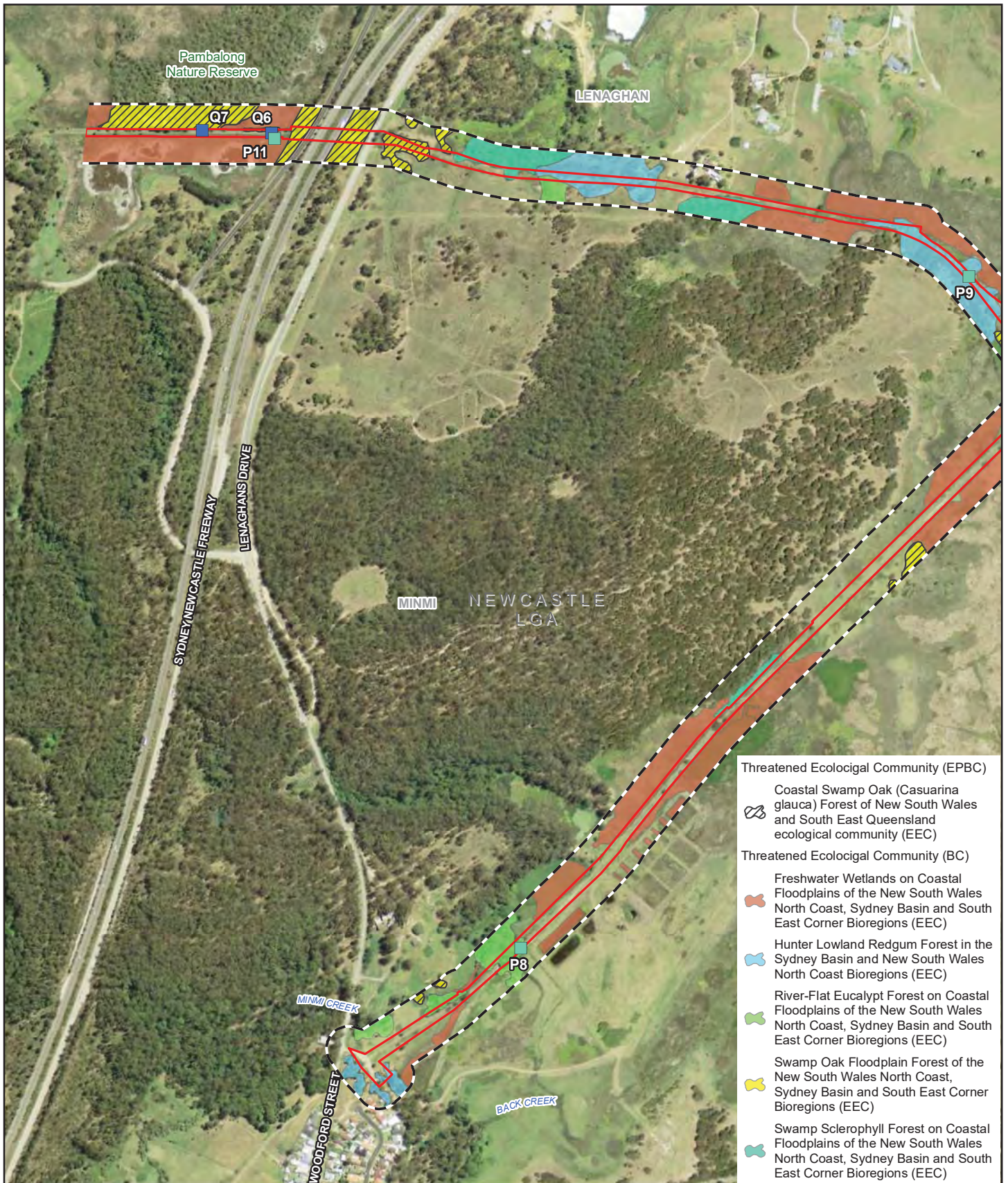


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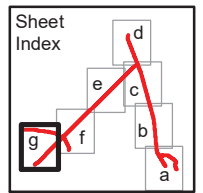
**Figure 6-2f**





- Threatened Ecological Community (EPBC)**
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (EEC)
- Threatened Ecological Community (BC)**
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (EEC)
  - River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)
  - Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC)

- LEGEND**
- Subject site
  - Study Area
  - BAM plot surveys (2016)
  - BAM plot surveys (2019)



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**Figure 6-2g**



## 6.3 Matters of national environmental significance

### 6.3.1 Threatened ecological communities

Three TECs listed under the EPBC Act were recorded within the study area, totalling approximately 11.6 ha (see Table 6-6):

- Lowland Rainforest of Subtropical Australia (CEEC)
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland (EEC)
- Subtropical and Temperate Coastal Saltmarsh (VEC)

Of the 11.6 ha of the above TECs that is present in the study area, approximately 0.2 ha is predicted to be removed by the proposal, consisting of largely disturbed edge habitat.

The latter two communities are typical of low lying areas, floodplains and coastal swamps and estuarine environments, and can be found throughout the study area. However, the Lowland Subtropical Rainforest ecological community is only present within the Hunter Wetland Centre as a small patch that is presently maintained as part of the centre grounds. Native non-endemic plantings have been established in this patch that do not reflect the natural composition of this community. There are large mature trees within the patch but there are no remnant trees that would represent residual “pre-clearing” vegetation (sensu TSSC, 2011). Whilst connected to other surrounding native vegetation communities, the occurrence of this ecological community in the study area is not linked to other patches of the ecological community.

The Lowland Rainforest of Subtropical Australia ecological community is naturally distributed much further north of the study area, being primarily located from Maryborough QLD to the Clarence River in Grafton, although the state-listed equivalent (Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions) is known to occur as far south as the Hawkesbury River (NSW Scientific Committee, 2011c). There are isolated occurrences of Lowland Rainforest of Subtropical Australia between the Clarence River and Hunter River, such as the Bellinger and Hastings valleys (TSSC, 2011).

Review of the earlier regional mapping database (LHCCREMS, 2003) indicates that the regional map units that could correspond to Lowland Rainforest of Subtropical Australia (EPBC Act) or Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions (BC Act) were not identified in the Hunter Wetlands Centre (at least since 2003, when the mapping database was prepared). There is a possibility that the community was historically cleared from the area and may have been re-established at the Hunter Wetlands Centre through planting and restoration efforts over a period of time. As a precautionary approach, the occurrence of this community has been treated as part of the critically endangered ecological community.

Under the EPBC Act, vulnerable communities are not MNES for the purposes of environmental approvals (Part 3 of the EPBC Act) and do not require further assessment (see also DotE, 2013). For this reason, potential impacts on the vulnerable Subtropical and Temperate Coastal Saltmarsh are not assessed further in this BDAR as an MNES.

### 6.3.2 Threatened species

No EPBC Act-listed threatened flora species were recorded, or are considered likely to occur within the subject site.

One threatened fauna species listed under the EPBC Act was recorded within the study area: the Large-eared Pied Bat (*Chalinolobus dwyeri*) was detected near the M1 tunnel and is likely to be roosting in the tunnel in low numbers (see discussion in Section 6.2.1).

Although the Green and Golden Bell Frog (*Litoria aurea*) was not recorded during survey, the species is assumed to be present for the purposes of this BDAR on the basis of the subject site's location within the known distribution of the Sandgate/Hexham Swamp population and its proximity to the Kooragang Island/Ash Island key population (see further discussion in Section 7.7.2).

Of the threatened fauna species that were recorded within the locality and considered in Appendix A, the species in Table 6-7 were assessed as moderately to highly likely to occur within the study area although not recorded during field surveys.

Species marked with an asterisk (\*) have been included in the table as they have been assumed as present under the requirements of the BAM. Detailed consideration of the habitat requirements of some of these species and their likely impact from the proposal however, suggests that this is likely to be a conservative approach. For the majority of the species listed in Table 6-7, further assessment of the habitat values of the study area suggests that habitat suitability to support these species is likely to be low, or if occasionally present, the predicted impacts of the proposal are expected to be minimal, with small losses in foraging habitat only.

For the species indicated by bold text in Table 6-7, the subject site represents or potentially represents important habitat and as such, these species have been assessed in further detail in Section 7.7.2.



Table 6-7 EPBC Act threatened species known, assumed or likely to occur in the subject site

Family	Scientific Name	Common Name	EPBC Act	Nature of occurrence	Further assessment
<b>Hylidae</b>	<i>Litoria aurea</i>	<b>Green and Golden Bell Frog**</b>	<b>V</b>	<b>Assumed to be present within the subject site, representing the Sandgate/Hexham Swamp Key Population.</b>	<b>Assessment of Significance completed</b>
Meliphagidae	<i>Anthochaera phrygia</i>	Regent Honeyeater*	CE	Mapped as an important area by OEH and may forage within the subject site from time to time as part of a broad foraging range but unlikely to breed in the subject site.	Not considered further due to the marginal nature of the habitat present on site. The nature and scale of the proposal suggests that impacts to the species are unlikely.
<b>Ardeidae</b>	<i>Botaurus poiciloptilus</i>	<b>Australasian Bittern*</b>	<b>E</b>	<b>Potential habitat identified within the study area for foraging and roosting.</b>	<b>Assessment of Significance completed</b>
<b>Scolopacidae</b>	<i>Calidris canutus</i>	<b>Red Knot, Knot</b>	<b>E, MW</b>	<b>Important areas mapped by OEH within the study area therefore assumed to be present.</b>	<b>Assessment of Significance completed</b>
<b>Scolopacidae</b>	<i>Calidris ferruginea</i>	<b>Curlw Sandpiper**</b>	<b>CE, MW</b>	<b>Important areas mapped by OEH within the study area therefore assumed to be present.</b>	<b>Assessment of Significance completed</b>
Scolopacidae	<i>Calidris tenuirostris</i>	Great Knot*	CE, MW	An uncommon summer migrant to the Hunter Estuary, primarily found in saline habitats along the North Arm of the Hunter River, usually in small numbers (Herbert, 2007).	Not considered further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area (records within the locality concentrated along the North Arm of the Hunter River). The nature and scale of the proposal suggests that impacts to the species are unlikely.
Psittacidae	<i>Lathamus discolor</i>	Swift Parrot*	CE	Would possibly forage in suitable winter-flowering Eucalypt trees within the subject site from time to time when present in mainland Australia. Does not breed on mainland Australia. The majority of the subject site supports treeless wetland vegetation, which is not suitable foraging habitat for the species.	Not considered further due to the marginal nature of the habitat present on site. The nature and scale of the proposal suggests that impacts to the species are unlikely.
<b>Scolopacidae</b>	<i>Limosa lapponica baueri</i>	<b>Bar-tailed Godwit</b>	<b>V, MW</b>	<b>Important areas mapped by OEH within the study area therefore assumed to be present.</b>	<b>Assessment of Significance completed</b>
<b>Scolopacidae</b>	<i>Numenius madagascariensis</i>	<b>Eastern Curlew</b>	<b>CE, MW</b>	<b>Important areas mapped by OEH within the study area therefore assumed to be present.</b>	<b>Assessment of Significance completed</b>

Family	Scientific Name	Common Name	EPBC Act	Nature of occurrence	Further assessment
Rostratulidae	<i>Rostratula australis</i>	Australian Painted Snipe*	E, M	Considered rare in Australia. Has been recorded in the Hunter Estuary (Herbert, 2007), habitat within the study area considered marginal.	Not considered further due to the marginal nature of the habitat present within the subject site. The nature and scale of the proposal suggests that impacts to the species are unlikely.
Vespertilionidae	<i>Chalinolobus dwyeri</i>	<b>Large-eared Pied Bat**</b>	V	<b>Roosting and foraging habitat present in the subject site and the species has been detected in the study area.</b>	<b>Assessment of Significance completed</b>
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala*	V	Meta-population (with breeding) occurs on eastern side of Hunter River. Only foraging habitat is present in the study area. This habitat is marginal, and is <i>not</i> considered to be core koala habitat (see Section 5.4.2) according to the Referral guidelines for the species (DotE, 2014).	Not considered further due to the marginal nature of the habitat present on site. The nature and scale of the proposal suggests that impacts to the species are unlikely.
Pteropodidae	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox*	V	Likely to forage within the subject site from time to time as part of a broad foraging range. Marginal foraging habitat within the eucalypt forests in the subject site. No camps are located within the subject site.	Not considered further due to the marginal nature of the habitat present on site. The nature and scale of the proposal suggests that impacts to the species are unlikely.

MW = Migratory Wetland, V = Vulnerable, E = Endangered, CE = Critically Endangered

\* Represented in the BAM assessment as a predicted threatened species and assumed to be present within the subject site on the basis of presence of suitable foraging habitat. Offsetting in the form of ecosystem credits for wetland habitats would address loss of foraging habitat for this species.

\*\* Represented in the BAM assessment as a candidate threatened species and assumed to be present or recorded on site. Offsetting required in the form of species credits.

Species in **bold** have been assessed in further detail.



### 6.3.3 Migratory species

Four EPBC Act-listed migratory bird species were recorded within the study area during surveys, representing two terrestrial bird species and three wetland bird species (Table 6-8)

Of the species that were recorded within the locality and considered in Appendix A, the species in Table 6-8 were assessed as moderately to highly likely to occur within the study area (or were otherwise recorded). A large proportion of these migratory species are wetland specialists, which reflects the recognised wetland habitat values of the Hunter Wetlands National Park and the Hunter Estuary Wetlands Ramsar site. The areas of suitable wetland habitat for most migratory bird species likely to occur in the study area are located in the estuarine and brackish habitats at the Shortland end of the study area, and within the Hunter Wetlands Centre.

The majority of these species would be most likely to forage in wetland habitats on saltmarsh and mudflats. In terms of roosting habitat, mangrove forests would be suitable roost sites for some species such as the Whimbrel and Grey-tailed Tattler, which are known to perch in mangroves during poor weather or at night (DEE, 2017b). However, for estuarine habitats in general, migratory shorebirds prefer roosting in large numbers in open areas close to feeding grounds that are slightly elevated to watch for predators, or in shallow pools such as flooded saltmarsh or grasslands that offer increased security from predation (DEE, 2017b). For this reason, the shallow grassed embankments of the former HWC Chichester water main and Richmond Vale railway have potential to be used by some birds as roosting sites as it is elevated and clear, and runs through foraging habitat.

Most migratory species do not breed in Australia, but migrate south to Australia from breeding grounds in the northern hemisphere to spend the Austral summer roosting and foraging in areas of suitable habitat before undertaking the return journey north.

The number of terrestrial migratory species recorded, or predicted to occur, is comparatively lower; these species are predicted to utilise forested habitats on the margins of the study area or the aerial space above the study area for hawking insects.

Table 6-8 Wetland migratory species known or likely to occur in the subject site

Family	Scientific Name	Common Name	EPBC Act	Recorded in the study area during survey	Nature of occurrence	Further assessment
Accipitridae	<i>Pandion haliaetus</i>	Eastern Osprey	MW		May occasionally forage above wetlands areas for fish.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Apodidae	<i>Apus pacificus</i>	Forked-tailed Swift	MT	X	May occur in the study area aerially hawking for insects.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail	MT		May occur in the study area aerially hawking for insects.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Charadriidae	<i>Pluvialis fulva</i>	Pacific Golden Plover	MW		Regular summer migrant that mostly utilises foraging sites east of the study area along the North Arm of the Hunter River and Ash Island.	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Charadriidae	<i>Pluvialis squatarola</i>	Grey Plover	MW		Considered accidental in the Hunter Estuary with 1 – 3 Grey Plovers occasionally recorded outside the study area (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Cuculidae	<i>Cuculus optatus</i>	Oriental Cuckoo	MT		Uncommon summer migrant associated with rainforest edges and mangroves.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Laridae	<i>Gelochelidon nilotica</i>	Gull-billed Tern	MW, M		May occasionally forage above wetlands areas for fish.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.



Family	Scientific Name	Common Name	EPBC Act	Recorded in the study area during survey	Nature of occurrence	Further assessment
Laridae	<i>Hydroprogne caspia</i>	Caspian Tern	MW, M	X	May occasionally forage above wetlands areas for fish.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-Eater	MT		May hawk for insects within the study area and perch on suitable shrubs, branches or fences.	Not assessed further as the nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Scolopacidae	<i>Actitis hypoleucos</i>	Common Sandpiper	MW		Uncommon summer migrant in the Hunter Estuary (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
<b>Scolopacidae</b>	<b><i>Calidris acuminata</i></b>	<b>Sharp-tailed Sandpiper</b>	<b>MW</b>	<b>X</b>	<b>Common summer migrant found in both fresh and saltwater habitats throughout the Hunter Estuary.</b>	<b>Assessment of significance prepared</b>
Scolopacidae	<i>Calidris melanotos</i>	Pectoral Sandpiper	MW		Rarely recorded in the Hunter Estuary (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Scolopacidae	<i>Calidris ruficollis</i>	Red-necked Stint	MW		Regular summer migrant to Hunter Estuary primarily found in saline habitats along the north Arm of the Hunter river and in ponds on Ash Island (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.

Family	Scientific Name	Common Name	EPBC Act	Recorded in the study area during survey	Nature of occurrence	Further assessment
Scolopacidae	<i>Charadrius bicinctus</i>	Double-banded Plover	MW		Uncommonly recorded in the Hunter Estuary where they may forage but are unlikely to roost (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
<b>Scolopacidae</b>	<b><i>Gallinago hardwickii</i></b>	<b>Latham's Snipe</b>	<b>MW</b>		<b>Usual summer migrant to the Hunter Estuary associated with freshwater wetlands including Hunter Wetlands Centre and Pambalong Nature Reserve (Herbert, 2007)</b>	<b>Assessment of significance prepared.</b>
Scolopacidae	<i>Limicola falcinellus</i>	Broad-billed Sandpiper	MW		Considered accidental in the Hunter Estuary with 1-4 birds occasionally recorded.	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Scolopacidae	<i>Limosa limosa</i>	Black-tailed Godwit	MW		Summer migrant primarily occurring in the saline parts of the Hunter Estuary east of the study area (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.
Scolopacidae	<i>Numenius phaeopus</i>	Whimbrel	MW		Summer migrant primarily occurring in the saline parts of the Hunter Estuary east of the study area (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely.



Family	Scientific Name	Common Name	EPBC Act	Recorded in the study area during survey	Nature of occurrence	Further assessment
Scolopacidae	<i>Tringa glareola</i>	Wood Sandpiper	MW, M		Rare summer migrant occasionally observed in freshwater swamps in the Hunter Estuary (Herbert, 2007)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely. <b>Assessment of significance prepared</b>
Scolopacidae	<i>Tringa nebularia</i>	Common Greenshank	MW	X	Common summer migrant. Usually within saline parts of the Hunter Estuary but occasionally utilises freshwater swamps (Herbert, 2007)	<b>Assessment of significance prepared</b>
Scolopacidae	<i>Tringa stagnatilis</i>	Marsh Sandpiper	MW, M		Regular summer migrant widespread throughout the Hunter Estuary in both saline and freshwater environments.	<b>Assessment of significance prepared</b>
Scolopacidae	<i>Xenus cinereus</i>	Terek Sandpiper	MW		Usual summer migrant to the Hunter Estuary east of the study area (Fern Bay, North Arm Sandflats, Stockton Channel)	Not assessed further due to the marginal nature of the habitat present on site, and the absence of records of the species within the study area. The nature and scale of the proposal suggests that impacts to the species are considered unlikely. <b>Assessment of significance prepared</b>
Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis	MW, M		Occasionally recorded in moderately large numbers on estuarine plain freshwater swamps (Herbert, 2007)	<b>Assessment of significance prepared</b>

MW = Migratory wetland, MT = Migratory terrestrial, M = Marine  
Species in **bold** have been assessed in further detail.

Note that migratory species that are also threatened (as indicated in Table 6-7) have been assessed as a threatened species.

#### 6.3.4 Wetlands of international importance

The study area occurs within a portion of the Hunter Estuary Wetlands Ramsar site, which is listed as a Wetland of International Importance under the Ramsar convention.

The Hunter Estuary Wetlands Ramsar site recognised as an important feeding and roosting site for a large seasonal population of shorebirds and as a waylay site for transient migrants. Over 250 species of birds have been recorded within the Ramsar site, including 45 species listed under international migratory conservation agreements. In addition, the Ramsar site provides habitat for the nationally threatened Green and Golden Bell Frog, Red Goshawk and Australasian Bittern (DEE, 2019a).

The Hunter Estuary Wetlands Ramsar site consists of two parts, the Kooragang Nature Reserve (now part of the Hunter Wetlands National Park) and the Hunter Wetlands Centre (NPWS, 2015). The Kooragang component of the site is situated in the estuary of the Hunter River, approximately 7 km north of Newcastle and represents the majority of the Ramsar site at 2926 hectares (DEE, 2019a).

The Hunter Wetlands Centre represents an additional 42 hectare component of the Ramsar site, located 2.5 km west from Kooragang (DEE, 2019a). Although the two components of the Ramsar site occur separately, they are linked hydrologically and by wildlife corridors associated with ironbark Creek, Ash Island and the Hunter River (DEE, 2019a).

The Shortland end of the study area occurs within the Hunter Wetlands Centre. The Hunter Wetlands Centre component of the Ramsar site is small and contains a complex of wetland types surrounded by urban development along three boundaries (DEE, 2019a). This is an urban wetland that has been restored. Habitat types at the Hunter Wetlands Centre Australia include restored semi-permanent/seasonal freshwater ponds and marshes, natural semi-permanent/seasonal brackish ponds and marshes, freshwater swamp forests and a coastal estuarine creek (DEE, 2019a).



# 7. Impact assessment

## 7.1 Overview

The future construction and operation of the proposal is likely to result in direct impacts on native biota and their habitats within the subject site. There is the potential for indirect impacts on retained areas of native vegetation and habitats adjacent to, and downstream of the subject site, both during construction and during the operational phase. The following sections provide an overview of recommended mitigation measures likely to be required to avoid or minimise such impacts. These measures are presented according to the hierarchy of avoidance and mitigation of impacts. The provision of offsets to counter residual impacts of the proposal is discussed in Section 8.

## 7.2 Avoidance of impacts

The proposal has been developed with due consideration of environmental constraints and has sought to avoid impacts on native vegetation and sensitive environments through route selection and consideration of bridge design, including:

- Locating the alignment of the proposal on land that has been previously cleared in association with the now decommissioned Richmond Vale railway and Hunter Water pipeline.
- Avoiding areas of high biodiversity values (by locating the proposal predominantly on previously cleared land).
- Proposing use of elevated boardwalks in sensitive areas such as wetlands instead of 'fill' construction methods.
- Aligning new bridges at Fishery Creek and Ironbark Creek with the stream contours (i.e. will be perpendicular to the banks), thus limiting the area of impact as much as possible.
- Limiting impacts on riparian vegetation and in-stream flora to the area immediately adjacent to proposed bridges.

The area of vegetation to be removed has been minimised as far as practical during design development, particularly with consideration of minimising clearing of native vegetation and habitat for sensitive fauna species. Site access, compounds and stockpile sites would be located in existing cleared areas within the subject site.

### 7.2.1 Detailed design phase

Measures to further avoid minimise impacts would be incorporated into the detailed design and are summarised below. In particular, the majority of opportunities to minimise impacts on roosting microbat species are design considerations rather than construction measures.

#### **Artificial lighting**

- The key impacts regarding the installation of artificial lighting to microbats is the potential for delayed roost emergence and roost abandonment. Roost abandonment may in turn lead to increased predation particularly if viable alternative roosting options are not available in the local area. This is of particular consequence for the threatened Southern Myotis that may roost in the tunnel year round and other species (e.g. Little Bent-wing Bat, *Miniopterus australis*) that may occasionally use the tunnel for roosting.

- Incorporating design features to minimise light spill onto the roof of the M1 tunnel where there are substantial numbers of bat roosts, such as constructing ‘shields’ or false ceilings around roost sites to maintain darkness within roosts. Creation of these light exclusion zones will reduce the potential for delayed roost emergence and roost abandonment. These shields/false ceilings will also provide a barrier between roosting bats and pedestrians using the tunnel during daylight hours.
- Incorporating variable lighting regimes along the alignment and in the M1 tunnel reduce the potential for light spill impacting foraging habitat, and minimise the chance of roost abandonment. This could involve switching off or dimming lights for part of the night, or use of movement sensor lights along the alignment and in the M1 tunnel that switch on upon approach and turn off after people pass.
- Incorporating design features to limit light spill into areas of adjoining sensitive habitat along the alignment, as far as practicable, to minimise the impacts of lighting to foraging habitat along the alignment. This could include the use of low intensity lamps to reduce the spread of illumination, directed lighting or light shields to create dark refuges between lamps.
- Use of certain light types such as long wavelength “warm white” lights rather than short wavelength “blue” lights.

### ***Bridge design***

- Locating bridge abutments, piers and temporary works to further avoid mangroves and saltmarsh vegetation (for example, exploiting natural gaps in mangrove and saltmarsh vegetation).
- Other design considerations (such as height, orientation, construction materials) to minimise shading of marine vegetation such as mangroves and saltmarshes.
- Incorporating design features for instream structures to avoid impact to river flow and fish passage.
- Incorporating design features to facilitate fish and amphibian passage, if required.

### ***Construction methods***

- Using construction methods that will limit the need for vegetation clearance in riparian areas.

### ***Landscaping***

- Strategic use of landscaping along the pathway within Hunter Wetlands National Park to create a visual disincentive for trail users to cross into areas of habitat for wetland birds.
- Landscaping would involve planting of suitable endemic species (such as low shrubs and native grasses) at high densities.

### ***Fencing***

- Use of fencing structures along the pathway within the Hunter Wetland National Park to protect wildlife (including wetland birds) from dogs and pedestrians.
- Incorporating fauna-friendly designs to reduce impacts on habitat connectivity and native fauna movements.
- Fencing should comprise five rows of galvanised steel plain wire with no mesh. Barbed wire may be used on the first, fourth and fifth wires if exclusion of stock is also required.



## 7.3 Minimisation of impacts

### 7.3.1 Construction measures

A range of measures will be required to mitigate impacts on biodiversity values, particularly at the construction phase of the proposal. During construction, a CEMP would be prepared specifying environmental safeguards to be implemented to avoid or minimise impacts arising from construction activities. The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water and pollutants, acid sulfate soils, as well as flora- and fauna-specific mitigation measures.

The CEMP would also include a wetland bird management plan, a microbat management plan and a Green and Golden Bell Frog management plan that identifies specific management measures to mitigate the impact of the proposal on these species during the construction process and to make provisions for the ongoing management and monitoring of these species after construction is completed. These plans would be prepared in consultation with appropriate experts and relevant government agencies.

The following are key impact mitigation considerations during construction that would be included in the CEMP and its sub-plans:

#### **General**

- General minimisation of clearing areas as far as practicable. Delineating a vegetation buffer with a high visibility barrier to prevent accidental clearing or disturbance of adjacent vegetation or aquatic habitat.
- Demarcation of adjoining sensitive areas through temporary fencing to prevent impacts during construction and/or inclusion of a tree retention plan or similar to protect these biodiversity resources where possible.
- Avoidance of stockpiling of materials adjacent to native vegetation wherever possible and locating stockpiles within existing cleared areas.
- Management of noxious and environmental weeds during construction, with weed material to be cleared and stockpiled separately to all other vegetation, removed from site and disposed of at an appropriately licenced disposal facility. When transporting weed waste from the site to the waste facility, trucks must be covered to avoid the spread of weed-contaminated material.
- Restriction of access or parking of vehicles or machinery in areas of native vegetation.
- Implementation of measures to avoid or minimise light spill into areas of adjoining sensitive habitat during construction.
- Implementation of procedures for clearing habitat, including pre-clearing surveys and clearing supervision of hollow-bearing trees and logs, to minimise fauna injury or mortality.
- Implementation of fauna handling and release protocols during any clearing works.
- Implementation of remediation activities as soon as practicable following construction works where native vegetation clearing is required including soil stabilisation and planting of native endemic species characteristic of the vegetation types identified within the study area.

### **Protection of waterways**

- Implementation of erosion and sediment control measures during construction to minimise pollution and sediment impacts on waterways and downstream aquatic environments, including estuarine communities. This could include measures such as the use of silt curtains during substrate disturbance activities (e.g. pile driving) to minimise the potential for migration of turbid plumes outside of the immediate construction footprint.
- Implementation of measures to manage fuels, chemicals, and liquids required during construction.
- Minimisation of impacts to riparian and instream habitats at creek crossings, for example using barge access rather than shore-based access during bridge construction.

### **Managing vehicle movements**

The proposal would increase the risk of injury or mortality of native fauna during the construction phase due to vehicle strike by increasing the rate of vehicle visitation to the site. This risk would be reduced by:

- Restricting vehicle movements to operational (daylight) hours.
- Implementing and enforcing appropriate speed limits for vehicles traversing the site.
- Establishment of 'no-go' areas, which are demarcated with high visibility barrier tape to prevent accidental impacts to vegetation and other biota adjacent to the disturbance footprint.

### **Timing of construction works**

Seasonal restrictions for clearing to mitigate impacts to sensitive fauna should include:

- Works that occur within the M1 tunnel to be undertaken from late March to May, which is outside the breeding period of the threatened microbats found within the tunnel to avoid placing any undue stress on any pregnant or lactating females that may utilise these roosts. Construction should completely stop works after May when microbats enter torpor and unnecessary energy expenditure during this time (such as finding alternative roost sites as a result of disturbance from construction) could reduce their likelihood of survival.
- Works within the M1 tunnel to occur at night following the emergence period and prior to the re-emergence period (e.g. 45 minutes after sunset and at least 45 minutes before sunrise) where possible, when bats are likely to be foraging rather than occupying roosts within the tunnel.
- Works within areas of potential shorebird habitat (i.e. chainages 5200 to 600 and the extension to Hunter Wetlands Centre) to occur between the end of April and beginning of September when the majority of migratory shorebirds utilising these habitats are in the northern hemisphere.
- Clearing and grubbing works within areas mapped as potential Green and Golden Bell Frog habitat should be between September to April when frogs are most active and can move away from potential disturbances in accordance with the EPBC Act policy statement 3.19 (DEWHA, 2009). If this is not possible, additional mitigation measures such as pre-clearance surveys would need to be implemented.
- If hollow-bearing trees or habitat trees are to be removed, they should be cleared outside of breeding/hibernation periods of hollow-dependant species or undergo thorough inspection from a qualified ecologist to determine any species present and appropriate management measures and procedures to be followed for removal of such trees.



### **Green and Golden Bell Frogs**

- Engagement of a suitably qualified ecologist prior to any clearing works to undertake pre-construction surveys for Green and Golden Bell Frog (between September and January). Determining whether individuals are present within the study area and an estimate of population size will assist in defining procedures to be detailed in the Green and Golden Bell Frog Management Plan.
- The Green and Golden Bell Frog management plan would detail at a minimum environment induction training, hygiene management, exclusion fencing, pre-clearance surveys, handling, relocation procedures and reporting procedures and impact mitigation measures.
- Installation of appropriate temporary frog fencing during the construction phase to exclude Green and Golden Bell Frogs from construction areas (whether they are recorded during pre-construction survey or not). Fencing should be placed within areas mapped as habitat for Green and Golden Bell Frog, plus 200 metres either side, and would remain in place until the completion of all construction activities including installation of fencing and revegetation. Frog fences would be monitored by the project ecologists, at a frequency determined by the results of the pre-construction surveys.
- Implementation of hygiene protocols to prevent the introduction and spread of Chytrid Fungus. This is critical as Chytrid Fungus is a key threat to the Green and Golden Bell Frog as well as other frog species. Strict protocols should be applied (regardless of whether Green and Golden Bell Frog is recorded during pre-construction surveys) and would need to be managed with due consideration to the proximity of the Kooragang Island/Ash Island key population and nearby habitats.

### **Microbats**

- Works should consider a staged approach through the M1 tunnel. For example staging may involve the following process:
  - Suspend a material barrier to delineate one third or half of the tunnel length. No work should be conducted on the other side of the barrier in order to minimise disturbance to roosting bats. The barrier should also aim to inhibit noise impacts through the tunnel.
  - Conduct work in that section until completed according to protocols (e.g. night time hours).
  - Access must be one way to ensure disturbance within the tunnel is limited to the section.
- Engagement of a suitably qualified ecologist prior to any clearing works to undertake pre-construction surveys of the M1 tunnel to confirm the presence of known microbat roost sites and identify any new roost sites, species present and activity levels.
- Installation of small false ceilings / shields around bat roosts to reduce impacts from light disturbance and construction activity within the M1 tunnel. These would remain in place following construction to also reduce the ongoing impacts of lighting in the tunnel and increased pedestrian activity.
- A microbat management plan that would detail at a minimum environment induction training, pre-construction / pre-clearance survey details, reporting procedures, impact mitigation measures and construction procedures.

### **Wetland birds**

- Engagement of a suitably qualified ecologist prior to any clearing works to undertake pre-construction surveys of wetland birds to determine usage of threatened species and inform procedures within the wetland bird management plan.
- A wetland bird management plan that would detail at a minimum environment induction training, impact mitigation measures and reporting procedures.

#### 7.3.2 Operational measures

The following mitigation measures would be implemented during the operational phase of the proposal. The details of these measures would be confirmed during the detailed design phase (section 7.2.1):

- Appropriate signage would be installed which states that dogs should be kept on a lead at all times while using the trail, to protect wetland birds. No dogs are permitted in the National Park.
- Appropriate signage would be installed which states that trail bikes (off-road motorcycles), which are known to disturb wildlife, are not permitted within the trail.
- Interpretive signage educating users on the importance of the surrounding wetlands and the species and ecological communities that occur there, as well as the importance of habitat within the M1 tunnel for roosting bats.
- Pathway lighting to be designed to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats.
- Ongoing management of retained native vegetation to reduce impacts of human activities and weed infestation (noting that herbicides should be avoided near wetland areas).
- Ongoing maintenance of fencing to ensure its effectiveness at restricting access to important wetland habitat.

#### 7.3.3 Monitoring

The wetland bird management plan, a microbat management plan and a Green and Golden Bell Frog management plan that to be included as part of the CEMP will make provisions for the ongoing management and monitoring of these species after construction is completed. These plans would be prepared in consultation with appropriate experts and relevant government agencies.

The management plans will make prescriptions relating to the duration of the respective monitoring programs, frequency of monitoring and timing of monitoring. The plans will also outline appropriate key performance measures and make provision for adaptive strategies should the monitoring determine that there are unfavourable outcomes. The management plans will also prescribe reporting requirements to document the findings of monitoring and to make recommendations regarding need for adaptive measures as appropriate.

## **7.4 Residual impacts**

The majority of the proposal is situated within and adjacent to the Hunter Wetlands National Park and is surrounded by wetland and estuarine habitats. The proposal will largely be positioned in cleared or exotic areas on the existing embankments of the former HWC Chichester water main and Richmond Vale railway that traverses the Hunter Wetlands National Park.



The Hunter Wetlands National Park contains both nationally and internationally important wetland systems with important habitat for a diverse range of wetland species. The Hunter Wetlands National Park is also broadly bound by the Sugarloaf Range to the west, which contains dry forest and escarpment habitats suitable for a number of native forest species, including forest owls and microchiropteran bats.

Due to the locational context of the proposal within a nationally important wetland, and proximity to the Sugarloaf Range, the key biodiversity values that are likely to be impacted by the proposal are identified by this BDAR to be:

- Migratory and threatened wetland and shorebird species
- Roosting microchiropteran bat species (at the M1 tunnel, on the western end of the subject site at the Stockrington connection)
- Green and Golden Bell Frog
- Threatened swamp and wetland ecological communities
- Sensitive aquatic habitats, including key fish habitat (protected marine vegetation)

The remainder of this chapter describes the potential impacts of the proposal on the key biodiversity values identified above. Potential impacts are broadly discussed in relation to construction and operational phases of the proposal.

Species for which the proposal may have serious and irreversible impacts (SAls) are also identified and assessed in accordance with Section 10.2.3 of the BAM (OEH, 2017a). As a number of the above entities are also listed under the EPBC Act, a summary of the potential impacts on MNES is provided at the end of this chapter.

#### 7.4.1 Construction impacts

##### *Vegetation clearing*

The proposal would require permanent removal of vegetation, including 3.3 ha of native vegetation and 26.5 ha of exotic/planted vegetation (see Table 7-1). The estimated vegetation loss assumes that all clearing and works associated with the proposal would be contained within the subject site.

The native vegetation to be removed consists of:

- 2.8 ha of TECs listed under the BC Act, of which 0.2 ha is also listed under the EPBC Act.
- 0.3 ha of protected marine vegetation under the FM Act in the form of mangrove and saltmarsh vegetation.
- 3.3 ha of native vegetation comprising foraging and roosting habitat for threatened and/or migratory fauna species.
- 26.5 ha of non-native vegetation comprising foraging and roosting habitat for some threatened and migratory fauna species.

Most of the vegetation that is proposed to be removed is limited to native regrowth forest (where original remnant forest was historically cleared for the railway and water main) and disturbed fringes of existing native wetland vegetation along the existing railway and water main embankment. Vegetation clearing within the Hunter Wetlands Centre at the Shortland end of the subject site is likely to comprise clearing of individual trees and pruning where required to allow access of plant and other construction equipment.

Despite the disturbed and modified nature of the fauna habitat to be removed, the types of habitat resources that would be disturbed include the following:

- Myrtaceous tree species that provide blossom, nectar, and fruiting forage for arboreal fauna and woodland bird species. These resources are restricted to remnant trees and regrowth forest at the western boundary of the wetlands and managed vegetation within the Hunter Wetlands Centre. The potential hollow resources provided by such trees are minimal to absent within the subject site.
- A low density of fallen logs and woody debris, which would provide marginal shelter and foraging habitat for native insects, common reptiles and amphibians.
- Exotic grassland habitat on the embankments along the pipeline and rail trail that provide potential foraging / roosting habitat for wetland birds and movement corridors for amphibians.
- Wetland vegetation on the margins of larger areas of mangrove forest, saltmarsh and brackish lagoons that provide foraging habitat for wetland and migratory birds, and the Green and Golden Bell Frog.

Table 7-1 Vegetation clearing within the proposal clearing area

PCT	Plant Community Type (PCT)	BC Act	EPBC Act	Extent in subject site (ha)
1528	Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast.	EEC	CEEC	0.18
1568	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Not listed	Not listed	0.22
1590	Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest	Not listed	Not listed	0.04
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	EEC	Not listed	0.76
1619	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	Not listed	Not listed	0.00
1718	Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	EEC	Not listed	0.41
1727	Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast	EEC	EEC	0.60
1747	Grey Mangrove low closed forest*	Not listed	Not listed	0.79
1746	Saltmarsh Estuarine Complex*	EEC	VEC	0.02
1737	Typha Rushland	EEC	Not listed	0.85
1808	Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline	EEC	Not listed	0.01
<b>TOTAL AREA OF PCTS (hectares)</b>				<b>3.3</b>
n/a	Planted vegetation	n/a	n/a	0.12
n/a	Exotic grassland	n/a	n/a	26.33
<b>TOTAL AREA (hectares)</b>				<b>29.8</b>

EEC – Endangered Ecological Community, CEEC – Critically Endangered Ecological Community, VEC – Vulnerable Ecological Community

\*Protected marine vegetation (Key Fish Habitat) (FM Act)

A number of mitigation measures are provided in Section 7.3 to minimise the potential for impacts to retained native vegetation adjacent to the study area.



### ***Impacts on aquatic habitats and protected marine vegetation***

The main impacts on aquatic habitats and protected marine vegetation is associated with the construction of the bridge crossings at Fishery Creek and Ironbark Creek. The proposal would result in the direct disturbance of approximately 0.9 ha of saltmarsh and mangrove habitats that are classified as protected marine vegetation under the FM Act. The predicted removal of 0.9 ha of saltmarsh and mangrove vegetation is approximately 10% of the occurrence within the study area and substantially less within the locality. Due to the small area of mangrove and saltmarsh vegetation predicted to be disturbed along existing tracks, and considering the larger areas of habitat that will be retained and undisturbed in the locality, the proposal is not likely to significantly reduce the extent of marine vegetation in the locality.

Potential shading of adjacent mangrove and saltmarsh vegetation from physical structures such as bridges can impact mangroves and saltmarsh, resulting in dieback or longer-term habitat loss. Shading impacts at the Ironbark and Fishery Creek crossings are likely to be minimal because the bridges are oriented north-south and adjacent mangrove and saltmarsh vegetation on the foreshore will continue to receive light for part of the day. At Fishery Creek, the proposed bridge decking will also be graded, and so adjacent vegetation will also receive dappled light through the decking.

The new bridges would be aligned with the stream contours (i.e. will be perpendicular to the banks), thus limiting the area of impact as much as possible. Impacts on riparian vegetation and in-stream flora would be limited to the area immediately adjacent to proposed bridges.

The use of elevated boardwalks and culverts at low points where the existing rail and water main embankment experience inundation is a low-impact option over other alternatives, and is also intended to minimise impacts to aquatic vegetation.

### ***Fragmentation and barrier effects***

The construction of a pedestrian and cycle path will be undertaken in an existing cleared corridor. Vegetation removal at the edges of the existing corridor is unlikely to widen the existing cleared corridor such that it will represent a hostile barrier for native flora and fauna species. The relatively small width of the proposal, and its placement within an existing cleared corridor, is not likely to fragment extant forest and wetland vegetation within the study area, nor will it impede movements of the highly mobile fauna species that are known to utilise the study area. Fence infrastructure will be fauna friendly and will not impede movements of native fauna, including wetland birds or amphibians.

### ***Injury and mortality of native fauna***

The proposal may cause displacement or mortality of fauna that are present at the time of vegetation clearing and construction activities. The majority of native bird species and non-arboreal mammal species occurring within the study area are likely to use these habitats as part of a wider network of habitat across the landscape. These species would likely disperse to avoid vegetation clearing and construction activities given their more mobile nature, and most individuals directly affected by the proposal are likely to be displaced into surrounding habitat rather than killed (if appropriate mitigation measures are implemented).

Less mobile terrestrial fauna, such as frogs and reptiles present within groundcover, nesting birds and their nestlings/eggs, nocturnal species sheltering in hollows during daylight hours and species in periods of torpor such as microbats are at most risk of mortality as a result of these activities.

Impacts to nocturnal species (such as microbats and arboreal mammals) from diurnal displacement from habitat clearing or disturbances include (but are not limited to) vulnerability to predation during daylight hours, increases in energy costs and potential increased competition for resources. Recommendations have been made in Section 7.3 to minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

### ***Soil and water pollution during the construction phase***

The proposal has potential to impact on water quality within adjacent and downstream wetland habitats during construction. Contamination associated with machinery and construction materials, and erosion/sedimentation associated with ground disturbance activities could have adverse impacts on surrounding sensitive wetland habitats, waterways and downstream aquatic environments, without appropriate pollution controls. Sediment-laden runoff to waterways can alter water quality and adversely affect aquatic life as well as wetland habitats for wetland species. Sedimentation and turbidity impacts can also arise from changes in flow velocity of waterways due to placement of instream structures associated with water crossings such as the proposed bridges across Ironbark Creek and Fishery Creek.

Potential water quality impacts would be managed through the implementation of soil and water management measures as described in Section 7.3, and include the use of appropriate erosion and sediment control devices and pollution control methods prescribed under a CEMP.

Disturbance of acid sulfate soils could also potentially impact aquatic habitats. The disturbance of acid sulfate soils can form sulphuric acid when soils react with oxygen in the air. Sulphuric acid can leach into surrounding environments, causing soils to become very acid and toxic and impacting waterways and soil health resulting in environmental and agricultural degradation. The construction of the proposal will largely take place on previously disturbed land (i.e. embankments associated with the rail and water main) where soils have historically been disturbed and oxidisation is likely to have already taken place. Furthermore, earthworks for the proposal would be limited to minor cut and fill along the proposal route to a depth of 0.2 metres or less.

Notwithstanding, potential risks from acid sulfate soils will be managed under an acid sulfate soil management plan prepared as part of the CEMP and as described in Section 6.4.3 of the EIS main report.

### ***Potential to modify hydrological regimes***

The use of boardwalks and culverts has been proposed to maintain the current hydrological regime of the wetlands and to further minimise impacts to aquatic vegetation. One section of the study area, near Fletcher (i.e. the Fletcher connection) is a greenfield site; to connect the proposal to Fletcher, the construction of a boardwalk and box culverts is proposed and is intended to minimise any changes to the current hydrology of the wetland by allowing drainage lines to continue to flow under the pathway. There may be temporary disturbances within these drainage lines during construction but temporary diversions will be put in place to maintain flows. Any flows requiring diversion would be intercepted, diverted and discharged as near as practical to the existing flow path(s). These measures will minimise the potential changes to flow pathways and flow volumes in the downstream environment.

Increases in surface water flows may occur as a result of the construction of hardstand along the pathway. This has potential to change local flow pathways, and increase flow volumes and velocities adjacent to the pathway. However, grassed shoulders will be maintained along the pathway, which would be expected to attenuate flows and act as a filtration for surface run-off into the surrounding wetland.

### **Noise and vibration**

Impacts from noise and vibration are expected during the various stages of construction as a result of vegetation clearing, vehicle movement and operation of plant for establishment of the trail. Raised levels of noise and vibration may deter native fauna from using the study area during construction or cause animals to temporarily abandon the study area in search of quieter areas.

Bat species using the tunnel for roosting and wetland bird species are likely to be more sensitive to noise impacts compared with other native fauna, particularly during breeding or torpor periods. Furthermore, construction noise may be concentrated or amplified in the enclosed M1 tunnel, compared with construction noise in the wetland (where noises are expected to be attenuated over distance in the open environment). In this respect, noise impacts have potential to be substantial, however most likely short term (e.g. 1-2 months), depending on the timing and method of construction. Mitigation measures including the timing of construction (e.g. during the non-breeding period of bats) and staging of the construction through the tunnel including the placement of barriers will be key to minimising the potential impacts of noise and vibration to roosting bats.

It is likely that fauna species that occur within the vicinity of the study area are somewhat habituated to noise impacts due to the proximity of residential areas and major roads, and that species that are more sensitive to increased noise levels have already moved away from these areas.

Measures to reduce noise and vibration impacts on native fauna have been summarised in Section 7.3.

### **Introduction of pathogens during construction**

Construction activities have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangalii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) throughout the subject site. Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment and employees. The spread of diseases and pathogens is not restricted to the construction phase of the proposal; they may also be introduced by visitors/users once construction is completed and the pathway is open to the public.

Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can lead to the extinction of local populations once introduced into an area. The minimisation and control of Chytrid fungus is a particularly important consideration for the proposal due to the historical and potential persistence of Green and Golden Bell Frog (*Litoria aurea*) within the subject site (the Sandgate/Hexham Swamp Key Population), and the proximity of the subject site to the Kooragang/Ash Island Key Population of Green and Golden Bell Frog.

Mitigation measures are included in Section 7.3 to minimise and mitigate the risk of pathogen establishment within the study area.

#### **7.4.2 Operational impacts**

### **Weed invasion and edge effects**

Removal of vegetation causes a number of new environmental conditions to develop along the edges of cleared environments, in particular in environments where the removal of the woody strata promotes the invasion of exotic species due to increased light and physical space.



Impacts from edge effects are considered to be minimal, as the subject site is already heavily edge impacted, with existing weed infestations and exotic perennial grasses present throughout the study area. Notwithstanding, mitigation measures are included in Section 7.3 to minimise and mitigate the risk of increased weed impacts within the study area, particularly as disturbance may facilitate the spread of propagules into waterways and sensitive aquatic environments.

### **Artificial lighting**

Permanent lighting along the proposed pathway has potential to result in light impacts on native fauna. Permanent lighting can discourage native species from using habitat where diffuse light penetrates into adjoining areas of vegetation. The foraging and nesting regimes of some nocturnal native mammals and birds can therefore be disrupted by lighting. In addition, the eyesight of nocturnal species (such as owls and possums) is hindered by bright lights, and when they are affected by this, they can become more susceptible to predation.

The key potential impact from permanent lighting of sections of the subject site is likely to be on bats roosting in the M1 tunnel. Bat responses to light are complex; responses can be species-specific with some species displaying more tolerance to non-dark roost sites compared with other species (Gonsalves and Law, 2018). Certain species are even known to utilise artificial roost sites such as nest boxes that do not provide completely dark roosting environments (Jung and Threlfall, 2016). For species that can tolerate artificial lighting, non-dark roost sites can be suboptimal compared with dark roost sites due to increased exposure to predation (Patriarca and Debernardi, 2014), with full illumination known to cause bats to abandon their roost sites (Laidlaw and Fenton, 1971). The type of lighting may also have an influence on the roost site, with bats known to avoid light emitting diode (LED) lamps, even when dimmed (Rowse *et al.*, 2016). Other known effects of artificial lighting near roost sites include delaying the onset of evening emergence, which consequently shortens the foraging time (Patriarca and Debernardi, 2014, and references therein). Cave-roosting bats are particularly sensitive to light more so than noise and pedestrian activity (Mann *et al.*, 2002), although the effect of artificial lighting is expected to be more significant at breeding sites rather than diurnal roosting sites as it may impact more immediately on breeding success.

Artificial lighting is known to facilitate foraging for some species, with artificial lighting known to benefit fast-flying aerial hawking species that catch their insect prey on the wing (Patriarca and Debernardi, 2014; Rowse *et al.*, 2016; Gonsalves and Law, 2018). Bat activity in some areas of the subject site may increase with the installation of artificial lighting where foraging activity could increase with increased insect activity or conversely the alternate scenario could also occur (e.g. reduction in bat activity).

Installation of 'shields' or false ceilings around roost sites would reduce the potential for delayed roost emergence and roost abandonment in the M1 tunnel, maintaining the suitability of these roosts for microbats. Implementation of other design measures discussed in section 7.2.1 would further reduce the potential for light impacts on roosting and foraging for microbats

### **Pedestrian activity**

Research indicates that human disturbance on wetland birds can cause a range of behavioural and/or physiological responses that may result in permanent or temporary consequences including displacement from preferred habitat, exposure of eggs or chicks, disruption of behavioural displays, disruption to foraging behaviour and increased energetic expenditure associated with responses (Glover *et al.*, 2011). By increasing and improving access through wetland areas it is reasonable to assume that increased pedestrian and bicycle traffic will increase disturbances to wetland bird species that may utilise the adjacent habitat. Some species may habituate to this disturbance, for example the Hunter Wetlands Centre is known to support a wide diversity and abundance of waterbirds as well as receiving regular human foot traffic that has the potential to disturb roosting and foraging birds. However, not every species is likely to habituate and some level of disturbance from human presence is still likely (Glover *et al.*, 2011).

In terms of migratory shorebirds, human disturbance is considered a major threat, particularly in areas identified as 'important habitat' (DEE, 2017b). The Hunter Estuary at large is recognised as providing vital habitat for a range of threatened migratory shorebird species (Brereton and Taylor-Wood, 2010; NPWS, 2015). However, as noted by DEE (2017b), "although a large area may be considered internationally or nationally important...within that area there may be particular sites that are more valuable than others, such as regular roosting and feeding sites...[and] it may be pertinent to strongly protect such sites from development and recreational activities that may disturb shorebirds, but allow these activities within the boundary of the broader area".

Data for relevant wetlands adjacent to the proposal such as Hexham Swamp and Pambalong Nature Reserve suggests that although some migratory shorebirds occasionally utilise these sites in low numbers (Herbert, 2007), overall they are unlikely to constitute 'important habitat' according to the process identified in DEE (2017b). The data in Herbert (2007) suggests that site fidelity for threatened shorebirds in these areas is low, indicating that other roosting and feeding sites within the Hunter Estuary that regularly support larger numbers of migratory shorebirds are likely to be more valuable to these species. If the individuals that occasionally visit wetland habitat adjacent to the proposal are disturbed by increased human traffic, it is unlikely that this will result in any significant impacts to populations of these species with suitable and readily available habitat available within the broader Hunter Estuary.

The distance at which birds will fly away in response to different kinds of disturbance (i.e. bicycles, pedestrians, cars) is referred to as the flight-initiation distance (FID) (Weston *et al.*, 2012). Few studies in Australia have provided measures of FIDs, and there are many limitations to FID data that is currently available, such as the variance in FID associated with the type of stimulus involved (e.g. walkers with dogs versus walkers without dogs) (Weston *et al.*, 2012). There is also limited data on whether behavioural responses to disturbance are related to consequences at the population level, such as increased mortality or reduced reproduction rates (Stillman *et al.*, 2007).

A consistent finding of research into disturbance of wildlife indicates that the impact of a disturbance is proportional to the distance between the stimulus (human activity) and the animal (Weston *et al.*, 2009). This suggests that although individuals in close proximity to the trail may experience disturbance, the level of disturbance is likely to decline with increasing distance from the trail. Depending on the species and their expected FID, birds within 100m of the trail (Lilleyman, 2017) are likely to be most susceptible to disturbance. It is difficult to quantify the impact that increased human activity associated with the proposal will have on wetland birds, and whether such impacts are likely to result in consequences at a population level. However, given the broad extents of suitable habitat available to wetland bird species beyond 100m from the trail, as well as in the Hunter Estuary at large, pedestrian disturbance is unlikely to result in a significant impact to wetland bird species that would result in population level declines.

Mitigation measures to increase public awareness and reduce the potential for disturbance to wetland birds are described in Section 7.3.

Increased pedestrians (foot traffic) and cyclists through the M1 tunnel particularly during daylight hours may negatively affect roosting microbats. For example, increases in human activity on the habitat of roosting microbat species, can lead to roost abandonment, and increases in the burning of winter fat storages (McCracken, 1989; DERM, 2011). Placement of barriers e.g. shields/false ceilings over the roost sites will minimise the potential impacts of increased pedestrian usage on roosting bats within the tunnel.

Mitigation measures to reduce the potential for disturbance to microbats are described in Section 7.3.

## 7.5 Prescribed impacts

Prescribed biodiversity impacts of relevance to the proposal have been considered along with other residual impacts in Section 7.4 with reference to Section 9.2 of the BAM:

- 'Impacts on habitat of threatened species or ecological communities associated with human made structures' through consideration of potential indirect impacts of noise and other disturbance on potential microbat roost sites in the M1 tunnel.
- 'Impacts on habitat associated with areas of non-native vegetation' through consideration of impacts associated with amphibians and wetland birds utilising the grassed embankments within the subject site and potential injury or mortality of fauna during construction.

Measures to minimise these prescribed impacts are described in Section 7.3.

## 7.6 Potential serious and irreversible impacts

An impact is to be regarded as serious and irreversible if it is likely to contribute significantly to the risk of a threatened species or ecological community in NSW becoming extinct. There are four principles set out in clause 6.7 of the *Biodiversity Conservation Regulation 2017* that capture the types of impact that are likely to contribute significantly to extinction risk of threatened species or communities listed under the BC Act. These are:

**Principle 1** – the impact will cause a further decline of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.

**Principle 2** – the impact will further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size.

**Principle 3** – the impact is an impact on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.



**Principle 4** – The impacted species or ecological community is unlikely to respond to measures to improve its habitat and vegetation integrity and therefore its members are not replaceable.

There are two potential SAI entities identified in the *Guidance to assist a decision-maker to determine a serious and irreversible impact* (OEH, 2017c) that are relevant to the proposal:

- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Curlew Sandpiper (*Calidris ferruginea*)

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is a potential SAI entity where breeding habitat is likely to be impacted by a proposal. This species is dependent on maternity caves (i.e. breeding habitat), which is a non-responding attribute (Principle 4). The proposal would impact on roosting and foraging habitat for the Large-eared Pied Bat but is not likely to impact on breeding habitat (see Section 6.2.1).

For this reason, the Large-eared Pied Bat is **not** an SAI entity for the purposes of this BDAR.

The Curlew Sandpiper (*Calidris ferruginea*) is a potential SAI entity where important habitat identified by OEH is likely to be impacted by a proposal. The Curlew Sandpiper is a migratory wetland bird that breeds in the northern hemisphere but relies on successful feeding in the austral summer to migrate over 10,000 km back to its breeding grounds. On the basis of Principle 3, impacts on important habitat in the non-breeding season could have serious and irreversible impacts on breeding. As the proposal is likely to impact on mapped important habitat, the Curlew Sandpiper is an SAI entity for the purposes of this BDAR and further assessment is provided below in accordance with Section 10.2.3 of the BAM (OEH, 2017a).

#### 7.6.1 Assessment of SAI entity, Curlew Sandpiper

##### **a) Actions and measures taken to avoid direct and indirect impact on the SAI entity**

The proposal will consist of a three metre wide track that will pass through a range of habitats, including areas mapped as important habitat for the Curlew Sandpiper.

Displacement caused by human activities and encroaching development pressures has been recognised as a threat to the Curlew Sandpiper at the Hunter River Estuary, being in close proximity to urban areas of Newcastle (NSW Scientific Committee, 2011b). Recognising this, the proposal has been designed to minimise impacts to ecological values at the site, including the Curlew Sandpiper, in the following ways (as described in Section 7.2):

- Locating the alignment within existing cleared areas and areas of exotic vegetation wherever possible to minimise native vegetation removal and associated disturbance to fauna habitats, including habitat of the Curlew Sandpiper.
- Installing elevated boardwalks in sensitive areas such as wetlands.
- Aligning new bridges with stream contours perpendicular to the banks.
- Limiting impacts on riparian vegetation and in-stream flora.

The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation, of which 0.9 ha of native vegetation and 18.1 ha of exotic grassland intersects with habitat mapped as important habitat for Curlew Sandpiper by OEH. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Ramsar site. Designing the proposal to align with already disturbed areas has resulted in reduced direct impacts to the Curlew Sandpiper in the form of habitat disturbance.

Roosting and foraging birds are most sensitive to discrete, unpredictable disturbances such as sudden, loud noises (for example demolition activities) and from objects that approach them from the water (such as boats) (DEE, 2017b). Potential impacts to the Curlew Sandpiper therefore include disturbance and disturbance to habitat as a result of construction, including increased noise, machinery, human visitation, sedimentation, erosion and pollutant run-off associated with construction activities.

Measures that will be taken to reduce the potential these impacts include:

- Restricting construction within areas of potential shorebird habitat (chainages 5200 to 600 and the extension to Hunter Wetlands Centre) to periods when migratory birds, including the Curlew Sandpiper, are in the northern hemisphere (between late April and the beginning of September) to avoid potential disturbance from increased noise, machinery and human visitation during construction activities.
- A CEMP and Sediment and Erosion Control Plan, including a wetland bird management sub-plan will be prepared to detail mitigation measures that will be implemented during construction to reduce the potential for impacts associated with sedimentation, erosion and pollutant run-off that have the potential to impact Curlew Sandpiper habitat in and adjacent to the subject site.

Potential indirect impacts to the Curlew Sandpiper that may occur in the operational phase of the proposal are primarily related to the potential for displacement due to human recreational activities in the subject site. The increased visitation through the Hunter Wetlands National Park at the completion of the proposal may result in increased anthropogenic disturbance. Studies have shown that the distance at which Curlew Sandpipers will fly away in response to different kinds of disturbance (i.e. bicycles, pedestrians, cars) known as the Flight Initiated Distance or 'FID' is a between 14 metres and 35 metres (Glover *et al.*, 2011). Mitigation measures that would be implemented to avoid these impacts include:

- Appropriate signage through the subject site designating areas where dogs are not permitted or should be kept on-leash (such as through the Ramsar site and Hunter Wetlands National Park).
- Designated areas for birdwatching and appropriate fauna-friendly fencing, to prevent users diverging from the pathway and trampling native vegetation that may result in damage Curlew Sandpiper habitat.
- Interpretive signs to educate the public on shorebird species utilising the site and appropriate ways to minimise disturbance to them.
- Sympathetic lighting strategies to minimise any lightspill into habitat areas.
- Planting of appropriate native species adjacent to the track to create a disincentive for people to stray into to adjacent habitat.

#### **b) Size of the local population directly and indirectly impacted by the proposal**

Curlew sandpipers are a common summer migrant found throughout the Hunter Estuary, primarily in saline habitats (Herbert, 2007). Though the Hunter Estuary has previously been thought to support up to 4000 individuals (when the species is in Australia), declining counts suggest that this has not been the case for several years (Brereton and Taylor-Wood, 2010). The frequency of counts exceeding 200 birds has declined since 1999, with the total NSW population thought to be approximately 2500 individuals (NSW Scientific Committee, 2011b). It has even been suggested that the changes within the estuary (particularly to tidal regimes) may have resulted in much of the previously suitable habitat for the species being no longer available (ARS, 2006).

The areas of habitat mapped as important for the Curlew Sandpiper by OEH are largely associated with known sites for wetland and migratory bird species in the Hunter Estuary including Hexham Swamp, the Hunter Wetlands Centre, Pambalong Nature Reserve, Minmi Sewage Treatment works, Market Swamp and Antennae wetland (Herbert, 2007). Of these locations, Curlew Sandpiper have been recorded at Hexham Swamp, the Hunter Wetlands Centre and Pambalong Nature Reserve.

There are 782 OEH BioNet Atlas records within 10 km of the study area, primarily within the Hunter Wetlands National Park, where suitable habitat for the species occurs. Curlew Sandpiper records within the broader Hunter Estuary are concentrated at a few key locations such as Fullerton Cove and Stockton Sandspit, where records of 400+ birds have been described (Herbert, 2007). Comparatively small numbers of individuals have been recorded at locations in close proximity to the study area, including the Hunter Wetlands Centre (1-5), Hexham Swamp (10) and Pambalong Nature Reserve (6-20), none of which have been identified as a key foraging location for the species (Herbert, 2007).

The locations relevant to the proposal (that occur in or adjacent to the subject site) are not thought to support a large number of birds from the local population utilising the Hunter Estuary at large. Herbert (2007) states that a maximum of 5 individual Curlew Sandpipers are 'occasionally recorded' at the Hunter Wetlands Centre, a maximum of 10 individuals are 'rarely recorded' at Hexham Swamp and up to 20 individuals have been observed at Pambalong Nature Reserve. The number of individuals using potential habitat in and adjacent to the study area is therefore estimated to be fewer than 20 individuals that may occasionally utilise habitat within the study area on a seasonal and intermittent basis. This represents 0.4% of the NSW population that may be impacted by the proposal (with the percentage of the local population likely to be much less).

**c) The extent to which the impact exceeds any threshold for the SAIL entity that is specified in the Guidance to assist a decision –maker to determine a serious and irreversible impact (OEH, 2017c)**

Thresholds for SAIL entities are designed to assist in determining whether an impact is likely to be serious and irreversible. Any area of mapped important habitat for the Curlew Sandpiper triggers further assessment as an SAIL entity, as explained at the beginning of Section 7.6.

The subject site intersects with habitat mapped as an important area for the Curlew Sandpiper (as confirmed by OEH for this proposal) and therefore triggers the SAIL threshold for the SAIL entity. The extent of important habitat that is predicted to be removed includes 18.1 ha of exotic grassland and 0.9 ha of native vegetation.

However, although the threshold for the SAIL is triggered, a significant and/or irreversible impact to the Curlew Sandpiper is not predicted due to the following reasons:

- A large proportion of the habitat mapped within the subject site to be removed consists of exotic grassland (18.1 hectares) associated with the existing alignment of the HWC Chichester rising main and Richmond Vale railway. This is not considered suitable habitat for Curlew Sandpiper, which utilises the edges of shallow water in intertidal mudflats and sheltered coasts (NSW Scientific Committee, 2011b).
- The 0.9 hectares of potential habitat to be removed is considered to be poor quality habitat for the Curlew Sandpiper based on its proximity to previously disturbed habitat and exotic vegetation.



- The habitat in and adjacent to the subject site is considered to be marginal habitat due to the low number of birds recorded there (Herbert, 2007). Most records for the species are concentrated at other sites within the Hunter Estuary such as Stockton Sandspit and Fullerton Cove, suggesting these represent more suitable, preferred foraging and roosting areas.
- If any birds are utilising the area, disturbance will be minimised through appropriate mitigation measures (as described in Section 7.3).

**d) The likely impact (including direct and indirect impacts) that the proposal will have on the habitat of the local population<sup>5</sup>, including:**

**i) Estimate of the change in habitat available to the local population as a result of the proposal**

Habitat mapped as important for the Curlew Sandpiper by OEH in and around the study area includes habitat associated with known records of the species within Hexham Swamp, the Hunter Wetlands Centre and Pambalong Nature Reserve. However, detailed vegetation mapping of Kooragang and Hexham Swamp National Park indicates that there is at least 7000 ha of habitat within the Hunter Wetlands National Park (Winning, 2012) but only 75.2 hectares of potential Curlew Sandpiper habitat within the study area (associated with PCTs 1747, 1746, 1737 and 1808; see Table 6-1).

Within the study area, 0.9 hectares of this potential native habitat will be subject to direct disturbances associated with widening the existing cleared alignment associated with the HWC Chichester rising main and Richmond Vale railway. The direct change in habitat available to the local Curlew Sandpiper population (i.e. the loss of 0.9 hectares of potential native habitat) as a result of the proposal is considered minor due to the following reasons:

- The habitat being removed is located along the edge of the existing, historically disturbed alignment, and occurs adjacent to primarily exotic grassland vegetation and is therefore considered low quality habitat for the Curlew Sandpiper.
- The habitat in and directly adjacent to the study area (including the Hunter Wetlands Centre, Hexham Swamp and Pambalong Nature Reserve), is thought to occasionally attract only a small number of Curlew Sandpipers (up to 20) (Stuart, 2017), suggesting that only a small fraction of the local population may occasionally use the site rather than relying on it as a key foraging location.
- The Hunter Wetlands National Park consists of over 6000 hectares, with the majority of the local Curlew Sandpiper population recorded consistently and in large numbers (>200 individuals) at several key locations outside the study area such as Fullerton Cove, Stockton Sandspit, Ash Island and Deep Pond (Stuart, 2017).

This indicates that the potential habitat in and around the study area where small numbers of individuals have occasionally been recorded, is not preferred habitat for the species within the broader landscape of the Hunter Estuary. As the majority of the population does not frequent the site, the change to available habitat, through both direct and indirect impacts, is considered to be minor and relevant to a small number of individuals that may occasionally utilise the site. It is therefore reasonable to conclude that the change in habitat available to the local population as a result of the proposal is negligible.

**ii) Proposed loss, modification, destruction or isolation of the available habitat used by the local population**

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<sup>5</sup> BloNet Atlas records or other documented, quantifiable means must be used by the assessor to estimate what percentage of the species' population and habitat is likely to be lost in the long term within the IBRA subregion due to the direct and indirect impacts of the development OEH (2017a). *Biodiversity Assessment Method*. NSW Office of Environment and Heritage..

Approximately 0.9 hectares of potential habitat for the Curlew Sandpiper would be directly impacted (removed) as a result of this proposal, a small fraction of the 75.2 hectares within the study area and a negligible amount in the context of the Hunter Wetlands National Park as a whole, which is over 6000 hectares and contains extensive suitable habitat for the Curlew Sandpiper (Stuart, 2017). Furthermore, this habitat has already been subjected to historical disturbance, as it is located along the existing, cleared alignment and as a result is not considered to be preferred habitat for the species.

The habitat used by the vast majority of the local population of Curlew Sandpipers occurs elsewhere in the Hunter Estuary, with only occasional records of a small number of individuals (<20) recorded using the available habitat in and adjacent to the subject site (Stuart, 2017). This suggests that any loss or modification to available Curlew Sandpiper habitat within the study area is likely to impact on only a small number of individuals that may occasionally visit the site.

Although the proposal will transect areas of potential habitat, given the mobility of Curlew Sandpipers this is not considered likely to isolate areas of available habitat and individuals are considered capable of easily moving between patches of suitable habitat within the landscape.

The primary modification to potential Curlew Sandpiper habitat associated with the proposal is the increased potential for disturbance associated with human recreational use of the site. However, given the site does not appear to represent preferred habitat within the Hunter Estuary and only a small number of individuals are thought to occasionally utilise the site (Stuart, 2017), it is reasonable to conclude that the proposal will not result in displacement of the local population. The existing track through the site is already used as an access track for walkers and birdwatchers, suggesting that individuals may be habituated to background disturbance associated with some human movements through the site.

**i) Modification of habitat required for the maintenance of processes important to the species' life cycle, genetic diversity and long-term evolutionary development**

The potential Curlew Sandpiper habitat that would be modified as a result of the proposal includes 0.9 hectares of potential habitat that will be removed within the subject site and an increase in disturbance associated with human recreational use of the track to the remaining 75.2 hectares within the study area.

The potential habitat in and adjacent to the study area may be utilised occasionally by a small number of individuals (<20) for foraging and/or roosting, based on previous records in the area (Stuart, 2017). However, given the broader landscape context, where favoured foraging and roosting habitat for the species appears to be located at other sites within the Hunter Estuary (Stuart, 2017), modification to this habitat is unlikely to disrupt processes important to the species' life cycle, genetic diversity or long-term evolutionary development. Extensive areas of suitable habitat within the Hunter Estuary would still allow the local population to fulfil these processes.

Given the low number of individuals thought to be utilising the site, the impacts of increased disturbance are considered to be low, and appropriately controlled with mitigation measures such as fencing and signage that will further reduce the likelihood of any impacts to birds that may occasionally visit habitat surrounding the track.

**e) The likely impact on the ecology of the local population (i.e. breeding, foraging, roosting and dispersal or movement pathways)**

The ecology of the local population of Curlew Sandpipers is unlikely to be impacted by the proposal due to the following reasons:

- The habitat in and directly adjacent to the study area (including the Hunter Wetlands Centre, Hexham Swamp and Pambalong Nature Reserve), is thought to occasionally support only a small number of individuals (up to 20) (Stuart, 2017), suggesting that it is not key foraging or roosting habitat for the local population such that its modification would impact the ecology of the local population.
- The Hunter Wetlands National Park consists of over 6000 hectares, with the majority of the local Curlew Sandpiper population recorded in large numbers (>200 individuals) at several key locations outside the study area such as Fullerton Cove, Stockton Sandspit, Ash Island and Deep Pond (Stuart, 2017). Key foraging and roosting locations important to the ecology of the local population are therefore considered to be outside the area of habitat subject to impact as a result of the proposal, and the proposal is not likely to compromise the ability of the local population to forage, roost or disperse successfully.
- The Curlew Sandpiper breeds in Siberia, however access to southern foraging grounds is important to ensure adequate rest and nourishment to make the return journey north. The proposal will not interfere with access to preferred foraging grounds in the adjacent Hunter Estuary and is therefore not considered to compromise the ability of the Curlew Sandpiper to successfully complete its lifecycle.
- The species is capable of undertaking long migrations and moving between areas of adjacent habitat, therefore the proposal is not considered to interfere with dispersal or movement pathways for the species.
- Mitigation measures associated with restricting construction to periods where the shorebirds are in the northern hemisphere will reduce potential for disturbance to the birds associated with noise, vehicles, machinery and increased human presence during construction.
- Mitigation measures requiring the implementation of appropriate erosion and sediment controls will reduce any potential for damage to foraging habitat from sedimentation, run-off or pollution.
- Installation of appropriate fencing and signage will reduce the likelihood of any impacts from increased human recreation to birds that may occasionally visit the potential habitat surrounding the track.

**f) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development**

The species is capable of undertaking large migrations, and is not sedentary within the foraging or roosting grounds it visits in the Hunter Estuary. The occasional records of individuals at Hexham Swamp, the Hunter Wetlands Centre and Pambalong Nature Reserve, indicate that individuals visit these locations on occasion as part of a broader network of preferred sites in the Hunter Estuary and beyond. The proposal is unlikely to cause any restrictions to such movements, and therefore will not fragment or isolate the population. Individuals utilising habitat associated with the study area and surrounds, will still be able to access this habitat.



**g) The relationship of the local population to other population(s) of the species. This must include consideration of the interaction and importance of the local population to other population(s) for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range**

The Curlew Sandpiper breeds in Siberia and migrates south during non-breeding periods across a wide range of global areas, including the East Asian-Australasian Flyaway, which is thought to support approximately 13% of the global population (Bamford *et al.*, 2008). Their distribution within Australia is widespread, but mostly limited to coastal regions from Queensland and the Northern Territory to as far south as Tasmania (DEE, 2015). The population of Curlew Sandpiper in NSW is thought to be around 2500 birds, with the Hunter Estuary considered to be an important site due to historical records of large numbers of birds being recorded there (Herbert, 2007).

The proposal is not considered to impose any restrictions on the interaction of the local Curlew Sandpiper population with other populations either within Australia or beyond. The proposal is not considered to interfere with the ability of the Curlew Sandpiper to meet its foraging and roosting needs while present in the Hunter Estuary, and it is therefore unlikely to impose any additional threats to individual survival that may impact upon factors such as breeding, genetics or dispersal.

**h) The extent to which the proposal will lead to an increase in threats and indirect impacts, including impacts from invasive species that may in turn lead to a decrease in the viability of the local population**

The proposal is considered unlikely to lead to an increase in impacts from invasive species above that which already occurs as a result of historical activities within the site such as the creation of the existing alignment through areas of Curlew Sandpiper habitat.

Noise and disturbance associated with construction would be a key disturbance factor, but mitigating this by restricting construction to periods when the birds have migrated to the northern hemisphere would offset this risk sufficiently to ensure the local population wouldn't incur impacts.

The main concerns for indirect impacts to the species relate to the potential for increased human movement and noise that may lead to disturbance of individuals that visit the site. As previously discussed, due to the small number of individuals recorded at relevant locations in and adjacent to the study area (<20), it is unlikely that the local population that utilises the broader Hunter Estuary, is reliant on these sites. As such, disturbances to individuals utilising the area are unlikely to contribute to a decrease in the viability of the local population, given the ability of these individuals to retreat to preferred feeding and roosting grounds in the broader Hunter Estuary to fulfil their ecological requirements.

Furthermore, it is possible that birds have already become habituated to a certain level of background disturbance, given the urban nature of the site and the prevalence of walkers, vehicles and other noises already using the area, particularly around the Hunter Wetlands Centre.

Appropriate signage should be erected at all entrance points of the trail to areas mapped as important habitat for this species prohibiting dogs, as well as fencing to reduce humans from diverging from the path. Such mitigation measures are likely to reduce the potential for disturbance if the Curlew Sandpiper is present in the vicinity of the study area.

Due to the existing rail alignment, indirect impacts such as edge effects are unlikely to increase with the proposed vegetation clearance. Impacts from pollutions, spread of pathogens and weeds are addressed in Section 7, and include the implementation of CEMPs and Sediment and Erosion Management Plans to minimise impacts from construction activities.

**i) An estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion**

The most recent estimate of the number of mature individuals in Australia was 115,000, with a decreasing trend (TSSC, 2015). According to the endangered species listing for the Curlew Sandpiper, the current estimated population within NSW is fewer than 2,500 individuals, with the Hunter Estuary considered the most important site for the species in NSW (NSW Scientific Committee, 2011b). Records summarised by Herbert (2007) suggests that 200 – 300 Curlew Sandpiper were recorded in the Hunter Estuary each season between 2000 – 2007 (NSW Scientific Committee, 2011b).

The importance of the Hunter Estuary to the Curlew Sandpiper, is reflected by the protection of over 6000 hectares within the Hunter Wetlands National Park, almost 3000 of which forms part of the Hunter Estuary Wetlands Ramsar site (which also includes the nearby Hunter Wetlands Centre). Most importantly, the locations where the Curlew Sandpiper have been recorded in the largest numbers, are protected within the NSW reserve system, ensuring available preferred habitat remains protected for the species.

**j) The measure(s) proposed to contribute to the recovery of the species in the IBRA subregion**

Contribution to the species recovery in the region will be achieved through securing offset land based on the amount of vegetation mapped as important habitat for the Curlew Sandpiper (a Candidate Threatened Species using the BAM calculator) that is removed. The species credits that would be required to offset the impacts of the proposal on candidate threatened species are summarised in Table 8-2. Securing an appropriate offset would contribute to the protection of habitat for the Curlew Sandpiper.

## 7.7 Consideration of MNES

This section provides a summary of the MNES that were identified (or were considered likely to occur) within the study area and could potentially be impacted by the proposal. Under the EPBC Act an activity is required for referral to the Australian Government Environmental Minister if it is likely to have, or will have, a significant impact on a Matter of National Significance (MNES) (DotE, 2013).

### 7.7.1 Threatened ecological communities

The proposal is unlikely to have a significant impact on critically endangered and endangered EPBC Act-listed TECs identified in the subject site (Appendix F) as:

- The proposal has been located and designed to minimise impacts on the local occurrences off these TECs. Only a thin strip of disturbed edge habitat will be removed which represents a small percentage of the local occurrences of the TECs.
- The proposal will result in minor fragmentation of these TECs within the study area.
- The proposal will not impact on habitat that is critical to the survival of these communities.
- Mitigation measures will be implemented to avoid/minimise impacts on higher quality adjoining areas that will be retained.
- The proposal is unlikely to affect the recovery of the TECs.

## 7.7.2 Threatened species

### *Green and Golden Bell Frog*

The subject site contains wetland vegetation that represents habitat for the Sandgate/Hexham Swamp key population of the Green and Golden Bell Frog (DEC, 2005; DECC, 2007). This population is not always detectable and there has been some conjecture as to whether it is still extant (DEC, 2005; DECC, 2007). Surveys completed in 2019 for this BDAR did not detect the species, however the conditions at the time of survey were unfavourable and outside the preferred survey period.

Although accessible records within the study area are from 1990 or earlier (OEH, 2018c), information on the Sandgate/Hexham key population indicates that the species has been recorded after this time (DEC, 2005; DECC, 2007), possibly as recently as 10 years ago (pers. comm. M. Mahoney, 2018). The recovery plan for the species acknowledges that the Sandgate/Hexham Swamp key population is transient nature and takes the view that the population is still extant and merely occupying other components of the extensive potential habitat comprising parts of the Hexham Swamp wetland (DEC, 2005). Considering this, the species is assumed to be present within the study area, albeit in a transient manner.

According to the EPBC Act significant impact guidelines for the species (EPBC Act Policy Statement 3.19, DEWHA, 2009), all existing populations for the purposes of the guidelines are treated as important populations.

As described by DEWHA (2009), a proposal could have a significant impact on the Vulnerable listed Green and Golden Bell Frog if it results in:

**Threshold 1.** The removal or degradation of aquatic or ephemeral habitat either where the Green and Golden Bell Frog has been recorded since 1995 or habitat that has been assessed as being suitable according to these guidelines. This can include impacts from Chytrid fungus or *Gambusia* originating off-site.

**Threshold 2.** The removal or degradation of terrestrial habitat within 200 metres of habitat identified in threshold 1.

**Threshold 3.** Breaking the continuity of vegetation fringing ephemeral or permanent waterways or other vegetated corridors linking habitats meeting the criteria in threshold 1.

The proposal is likely to meet Threshold 1 and/or Threshold 2 if the views of the recovery plan for the species is upheld and the population is assumed to be present in the study area. The EPBC Act Policy Statement 3.19 states 'a referral under the EPBC Act should be considered' if an action meets one or more of the policy thresholds (DEWHA, 2009).

Notwithstanding the above, the proposal is unlikely to have a significant impact on the Green and Golden Bell Frog (Appendix F) as:

- The population is known to be transient and may occur across a larger area such that construction activities could have a high probability of avoiding interactions with individuals.
- The proposal would remove 3.3 ha of edge vegetation along an existing cleared corridor.
- The majority of areas of potential habitat within the study area would not be impacted by the proposal.
- Most suitable breeding habitat in the study area occurs outside of the construction footprint.
- Construction would be conducted outside of the breeding season, therefore avoiding impacts to the species lifecycle.



- Mitigation measures would be put in place to minimise and manage risks such as introduction and/or spread of invasive species and pathogens during construction.
- The proposal is unlikely to isolate the population, or create a permanent barrier that would fragment the population into two populations.

### **Large-eared Pied Bat**

The 2019 acoustic microbat surveys recorded 'definite' calls of the Vulnerable listed Large-eared Pied Bat at the M1 tunnel (*Chalinolobus dwyeri*) (refer to 5.4.1) and the species is concluded to be roosting in the tunnel in low numbers. These roosting habitats are not considered suitable breeding habitat for the species. Maternity roosts for the Large-eared Pied Bat occur in a small number of known locations associated with sandstone escarpments (DERM, 2011) and have specific requirements, including large caves with dome roofs and a stable microclimate with specific temperature and humidity ranges (DERM, 2011). The nature of the habitat within the M1 tunnel suggests that although unsuitable for breeding, it may be utilised on occasion by a small number of individuals as a temporary and transient roost site. No other suitable roosting habitat for the species was detected in the study area.

The proposal includes the removal of a linear strip of vegetation associated with an existing track, which contains 1.6 ha of marginal potential foraging habitat for the species. This is a very small fraction of available habitat in the broader landscape for this highly mobile species, and as the study area is surrounded by large extents of contiguous native woodland vegetation that would represent higher quality foraging habitat for the species, the impact of removal of this vegetation is considered negligible.

The proposal is unlikely to have a significant impact on the Large-eared Pied Bat (Appendix F) as:

- The habitat is not considered suitable to support an important population of the species, therefore no impacts to important populations of the species will occur.
- No habitat critical to the survival of the species will be adversely affected.
- No habitat will be modified such that the species is likely to decline as a result.
- No invasive species that are harmful to the species are likely to become established in its habitat as a result of the proposal.
- No diseases that would cause the species to decline are likely to be introduced as a result of the proposal.
- The proposal does not interfere with the recovery of the species.

### **Curlew Sandpiper**

Curlew sandpipers are a common summer migrant found throughout the Hunter Estuary, primarily in saline habitats (Herbert, 2007). Though the Hunter Estuary has previously been thought to support up to 4000 individuals (when the species is in Australia), declining counts suggest that this has not been the case for several years (Brereton and Taylor-Wood, 2010). The frequency of counts exceeding 200 birds has declined since 1999, with the total NSW population thought to be approximately 2500 individuals (NSW Scientific Committee, 2011b). It has even been suggested that the changes within the estuary (particularly to tidal regimes) may have resulted in much of the previously suitable habitat for the species being no longer available (ARS, 2006).

The areas of habitat mapped as important for the Curlew Sandpiper by OEH are largely associated with known sites for wetland and migratory bird species in the Hunter Estuary including Hexham Swamp, the Hunter Wetlands Centre, Pambalong Nature Reserve, Minmi Sewage Treatment works, Market Swamp and Antennae wetland (Herbert, 2007). Of these locations, Curlew Sandpiper have been recorded at Hexham Swamp, the Hunter Wetlands Centre and Pambalong Nature Reserve.

The locations relevant to the proposal (that occur in or adjacent to the subject site) are not thought to support a large number of birds from the local population utilising the Hunter Estuary at large. Herbert (2007) states that a maximum of 5 individual Curlew Sandpipers are 'occasionally recorded' at the Hunter Wetlands Centre, a maximum of 10 individuals are 'rarely recorded' at Hexham Swamp and up to 20 individuals have been observed at Pambalong Nature Reserve.

The number of individuals using potential habitat in and adjacent to the study area is therefore estimated to be fewer than 20 individuals that may occasionally utilise habitat within the study area on a seasonal and intermittent basis.

Considering the above, proposal is unlikely to have a significant impact on the Curlew Sandpiper for the following reasons (Appendix F):

- Within the Hunter Estuary, records for the Curlew Sandpiper are concentrated east of the study area at locations such as Fullerton Cove and Stockton Sandspit.
- According to Herbert (2007) the Curlew Sandpiper has occurred occasionally in low numbers at significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre). This low number of records associated with the study area suggests that the habitat is marginal for the species.
- Removal of 0.9 ha of marginal potential habitat for the Curlew Sandpiper is therefore unlikely to result in a significant impact to the species.

### **Red Knot**

The Hunter Estuary has been known to support over 1000 individual Red Knots (Herbert, 2007) (0.5% of the East Asian Australasian Flyway population). Individuals tend to arrive in the Hunter Estuary in September, foraging for a short time before the majority move further south to Victoria (Herbert, 2007).

Although the Hunter Estuary at times supports a large population of the species, Red Knot appear to confine their activities to key locations such as Kooragang Dykes where they are most often observed, Stockton Spit and occasionally at Fullerton Cove Beach and Ash Island (Herbert, 2007). The Red Knot had not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre) as of 2007 (Herbert, 2007), however recent records in the Atlas of Living Australia suggests a small number of individuals may occasionally visit the Hexham Swamp.

Considering the above, proposal is unlikely to have a significant impact on the Red Knot for the following reasons (Appendix F):

- The Hunter Estuary is known to support a large population of Red Knots at certain times on their migration from the northern hemisphere to foraging grounds further south.
- Within the Hunter Estuary, records of the Red Knot are primarily associated with saline sites such as Stockton Sandspit and Fullerton Cove and Ash Island (Herbert, 2007).

- The Red Knot had not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre) until recently, with a small number of individuals recorded in the Atlas of Living Australia in 2018.
- The absence of records of the species at these locations suggests habitat within the study area is low quality for the species, and individuals are unlikely to occur there on a regular basis.
- Removal of 0.9 ha of marginal potential habitat for the Red Knot is therefore unlikely to result in a significant impact to the species.

### **Eastern Curlew**

The Hunter Estuary is an internationally important site for the Eastern Curlew as it supports more than 1% of the population (Brereton and Taylor-Wood, 2010). The 1% threshold for the species is 380 individuals (Bamford *et al.*, 2008), although maximum counts for the species have recorded between 800 and 1000 Eastern Curlews in the Hunter Estuary up until the late 1990s (Herbert, 2007). The Hunter Estuary population is considered an important population for the Eastern Curlew.

However, within the Hunter Estuary at large, Eastern Curlews confine their foraging and roosting activities to the saline parts, particularly sites in and around the North Arm of the Hunter River. Kooragang Dykes and Stockton Sandspit regularly record the most numbers of individuals and are key foraging sites for the local population, with Windeyeres Reach the preferred nocturnal roost location. According to Herbert (2007) the Eastern Curlew has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre). This is likely due to the species preference for large intertidal mudflats and sandflats, often with beds of seagrass. In contrast, Hexham Swamp for example, has undergone drainage works and closure of tidal floodgates that have prevented tidal inundation (Herbert, 2007), and potential habitat within the study area is therefore considered marginal for the species.

Considering the above, proposal is unlikely to have a significant impact on the Eastern Curlew for the following reasons (Appendix F):

- The Hunter Estuary is known to support an important population of the Eastern Curlew (up to 1000 birds or >1% of the East Asian Australasian Flyway).
- Within the Hunter Estuary, the Eastern Curlew population confines its activity to saline sites, particularly Stockton Sandspit and Fullerton Cover.
- According to Herbert (2007) the Eastern Curlew has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre).
- The absence of records of the species at these locations suggests habitat within the study area is low quality for the species, and individuals are unlikely to occur there.
- The proposal is therefore unlikely to result in a significant impact to the Eastern Curlew.

### **Bar-tailed Godwit**

Considering the above, proposal is unlikely to have a significant impact on the Bar-tailed Godwit for the following reasons (Appendix F):

- Within the Hunter Estuary, the Bar-tailed Godwit population confines its activity to saline sites, particularly Stockton Sandspit and Fullerton Cove (Herbert, 2007).



- According to Herbert (2007), the Bar-tailed Godwit has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre).
- The absence of records of the species at these locations suggests habitat within the study area is low quality for the species, and individuals are unlikely to occur there.
- Removal of 0.9 ha of marginal potential habitat for the Bar-tailed Godwit is therefore unlikely to result in a significant impact to the species.

### **Australasian Bittern**

The Australasian Bittern is solitary and cryptic, hence rarely observed (Herbert, 2007). The population is considered to be declining due to a reduction in the area of occupancy of the species associated with the clearing or modification of wetlands for development (TSSC, 2019).

Over half to two thirds of the national population is estimated to occur in NSW, an estimated 660-1660 mature individuals (NSW Scientific Committee, 2011a).

Herbert (2007) considers that there is sufficient habitat within the Hunter Estuary to support a significant population of the species, including breeding habitat, although breeding has not been recorded. Most of the records within Hunter Estuary occur at Hexham Swamp, where modifications to the tidal regime have tended to increase the potential habitat for bitterns in the form of increasing the area of *Phragmites* and *Typha* dominated freshwater swamps (Herbert, 2007).

The area of potential habitat for the population within the study area includes approximately 93 hectares. Approximately 1.7 hectares of this vegetation will be removed as part of the proposal. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site.

Considering the above, proposal is unlikely to have a significant impact on the Australasian Bittern for the following reasons (Appendix F):

- The Hunter Estuary is likely to support an important population of the Australasian Bittern.
- Extensive habitat within the Hunter Estuary exists for the local population, which is capable of undertaking large movements between areas of suitable habitat.
- The 1.7 hectares of potential habitat for the species that is being removed is not considered critical habitat due to its location at the edge of a previously disturbed alignment likely to be unsuitable for this shy and cryptic species that prefers dense vegetation.
- Removal of this habitat is not considered likely to have an adverse effect on the species.

#### 7.7.3 Migratory species

The following migratory species were assessed as an MNES in Appendix F, except those marked with an asterisk (\*) which were assessed as threatened species in Section 7.7.2:

- Latham's Snipe (*Gallinago hardwickii*)
- Marsh Sandpiper (*Tringa stagnatilis*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- Common Greenshank (*Tringa nebularia*)
- Glossy Ibis (*Plegadis falcinellus*)

- \*Red Knot (*Calidris canutus*)
- \*Curlew Sandpiper (*Calidris ferruginea*)
- \*Bar-tailed Godwit (*Limosa lapponica baueri*)
- \*Eastern Curlew (*Numenius madagascariensis*)

All of the above species except the Glossy Ibis are regular, common or usual summer migrants to the Hunter Estuary (Herbert, 2007). All species except the Glossy Ibis breed in in the northern hemisphere. The Glossy Ibis is not known to breed in the Hunter Estuary and is treated as a bird of passage, with occurrence and numbers varying according to local and regional conditions (Herbert, 2007).

Discussion on important habitat for these species are provided in Appendix F to support the assessment of significance prepared for migratory MNES. The assessment of significant impacts indicated that no significant impacts are likely to occur as a result of the proposal (see Appendix F) given that:

- The 3.3 ha of native vegetation being removed is considered marginal due to its location along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site.
- Implementation of mitigation measures (detailed in Section 7.3) would reduce the potential for disturbance to these species and modification to habitat.

#### 7.7.4 Wetlands of international importance (Ramsar wetlands)

The Hunter Estuary Wetlands Ramsar Site (No. 24) is located at the Hunter Wetlands Centre site (see Figure 4-4). Within the Hunter Wetlands Centre, approximately 0.6 ha of native vegetation along the edges of an existing unsealed track will be removed or trimmed to accommodate the construction of the pathway. Approximately 0.2 ha of this vegetation represents rainforest or open forest types, with the remaining 0.4 ha representing wetland/swamp forest vegetation types (see Table 7-2).

The assessment of significant impacts indicated that no significant impacts are likely to occur as a result of the proposal (see Appendix F) given that:

- The proposal is appropriately located along an existing track to minimise the area of impact on native vegetation.
- The area of impact will be limited to approximately 0.6 ha of vegetation along the edges of the existing track.
- The proposal is unlikely to substantially change the hydrological regime of the Ramsar site.
- Measures are proposed to protect species and habitat associated with the wetlands.
- Measures are proposed to protect water quality within the wetlands.
- Measures are proposed to prevent the spread of invasive species within the wetlands.

Table 7-2 Vegetation proposed to be removed within the Hunter Wetlands Centre (i.e. Ramsar site)

Plant community type	Area (ha)
Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast (PCT 1528)	0.17
Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (PCT 1590)	0.02
Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast (PCT 1718)	0.21
Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast (PCT 1727)	0.14
Typha Rushland (PCT 1737)	> 0.001
<b>Subtotal native vegetation (ha)</b>	<b>0.6</b>
Plantings	0.12
Exotic grassland	0.01
Cleared	0.09
<b>Total area (ha)</b>	<b>0.8</b>

## 8. Offset and credit summary

### 8.1 BC Act offset requirements

#### 8.1.1 Impacts requiring offset

Impacts associated with the proposal that require offsetting include the removal of 3.3 ha of native vegetation, and associated habitat for threatened biota. Impacts within the subject site that require biodiversity offsets are shown on Figure 8-1. The Biodiversity credit report is included in Appendix E and key findings are summarised below.

#### ***Ecosystem credits***

The data from the fieldwork and mapping was entered into version 1.2.6.00 of the BAM credit calculator as a 'Development Assessment' to determine the number and type of biodiversity credits that would be required to offset impacts of the proposal.

There are 3.3 hectares of native vegetation (woody and non-woody) within the subject site that would be impacted by the proposal. It is assumed that the construction of the pathway and associated facilities would remove all the vegetation within the subject site.

The ecosystem credits types that would be required to offset the impacts of the proposal on native vegetation are summarised in Table 8-1.

#### ***Species credits***

The Barking Owl, Black-necked Stork, Brown Treecreeper, Eastern Freetail Bat, Little Bentwing-bat, Little Eagle, White-bellied Sea Eagle, White-fronted Chat and Yellow-bellied Sheathtail Bat were recorded within the subject site during field surveys and are confirmed predicted threatened species for this assessment. The ecosystem credits listed above would offset the removal of habitat for these species.

Of these, the Barking Owl, Eastern Freetail Bat, Little Bentwing-bat, Little Eagle and White-bellied Sea Eagle are dual credit species, for which the species credit component is associated with breeding habitat. No suitable breeding habitat is present within the subject site for these species and therefore, no species credits have been calculated for these species.

There are six candidate threatened species for which offsets are required. The species credits that would be required to offset the impacts of the proposal on these candidate threatened species are summarised in Table 8-2.



Table 8-1 Ecosystem credits required to offset impacts of the proposal

Vegetation Zone	Plant community type	Area (ha)	Current vegetation integrity score	Future vegetation integrity score	Ecosystem credits required
1	Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast (PCT 1528)	0.18	69.2	0	6
2	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast (PCT 1568)	0.22	43.8	0	4
3	Forest Red Gum grassy open forest on floodplains of the lower Hunter (PCT 1598)	0.80	54.1	0	22
4	Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast (PCT 1718)	0.41	40.3	0	8
5	Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast (PCT 1727)	0.60	30.5	0	9
6	Grey Mangrove low closed forest (PCT 1747)	0.26	82.4	0	9
7	Typha Rushland (PCT 1737)	0.86	79.8	0	34
<b>Total ecosystem credits required</b>					<b>92</b>

Table 8-2 Species credits required to offset impacts of the proposal

Species	Common name	Area (ha)	Species credits required
<i>Calidris ferruginea</i> (breeding)	Curlew Sandpiper (breeding)	0.9	56
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	1.6	54
<i>Limosa limosa</i> (breeding)	Black-tailed Godwit (breeding)	0.9	37
<i>Litoria aurea</i>	Green and Golden Bell Frog	3.3	95
<i>Myotis macropus</i>	Southern Myotis	0.7	14
<i>Xenus cinereus</i> (breeding)	Terek Sandpiper (breeding)	0.9	37
<b>Total species credits required</b>			<b>293</b>

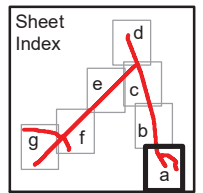




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**LEGEND**

- Subject site
- Study Area
- Watercourse
- Areas requiring offsetting



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 Metres  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 56



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**Figure 8-1a**

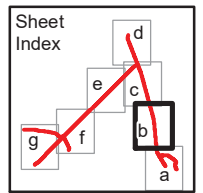




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**LEGEND**

-  Subject site
-  Study Area
-  Watercourse
-  Areas requiring offsetting



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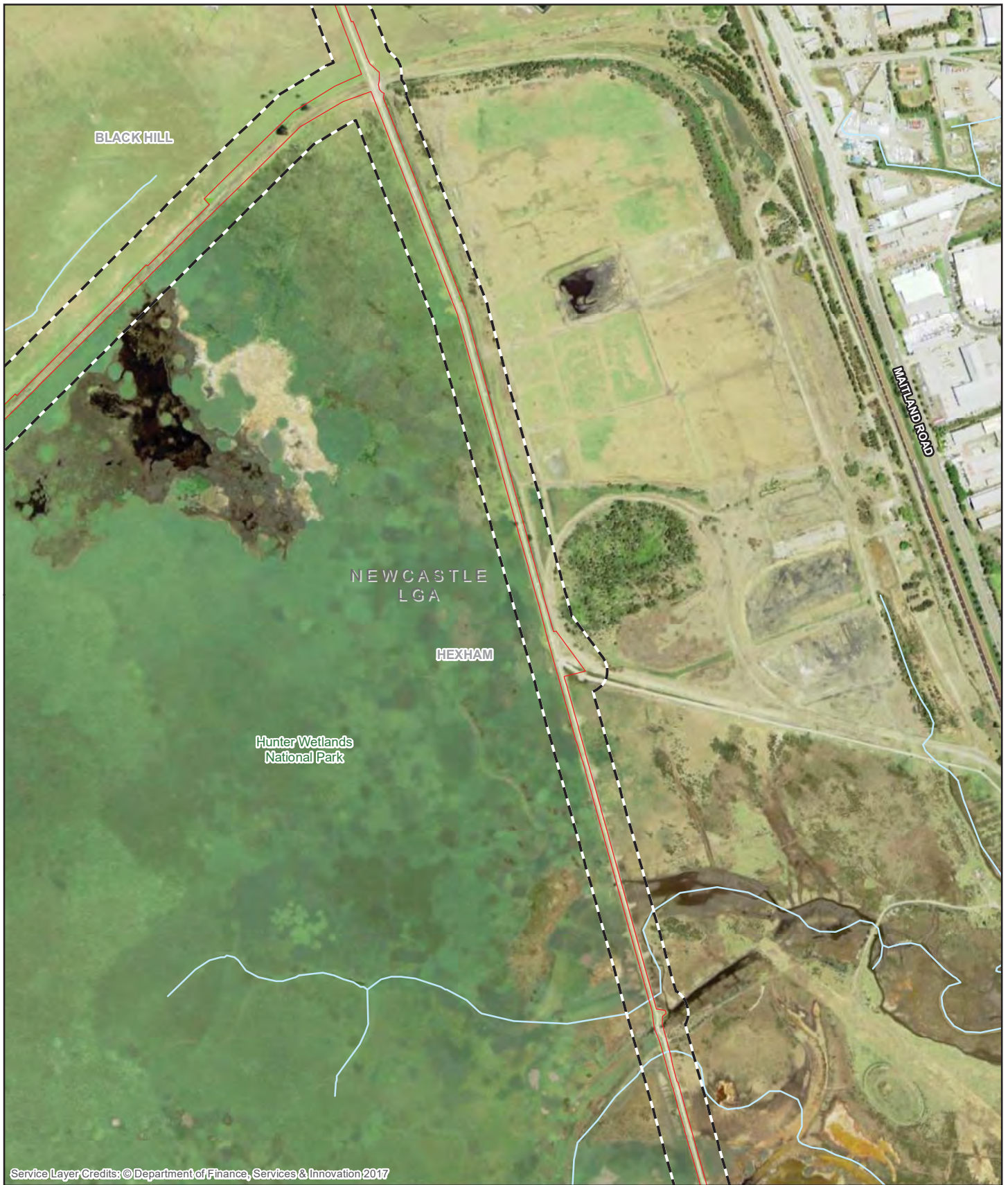
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Date 23 Sep 2019

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Figure 8-1b

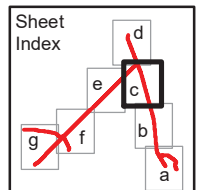




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**LEGEND**

-  Subject site
-  Study Area
-  Watercourse
-  Areas requiring offsetting



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Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
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Figure 8-1c

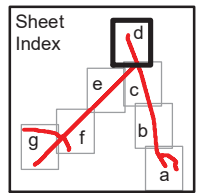




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**LEGEND**

- Subject site
- Study Area
- Watercourse
- Areas requiring offsetting



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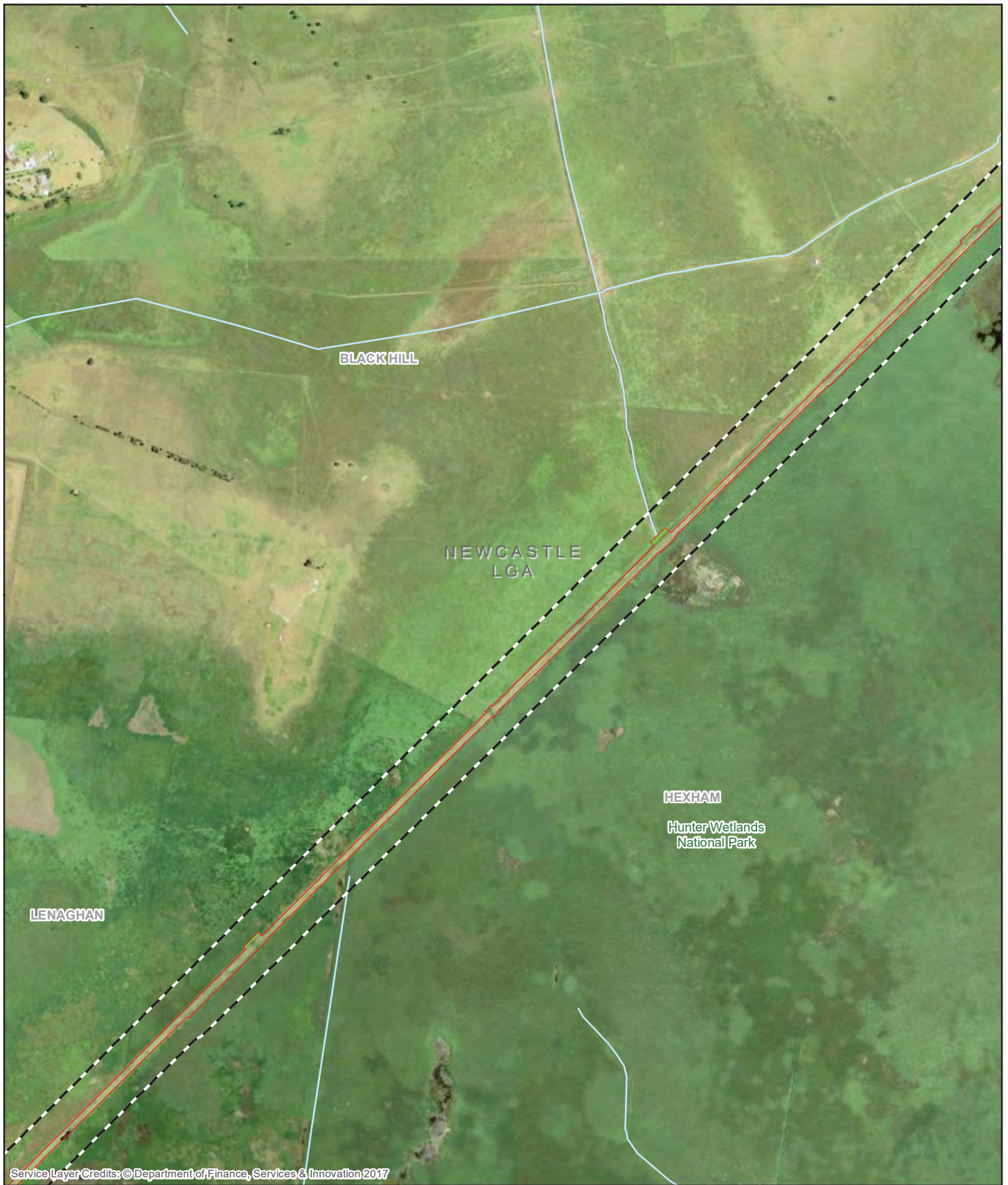
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**Figure 8-1d**

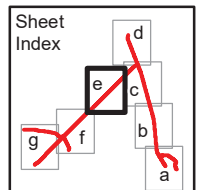




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**LEGEND**

- Subject site
- Study Area
- Watercourse
- Areas requiring offsetting



Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 56



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**Figure 8-1e**

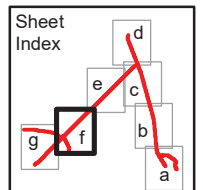




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**LEGEND**

- Subject site
- Study Area
- Watercourse
- Areas requiring offsetting



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 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
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**Figure 8-1f**

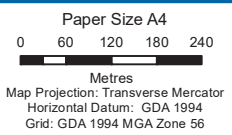
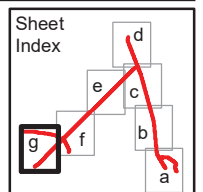




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**LEGEND**

-  Subject site
-  Study Area
-  Watercourse
-  Areas requiring offsetting



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**Figure 8-1g**



### 8.1.2 Impacts not requiring further assessment

Assessment is not required for areas of the subject site without native vegetation. No credits were calculated for areas containing non-native vegetation. These areas are still assessed for threatened species habitat in accordance with Section 6 of the BAM (OEH, 2017a). The assessment indicates that predicted impacts on non-native vegetation is unlikely to have a significant impact on threatened species (namely migratory birds that may roost on grassy embankments).

### 8.1.3 Options to meet offset obligations/approach to delivering offsets

In accordance with the offset rules established by the *Biodiversity Conservation Regulation 2017* there are various means by which offset obligations can be met. These include:

- Retiring the appropriate credits from an established stewardship site.
- Monetary payment directly into the Biodiversity Conservation Fund (BCF).
- Funding an approved biodiversity action. Funding a biodiversity action may be available as a last resort, subject to consultation with approval authorities, if all other options are determined to be unsuitable.

#### **Existing biodiversity credits**

The preferred approach to offset the residual impacts of the proposal is to secure and retire appropriate credits from stewardship site/s that fit within the trading rules of the BOS in accordance with the 'like for like' report generated by the credit calculator. The like for like trading rules for the biodiversity credits required for the proposal are listed in the credit report provided in Appendix E. Matching credits can be acquired either:

- Through purchase from the credit market, or
- By establishing a Biodiversity Stewardship site (i.e. an offset site) that can generate matching credits to offset the Project

If such credits are unavailable, credits would be sourced in accordance with the 'variation report' generated by the BAM calculator.

#### **Payment into the Biodiversity Conservation Fund**

A payment to the Biodiversity Conservation Trust (BCT) could be considered if a suitable number and type of biodiversity credits could not be secured from third parties.

The BCF is administered by the BCT to ensure that landowners have the funds needed to carry out management actions on Stewardship sites and provides a financial incentive to landowners to carry out those actions. Under certain circumstances, a payment can be made directly into the BCF by proponents to offset the impacts of a proposed development in lieu of purchasing and retiring biodiversity credits. The BCT must then use funds in the BCF to purchase and retire appropriate biodiversity credits. The value of the payment is determined using the Offset Payments Calculator, which incorporates the credit price as well as a risk premium and administrative costs.

It should be noted that payment for offsets are subject to change and that credit payment prices are reviewed by the BCT quarterly. The payment amounts presented in Table 8-3 and Table 8-4 below were calculated and valid as of 4 July 2019.

Table 8-3 Estimated biodiversity offset (ecosystem credit) payment price

Credit class	Price per credit (including risk premiums and administrative costs)	No. of ecosystem credits	Final credits price
1528 - Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast.	\$2,723.34	6	\$16,340.02
1568 - Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	\$2,723.34	4	\$10,893.35
1598 - Forest Red Gum grassy open forest on floodplains of the lower Hunter	\$1,651.98	22	\$36,343.65
1718 - Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	\$3,308.83	8	\$26,470.60
1727 - Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast	\$5,216.29	9	\$46,946.64
1747 - Grey Mangrove low closed forest	\$2,723.34	9	\$24,510.03
1737 - Typha rushland	\$2,723.34	34	\$92,593.46
<b>Subtotal (excl. GST)</b>			<b>\$254,097.75</b>
<b>GST</b>			<b>\$25,409.78</b>
<b>Total</b>			<b>\$279,507.52</b>

Table 8-4 Estimated biodiversity offset (species credit) payment price

Species	Threat status (BC Act)	Price per credit	Risk premium	Admin cost	No. of species credits	Final credits price
Curlew Sandpiper	E	\$506.66	19.99%	\$20.00	56	\$35,164.71
Large-eared Pied Bat	V	\$725.00	19.99%	\$20.00	54	\$48,056.08
Black-tailed Godwit	V	\$506.66	19.99%	\$20.00	37	\$23,233.83
Green and Golden Bell Frog	E	\$7,112.66	19.99%	\$20.00	95	\$812,675.67
Southern Myotis	V	\$725.00	19.99%	\$20.00	14	\$12,458.98
Terek Sandpiper	V	\$506.66	19.99%	\$20.00	37	\$23,233.83
<b>Subtotal (excl. GST)</b>						<b>\$954,823.10</b>
<b>GST</b>						<b>\$95,482.31</b>
<b>Total species credits (incl. GST)</b>						<b>\$1,050,305.41</b>

## 8.2 Offsets for impacts on MNES

As previously discussed, some biota identified in this BDAR are MNES listed under the Commonwealth EPBC Act, including threatened ecological communities (saltmarsh communities and Swamp Oak swamp forest), the Green and Golden Bell Frog, Large-eared Pied Bat, Curlew Sandpiper, Eastern Curlew, Red Knot, Bar-tailed Godwit and migratory wetland birds. Additional assessment and approval could be required under the EPBC Act if the proposal is declared a controlled action due to significant residual impacts on one or more of these MNES.



The Commonwealth DEE would require biodiversity offsets, determined in accordance with the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (EPBC Act Offsets Policy) (DSEWPaC, 2012b), for any significant residual impacts on specific MNES.

The assessments of significance prepared for the relevant MNES identified in this BDAR (Appendix F) and discussed in Section 7.7 indicates that the proposal is unlikely to have a significant impact on MNES, and thus the proposal would not be a controlled action and no offsets would be required under the EPBC Act. However, the proposal has potential to significantly impact the Green and Golden Bell Frog according to the species specific significant impact guidelines (DEWHA, 2009, and refer to Section 7.7.2.1) and a Referral is recommended on that basis.

### 8.3 Offsetting of impacts on key fish habitats and protected marine vegetation

The *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) details DPI's policies and guidelines for mitigating and offsetting impacts on fish habitat. DPI enforces a 'no net loss' habitat policy as a permit condition or condition of consent. This applies to development applications, including integrated developments.

Offsetting options to achieve a no net loss outcome include habitat rehabilitation and/or provision of environmental compensation for impacts on fish habitat. In the case of mangroves and saltmarsh, transplanting the vegetation from the impact site to a compensation site could be required. A management plan must be prepared for any compensatory area of habitat (DPI, 2013) (DPI, 2013). NSW DPI calculates environmental compensation on a minimum 2:1 basis for all key fish habitat (Types 1-3) to help redress other indirect impacts of development. This is calculated at the rate of \$51/m<sup>2</sup> of impact area for marine and freshwater vegetation which equates to \$102/m<sup>2</sup> to meet the 2:1 habitat offset requirement (DPI, 2013).

Consultation with the Minister for Primary Industries would be undertaken for the proposal in relation to potential impacts on protected marine vegetation (mangroves and saltmarsh) and key fish habitat and the identification of an appropriate offset for such impacts.

In addition, the following permits may be required in relation to the bridge crossings at Fishery and Ironbark Creeks:

- **Section 201** – permit to carry out dredging or reclamation works (i.e. any excavation within, or filling or draining of, water land. Any removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of any other material from water land that disturbs, moves or harms these in-stream habitats).
- **Section 205** – permit to harm (cut, remove, damage, destroy, shade etc.) marine vegetation (saltmarshes, mangroves, seagrass and seaweed).
- **Section 219** – permit to obstruct the free passage of fish.

## 9. Conclusion

The Richmond Vale Rail Trail is proposed along the former Richmond Vale railway between Kurri Kurri and Shortland, and along the former Chichester to Newcastle water main between Shortland and Tarro, through the Hunter Wetlands National Park and adjacent to a small section of the Hunter Estuary Wetlands Ramsar site associated with the Hunter Wetlands Centre. The Shortland to Tarro and Pambalong section of the Richmond Vale Rail Trail (the proposal) is the subject of this BDAR.

### **Key biodiversity values**

The proposal will traverse the Hunter Wetlands National Park from Pambalong to Shortland and a small section of the Hunter Estuary Wetlands Ramsar site associated with the Hunter Wetlands Centre. The Hunter Wetlands National Park and Hunter Estuary Wetlands Ramsar site protect ecologically sensitive wetland environments and includes lands categorised as Coastal SEPP wetlands, nationally and internationally important wetlands, habitat for a key population of Green and Golden Bell Frog, important habitat for a number of migratory shorebird species and protected estuarine vegetation. The Hunter Wetlands National Park is located within the Ironbark Creek catchment, which has direct hydrogeographical connections to the South Channel of the Hunter River and its associated deltaic habitats and is classified as key fish habitat. The Hunter Wetlands National Park is also broadly bound by the Sugarloaf Range to the west, which contains dry forest and escarpment habitats suitable for a number of native forest species, including forest owls and Microchiropteran bats. Constructed tunnels and culverts at the Pambalong end of the proposal are located near forest habitats that are well-connected to habitats on the eastern fall of the Sugarloaf Range.

Considering the above, the key biodiversity values that the proposal is likely to have an impact on include:

- Threatened species listed under the EPBC Act including the Large-eared Pied Bat, Green and Golden Bell Frog, Eastern Curlew, Red Knot and Curlew Sandpiper.
- Migratory species listed under the EPBC Act.
- Three threatened ecological communities listed under the EPBC Act.
- Seven threatened ecological communities listed under the BC Act.
- A number of 'predicted' and 'candidate' threatened species listed under the BC Act.
- Sensitive aquatic habitats and downstream receivers, including key fish habitat (protected marine vegetation).

### **Avoidance and mitigation**

The proposal has been developed to minimise the footprint as far as practical and is located to take advantage of previously cleared areas associated with the existing railway and water main corridor. Other design considerations discussed in this BDAR are likely to further minimise vegetation loss, including use of boardwalks.

Mitigation measures discussed in this BDAR have been proposed to further mitigate the potential impacts of the proposal. A CEMP (or equivalent) would be required for the construction phase of the proposal, and would be prepared prior to issue of the Construction Certificate. The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water, and weeds and pollutants. Potential impacts on waterways and aquatic habitats and downstream receivers during construction would primarily be managed through the implementation of erosion and sediment control measures, and appropriate hygiene protocols under a CEMP. Lighting impacts on microbat roosts would be largely mitigated through detailed design solutions. Effective use of soft barriers such as landscaped edges along the pathway would be implemented to protect roosting wetland birds that would utilise the grassed embankments along the pathway. The management of wetland birds, microbats and Green and Golden Bell Frog would be coordinated through three management plans prepared as sub-plans to the CEMP.

### **Residual impacts**

The construction of the proposal will necessitate the removal of small areas of native vegetation on the edges of the railway and water main corridor. The proposed vegetation loss includes:

- 3.3 ha of native vegetation representing marginal foraging and roosting habitat for wetland and forest species.
- 2.8 ha of TECs listed under the BC Act, of which 0.2 ha is also listed under the EPBC Act.
- 0.3 ha of mangrove and saltmarsh vegetation comprising protected marine vegetation under the FM Act.
- Prescribed impacts identified in this BDAR include:
  - Impacts of artificial lighting of the M1 tunnel on cave-roosting bat species, during construction and after construction is completed.
  - Potential impacts of increased pedestrian and cycle traffic along the pathway through the Hunter Wetland National Park on migratory wetland birds.

Additional assessment of the Curlew Sandpiper as an SAIL entity indicates that the proposal is unlikely to have a serious and irreversible impact on the species.

### **Offsetting under the BC Act**

The BDAR has identified the following offsetting requirements to address residual impacts on threatened species and communities listed under the BC Act:

- 92 ecosystem credits to address loss of 3.3 ha of native vegetation representing TECs and/or threatened species habitat for a number of predicted threatened species
- 293 species credits to address impacts on six candidate threatened species, including:
  - Curlew Sandpiper
  - Large-eared Pied Bat
  - Black-tailed Godwit
  - Green and Golden Bell Frog
  - Southern Myotis



### **Assessment under the EPBC Act and FM Act**

The predicted loss of native vegetation is unlikely to cause a significant impact on TECs listed under the EPBC Act or have significant adverse impacts on marine vegetation protected under the FM Act. With the implementation of appropriate mitigation measures, the proposal is not likely to have significant impacts on migratory wetland birds, threatened microbats and sensitive aquatic environments, including key fish habitat and internationally important wetlands.

The proposal is located within an area known to support the Green and Golden Bell Frog Sandgate/Hexham Swamp key population. Based on consideration of the significant impact criteria for Vulnerable species, the proposal is unlikely to have a significant impact on the Green and Golden Bell Frog. However, the proposal is likely to meet Threshold 1 and/or Threshold 2 set out in the species-specific significant impact guidelines (EPBC Act Policy Statement 3.19) as works will occur, 'within 200 metres of habitat... either where the Green and Golden Bell Frog has been recorded since 1995 or habitat that has been assessed as being suitable according to these guidelines'. The EPBC Act Policy Statement 3.19 states 'a referral under the EPBC Act should be considered' if an action meets one or more of the policy thresholds.

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# Appendices

# Appendix A – Threatened species likelihood of occurrence assessment

## **Databases Searched**

Office of Environment and Heritage (OEH) Threatened species profiles- threatened ecological communities known or predicted to occur within the Hunter CMA subregion.

Department of the Environment and Energy (DEE) EPBC PMST Online Search.

Department of Primary Industries (DPI) Records viewer search for threatened and protected aquatic species (Google Earth).

Office of Environment and Heritage (OEH) NSW Wildlife Atlas Search - threatened species results within a 10 km buffer.

## **Likelihood of Occurrence**

Matters considered in determining the likelihood of occurrence include:

- Known natural distributions including prior records (database searches) and site survey results
- Geological/soil preferences
- Specific habitat requirements (e.g. aquatic environs, seasonal nectar resources, tree hollows etc.)
- Climatic considerations (e.g. wet summers; snow fall)
- Home range size and habitat dependence
- Topographical preferences (e.g. coastal headlands, ridgetops, midslopes, gilgai, wetlands)

The likelihood of occurrence scale is defined as follows:

Scale	Description
Known	Species known to occur within the site (e.g. breeding and foraging habitat; foraging habitat; movement corridors). Detected on or immediately adjacent to the site.
High	Presence of high value suitable habitat (e.g. breeding and foraging habitat; important movement corridors). Not detected.
Moderate	Presence of medium value suitable habitat (e.g. disturbed breeding conditions; constrained foraging habitat; movement corridors). Not detected.
Low	Presence of low value suitable habitat (e.g. disturbed conditions; isolated small habitat area; fragmented movement corridors). Not detected.
None	No suitable habitat or corridors linking suitable habitat present. Not detected.



Threatened and migratory fauna

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PNIST Report* (OE 2019)	BioNet database records in the locality* (10km OEH, 2019)	BAMC*	Likelihood of occurrence in subject site	Justification
Amphibia	Hydriidae	<i>Litoria aurea</i>	Green and Golden Bell Frog	-	E	V	Species	Formerly occurred from Brunswick Heads to Victoria, but >50% of populations now extirpated. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands. Prefers sites containing eucalypt (T'pha spp.) or sedge/rubus (Elaecharis spp.), which are unshaded and have a grassy area and/or rubble as shelter/nest/egg habitat nearby. Gambusia hydrokoki is a key threat as they feed on green and Golden Bell Frog eggs and tadpoles.	-	Species or species habitat known to occur within 10 km	7236	Y	Moderate	Numerous records occur within the locality. Suitable foraging and breeding habitat identified within the study area. Species also previously recorded within study area, predominantly historic records. Suitable habitat in estuaries and freshwater wetlands habitats.
Amphibia	Hydriidae	<i>Litoria brevipalmata</i>	Green-headed Frog	-	V	-	Species	Isolated localities along the coast and ranges from just north of Wollongong to south-east Queensland. Green-headed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers sites containing eucalypt (T'pha spp.) or sedge/rubus (Elaecharis spp.), which are unshaded and have a grassy area and/or rubble as shelter/nest/egg habitat nearby. Gambusia hydrokoki is a key threat as they feed on green and Golden Bell Frog eggs and tadpoles.	-	-	Y	Unlikely	Not previously recorded within the locality. Preferred habitats such as dry eucalypt and heath vegetation are generally marginal to absent in the study area. No previous records in the locality.	
Amphibia	Hydriidae	<i>Litoria illysiophni</i>	Littlesh's Tree Frog, Heath Frog	-	V	V	Species	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Waglan State National Park to the coast. It inhabits eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	-	Predicted to occur within 10 km	-	Unlikely	The subject site does not occur on plateaus and slopes in upstream areas.	
Amphibia	Myobatrachidae	<i>Cinia flinulata</i>	Wailum Froglet	-	V	-	Species	Wailum Froglets are found along the coastal margin from Ljibella National Park in south-east Queensland to Kurrul in Sydney. Wailum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They typically occur in seagrass and wet heathlands. They can also be found along drainage lines within other vegetation communities and wet heathlands. They are thought to be associated with shallow ephemeral pools and drainage ditches with permanent water as well as shallow ephemeral pools and drainage ditches. Breeding is thought to peak in the colder months, but can occur throughout the year following rain. Shelter sites are wet or very damp and often located near the water's edge. Males may call throughout the year and at any time of day, peaking following rain.	-	-	Y	Unlikely	The species is associated with heath habitats and only occasionally in swamp sclerophyll forests. There is marginal habitat for the species within the study area and almost no habitat for the species within the subject site. All the records in the locality are from Willamtown, where the species is known to occur in the heath habitats associated with the Tomago sandbeds.	
Amphibia	Myobatrachidae	<i>Helleoporos australiacus</i>	Giant Burrowing Frog	-	V	V	Species	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollum National Park. Appears to exist as two populations with a 100 km gap in records between Jarvis Bay and the coast. It inhabits eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground. Breeds in ephemeral to permanent streams with permanent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	-	Predicted to occur within 10 km	-	None	Not previously recorded within the locality. No suitable habitat occurs within the study area.	
Amphibia	Myobatrachidae	<i>Mixophyes balbus</i>	Slutering Frog	-	E	V	Species	Occurs along the east coast of Australia. Found in rainforest and wet, tall open forest. Shelter in eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground. Breeds in ephemeral to permanent streams with permanent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	-	Predicted to occur within 10 km	-	Unlikely	Marginal quality habitat occurs within the Rainforest in the study area but considered unsuitable due to its restricted extent and isolation from other suitable habitats for the species. Ephemeral stream development/impacts also occur immediately upstream of the habitat.	
Amphibia	Myobatrachidae	<i>Uperoleia mahonyi</i>	Mahony's Toadlet	-	E	-	Species	Mahony's Toadlet is endemic to the mid-north coast of New South Wales (NSW) and to date has been recorded only in the mid-north coast of NSW. It inhabits eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground. Breeds in ephemeral to permanent streams with permanent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	-	-	Y	Unlikely	The species is associated with heath habitats and only occasionally in swamp sclerophyll forests. There is marginal habitat for the species within the study area and almost no habitat for the species within the subject site. All the records in the locality are from Willamtown, where the species is known to occur in the heath habitats associated with the Tomago sandbeds.	
Aves	Acantithidae	<i>Cathartes aura</i>	Spotted Warbler	-	V	-	Ecosystem	Distributed from south-eastern Queensland, through central and eastern NSW to Victoria. In NSW, Spotted Warblers occur acacalypt and cypress woodlands on the slopes west of the Great Dividing Range. With an extension of range into the cypress woodlands of the northern Riverina. Spotted Warblers are also found in the coastal zone of NSW. The species is sedentary, living in pairs or flocks and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understory for arthropods and seeds (Ford et al. 1988). Home ranges vary from 6-12 hectares.	-	-	Y	Moderate	Potential foraging habitat in woodland/forest habitats to the east of the Subject Site. This species would be a potential visitor to the area.	
Aves	Accipitridae	<i>Circus assimilis</i>	Spotted Harrier	-	V	-	Ecosystem	Occurs throughout Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). Most commonly in native grassland but also in agricultural land, foraging over open habitats including edges of riparian wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).	-	-	Y	High	This species has previously been recorded in the Shury Area (BioNet). Suitable foraging habitat across the entire subject site. No stick nests were observed in the Subject Site during targeted surveys.	
Aves	Accipitridae	<i>Elanoides forficatus</i>	Red Goshawk	-	CE	V	Species	Very rare in NSW, generally confined to the Northern Rivers bioregion with most records in the Clarence River catchment with few around the lower Richmond and Tweed Rivers. Inhabits open woodland and forest, preferring mixed subtropical rainforest, Melaleuca swamp forest and riparian woodland. It is a sedentary species, nesting in hollow trees (up to 120m and in NT), and in NSW appear to move from nesting areas in the ranges to coastal areas to coastal plains. Generally breed in tall trees within 1km of a river or wetland.	-	Species or species habitat likely to occur within area	-	Unlikely	Preferred habitat not present within the proposal area. No records in the locality.	
Aves	Accipitridae	<i>Falco leucogaster</i>	White-bellied Sea-eagle	-	V	M	Ecosystem/ species (breeding)	Primarily coastal but may extend inland over major river systems. Feeds mainly off aquatic animals such as fish, turtles and sea snakes, but it takes birds and mammals as well. It is a skilled hunter and will attack prey up to the size of a swan. Sea-Eagles also feed on carrion (dead prey) such as sheep and fish along the waterline. They harass smaller birds, forcing them to drop any food that they are carrying. Sea-Eagles feed alone, in pairs or in family groups. White-bellied Sea-eagles are highly territorial and defend their nesting sites. They are highly dependent on trees located in a tree up to 30m above the ground, but may also be placed on the ground or on rocks where there are no suitable trees. At the start of the breeding season, the nest is lined with fresh green leaves and twigs. The female carries out most of the incubation of the white eggs, but the male performs the duty from time to time.	-	Predicted to occur within 10 km	148	Y	Known	There are numerous records in the locality and the species has been recorded foraging over the subject site. No old or existing nests. No suitable nest sites observed during survey.
Aves	Accipitridae	<i>Hieraeetus morphnoides</i>	Little Eagle	-	V	-	Ecosystem/ species	Breeds close to water, mainly in tall open forest/woodland but also in dense forest, rainforest, broad watercourses and rarely in tall, isolated trees. Usually forages over large expanses of open water, but also over open terrestrial habitats (e.g. grasslands).	-	-	Y	Known	The species was recorded foraging over the subject site during survey, but no suitable nesting habitat was observed. No records in the locality. There is potential for suitable breeding habitat in the wider study area.	

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PMST Report* (OEE 2019)	BioNet database "risk to locality" (10km OEH, 2019)	BAMC*	Likelihood of occurrence in subject site	Justification
Aves	Accipitridae	<i>Lopholaima isura</i>	Square-tailed Kite	-	V	-	Ecosystem/ species (breeding)	Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands, open forests, with preference for timbered watercourses. Favour productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. Large home range > 100 km <sup>2</sup> .	-	-	4	Y	High	There is suitable foraging habitat in the study area. No nests were observed during survey, indicating no breeding within the study area, although the species is likely to forage over the study area.
Aves	Accipitridae	<i>Falco sparverius</i>	Eastern Osprey	-	-	MW	Ecosystem/ species (breeding)	Favours coastal swamps, especially the mouths of large rivers, lagoons and lakes. They feed on fish over clear, open water. Breeding takes place from July to September in NSW, with nests being built high up in dead trees or in dead crowns of live trees, usually within one kilometre of the water. This duck is a rare visitor to Australia. Habitat consists of grassland, wetland, marshes, freshwater lakes. The Garganey breeds in Europe and Asia. It migrates south to Africa and Asia in winter. It is a rare visitor to coastal wetlands in Australia.	-	-	29	Y	Moderate	Suitable foraging habitat is present in the study area. No suitable nest sites observed in study area
Aves	Anatidae	<i>Anas querquedula</i>	Garganey	-	-	MW	n/a	Early migratory frigate, breeds between breeding swamps and over surrounding lakes. Young birds disperse in April-May from breeding swamps in inland NSW to Murray River system and coastal lakes. Prefers deep water in large permanent wetlands and swamps, with dense aquatic vegetation. Nests in Cumbungi over deep water or in trampled Ligum, sedges or spike-rushes. Completely aquatic, swimming along the edge of dense cover.	-	-	1	-	Unlikely	Although marginal quality foraging habitat occurs within the study area, it is considered unlikely to occur within the study area.
Aves	Anatidae	<i>Oxyura australis</i>	Blue-billed Duck	-	V	-	Ecosystem	Endemic to Australia. Breeds in large temporary swamps created by floods in the Bullock and Lake Eye basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW with Victoria during strong rains. The species prefers permanent freshwater wetlands, but also occurs in temporary wetlands. Commonly found in the Darling Downs region. They move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.	-	-	6	Y	Moderate	Suitable foraging habitat is present in the study area.
Aves	Anatidae	<i>Scolopetta naevosa</i>	Freckled Duck	-	V	-	Ecosystem	The Magpie Goose is still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Migrants can follow food sources to south-eastern NSW. Mainly found in shallow wetlands (less than 1 m deep) with dense growth of reeds or sedges.	-	-	20	Y	Low	Suitable foraging habitat present within the subject site but considered uncommon within the Hunter region and rarely recorded.
Aves	Ansermatidae	<i>Anseranas semipalmata</i>	Magpie Goose	-	V	-	Ecosystem	The White-throated Needletail is widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. It is also recorded in southern NSW. It is a common migrant to inland swamps. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occurs above most habitat types, but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	-	-	82	Y	High	The Magpie Goose is known to the area with most birds nesting at the Hunter Wetlands Centre. The species is known to breed in suitable known foraging habitat identified within coastal wetlands habitat within the study area.
Aves	Apodidae	<i>Hirundo caudaeferus</i>	White-throated Needletail	-	-	MT	n/a	The Magpie Goose is known to the area with most birds nesting at the Hunter Wetlands Centre. The species is known to breed in suitable known foraging habitat identified within coastal wetlands habitat within the study area.	-	-	22	-	Moderate	Exclusively aerial species that may utilise the airspace above the study area for hawking insects.
Aves	Apodidae	<i>Apus pacificus</i>	Fork-tailed Swift	-	-	MT	n/a	Recorded in all regions of NSW. Non-breeding, and almost exclusively aerial while in Australia. Occurs over urban and rural areas as well as areas of native vegetation.	-	-	9	-	Known	Recorded during field survey. This species is almost exclusively aerial. It is considered that this species may use the aerial space above the study area.
Aves	Ardeidae	<i>Ardea alba</i>	Great Egret	-	-	M	n/a	Occurs across NSW. Within NSW there are breeding colonies within the Darling Riverine Plains State Reported from a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial).	-	-	-	Possible	Moderate	Not observed during field surveys. Preferred habitat present within the proposal area within Typhe Rushland and Coastal Saltmarsh.
Aves	Ardeidae	<i>Ardea alba</i>	Cattle Egret	-	-	M	n/a	Occurs across NSW. Principal breeding sites are the central east coast from Newcastle to Bundaberg. Also breeds in major inland wetlands in north NSW (notably the Macquarie Marshes). Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. Uses predominantly shallow, open and fresh wetlands with low emergent vegetation and abundant aquatic flora. Sometimes observed in swamps with tall emergent vegetation and commonly use waterways for dispersal.	-	-	955	-	Known	Species has been previously recorded within the study area. Suitable foraging and breeding present within the coastal freshwater wetland and exotic grassland habitat types. Important breeding habitat within the Shorland Wetland Centre
Aves	Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret	-	-	M	n/a	Within Australia, the Intermediate Egret can be found at wetlands throughout the northern third of the continent as well as the eastern third. They are generally absent from Tasmania. Mostly a denizen of the shallow in terrestrial wetlands, the Intermediate Egret prefers freshwater swamps, billabongs, floodplains and wet grasslands with dense aquatic vegetation, and is only occasionally found in coastal or inland habitats. NSW (except the north-west). Favours permanent freshwater wetlands with tall dense sedges (particularly Typhe sparganum) and other sedges, with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds at night on frogs, fish, yabbies, spiders, insects and snails.	-	-	-	-	Moderate	Suitable foraging habitat present within the subject site.
Aves	Ardeidae	<i>Botaurus poiciloptilus</i>	Australian Bittern	-	E	E	Ecosystem	It occurs mainly in freshwater wetlands in the temperate southeast and south-west of Australia and, rarely, in estuaries or tidal wetlands (Marchant and Higgins, 1990). Human modifications to the landscape, such as drainage, have reduced the area of Phragmites and Typhe freshwater swamps. The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation (Marchant & Higgins 1990). Where permanent water is present, this species may occur in flooded grassland, forest, woodland, rainforest and mangroves (Marchant & Higgins 1990).	-	-	26	Y	High	Not observed during field surveys but previously recorded in study area according to the BioNet search. There is suitable foraging habitat identified within coastal freshwater wetland habitats within the study area.
Aves	Ardeidae	<i>Ixobrychus flavicollis</i>	Black Bittern	-	V	-	Ecosystem	The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually in areas with tall dense sedges (particularly Typhe sparganum) and other sedges, with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds at night on frogs, fish, yabbies, spiders, insects and snails.	-	-	3	Y	Moderate	There is suitable foraging habitat in the study area.
Aves	Ardeidae	<i>Actitis macularia</i>	Dusky Woodswallow	-	V	-	Ecosystem	The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually in areas with tall dense sedges (particularly Typhe sparganum) and other sedges, with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds at night on frogs, fish, yabbies, spiders, insects and snails.	-	-	15	-	Low	This species was not observed during targeted field surveys. This species is considered to be only an occasional visitor to site for foraging or perching within woodland and forested areas of the study area.
Aves	Burniidae	<i>Burnia grularis</i>	Bush Stone-curlew	-	E	-	Species	The Bush Stone-curlew is found throughout Australia except for the central southern coast and is common in the south-east. It is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feeds on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare patch.	-	-	3	Y	Unlikely	Suitable habitat for this species within the subject site is represented by fringing or marginal forested and woodland habitat with woody debris and leafy litter. However, there are very few records within the locality, and the open forest areas have a suitable abundance of forested timber is very limited within the subject site.
Aves	Cathartidae	<i>Cathartes aura</i>	Gang-gang Cockatoo	-	V	-	Ecosystem/ species (breeding)	Restricted to SE coast and highlands south from the Hunter Valley. Spends summer in tall mountain forests and woodlands, usually heavily timbered and mature wet sclerophyll forests. Winters at lower altitudes in drier more open eucalypt forest and woodlands, particularly in coastal areas. Nests in summer in large tree hollows, often close to water, usually in tall mature sclerophyll forest. Feeds on acorns, particularly Eucalyptus and Acacia, also berries, fruit and insects (Higgins 1999).	-	-	9	Y	Moderate	Possible foraging habitat within the Blue-Gum Forest to the west of the study site. The species typically breeds in tall mountain forests and woodlands at higher elevations and is unlikely to nest within the subject site, although they may be permitted to forage within the subject site.

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PMST Report* (OEE 2019)	BioNet database "radius" to the locality (10km) (OEH, 2019)	BAMC*	Likelihood of occurrence in subject site	Justification
Aves	Cuculidae	<i>Calyptornis leucurus</i>	Glossy Black-Cuckoo	-	V	-	Ecosystem/ species (breeding)	Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of Allocasuarina species. Prefers woodland and open forests, rarely away from Allocasuarina. Roosts in early canopy trees, preferably eucalypts, usually <1 km from the ground in large (approx. 20 cm) hollow trees, stumps or snags, usually in Eucalypts (Higgins 1989).	-	-	8	Y	Moderate	There are some Allocasuarina trees within the forested areas in the western portion of the study area, but very few losses within the subject site itself. The species may fly over the subject site on occasion. No large hollow-bearing trees present in proximity to Allocasuarina trees. There is generally a patchy of Allocasuarina trees resources in the study area to support breeding.
Aves	Charadriidae	<i>Charadrius mongolus</i>	Lesser Sand-plover	-	V	E, MW	Ecosystem/ species (breeding)	Found around the entire coast but is most common in the Gulf of Carpentaria, and along the east coast of Queensland and northern NSW (OEH 2012). Almost entirely coastal in NSW, favouring the benches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms (OEH 2012).	-	-	36	Y	Low	Considered a rare summer migrant, only occasionally recorded in the Hunter Estuary (Herbert 2007). Marginal foraging habitat present in the subject site.
Aves	Charadriidae	<i>Ploveris fulva</i>	Pacific Golden Plover	-	-	MW	n/a	Occurs along the east coast, especially along Queensland and New South Wales. Usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. They are less often recorded in inland wetlands, but they do occur in some inland wetlands, especially in swamps, pools, swamps and wet claypans, especially those with muddy margins and often with submerged vegetation or short emergent grass.	-	-	311	-	Low	Records concentrated on the North Arm of the Hunter River, close to the subject site, which is likely to be marginal for the species.
Aves	Charadriidae	<i>Ploveris squatarola</i>	Grey Plover	-	-	MW	n/a	In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-fats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or wetlands of salt-lakes (Marchant & Higgins 1983 and references therein). On their breeding grounds they inhabit tundra (Domenitow & Gladkov 1951).	-	-	8	-	Low	Rare visitor to the Hunter Estuary only ~13 birds occasionally recorded (Herbert 2007).
Aves	Columbidae	<i>Epiphiophrynus asiaticus</i>	Black-necked Stork	-	E	-	Ecosystem	In NSW, becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of the Hunter Estuary. It is a common migrant to the Hunter Estuary, where it occurs in the northeast. Primarily inhabits permanent freshwater wetlands and surrounding vegetation including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters. Will also forage in inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water. Breeds during summer, nesting in or near a freshwater swamp.	-	n/a	131	Y	Known	Recorded on site during baseline surveys.
Aves	Columbidae	<i>Chalcophaps indica</i>	Brown Treecreeper (eastern subspecies)	-	V	-	Ecosystem	The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forests in the Blue Mountains and the Darling Range. It is a common migrant to the Hunter Estuary, where it occurs in the northeast. Primarily inhabits permanent freshwater wetlands and surrounding vegetation dominated by steep-sided riparian forest, but also occurs in grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of acacia, saltbush, lignum, combing and grasses; usually not found in woodlands with a dense shrub layer; lichen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	-	-	33	Y	Known	Recorded during 2016 field surveys. Foraging habitats within the study area are considered to be of low quality. No suitable hollows in study area.
Aves	Columbidae	<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	-	V	-	Ecosystem	Occurs in or near forest, but also occurs in open grassy areas. Feeds on a wide range of fruits and seeds, including ripening fruit. Thought to be an effective medium to long-distance vector for seed dispersal.	-	-	6	Y	Moderate	Potential habitat within the lowland rainforest areas at the Hunter Wetland Centre.
Aves	Columbidae	<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	-	V	-	Ecosystem	Feeds alone, or in loose flocks at any height in the canopy. The nest is a typical pigeon nest - a flimsy platform of sticks on a thin branch or a palm frond, often over water, usually 3 - 10 m above the ground. Breeds in spring and early summer. Most often seen in mature forests, but also found in regrowth.	-	-	5	Y	Moderate	Potential habitat within the lowland rainforest areas at the Hunter Wetland Centre.
Aves	Columbidae	<i>Ptilinopus superbus</i>	Superb Fruit-Dove	-	V	-	Ecosystem	Coast and ranges of eastern NSW and Queensland, from Newcastle to Cape York. Vagrants are occasionally found further south to Victoria. Occur mainly in sub-tropical and dry rainforest and occasionally in most eucalypt forest and swamp forest, where fruit is plentiful. They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruit.	-	-	4	Y	Moderate	Potential habitat within the lowland rainforest areas at the Hunter Wetland Centre.
Aves	Columbidae	<i>Cuculus optatus</i>	Oriental Cuckoo	-	-	MT	n/a	The Superb Fruit-dove occurs principally from north-eastern to north-eastern NSW, where it is most common in the Hunter Estuary and the coastal ranges and plains, and also occurs for south as Monywa. There are records of vagrants as far south as eastern Victoria and Tasmania. Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Breeding takes place from September to January. The nest is a shallow cup of sticks and twigs, lying in a large tree or shrub, and is usually 5-30 metres up in rainforest and rainforest edge tree and shrub species.	-	-	-	-	Moderate	Potential preferred habitat present within the proposal area within eucalypt forest.
Aves	Diuridae	<i>Mylagra cyaneoleuca</i>	Salm Flycatcher	-	-	MT	n/a	It has a large breeding range in northern Eurasia. It breeds across much of Russia west to the Komi Republic with occasional records as far west as Saint Petersburg. It also breeds in northern Kazakhstan, Mongolia, northern China, Korea and Japan. It mainly inhabits forests, occurring in coniferous, deciduous and mixed forest. It feeds mainly on insects and their larvae, foraging for insects in the canopy and on the ground. It is a common migrant to the Hunter Estuary, where it occurs in the northeast. Primarily inhabits permanent freshwater wetlands and surrounding vegetation dominated by steep-sided riparian forest, but also occurs in grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of acacia, saltbush, lignum, combing and grasses; usually not found in woodlands with a dense shrub layer; lichen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	-	-	-	-	Unlikely	This species occupies heavily vegetated gullies in tall wet sclerophyll forests and is only likely to visit the study area on a transient basis as a non-breeding visitor. There are no known records in the locality.
Aves	Domesticidae	<i>Domesticus antipodensis</i>	Antipodean Albatross	-	V	V, MM	n/a	A large Albatross species, with breeding confined to New Zealand. The species ranges across the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia. This species regularly occurs in small numbers off the NSW south coast from Green Cape to Newcastle during winter when they forage on outfalls. Although representing a small proportion on its total foraging area, potential foraging in NSW waters is nonetheless considered significant for the species.	-	-	-	-	None	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.
Aves	Domesticidae	<i>Domesticus gibsoni</i>	Gibson's Albatross	-	V	V	n/a	A large Albatross species, with breeding confined to New Zealand. Essentially endemic to the Auckland Islands of New Zealand. The non-breeding range is poorly known however the species occurs in the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia. This species regularly occurs in small numbers off the NSW south coast from Green Cape to Newcastle during winter when they forage on outfalls. Although representing a small proportion on its total foraging area, potential foraging in NSW waters is nonetheless considered significant for the species.	-	-	-	-	None	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.
Aves	Domesticidae	<i>Domesticus eximius</i>	Southern Royal Albatross	-	-	V, MM	n/a	Over 99% of the southern royal albatross population breeds on Campbell Island, and a small proportion on the Auckland Islands. Southern royal albatrosses are generally solitary at sea. Young are generally seen in the southern Pacific Ocean to feed in South American waters before returning to the breeding areas by circumnavigating the globe.	-	-	-	-	None	Species marine pelagic. No habitat for this species occurs within the study area.



Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PMSR Report <sup>1</sup> (OEE 2019)	BioNet database "nearby" (10km) (OEH, 2019)	BAMC <sup>2</sup>	Likelihood of occurrence in subject site	Justification
Aves	Diomedidae	<i>Diomedea exulans (casus/abo)</i>	Wandering Albatross	-	V	V, MM	n/a	The Wandering Albatross breeds on Macquarie Island, it feeds in Australian portions of the Southern Ocean. In the Australasian region, it occurs inshore, offshore and in pelagic waters.	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species marine pelagic. No habitat for this species occurs within the study area.	
Aves	Diomedidae	<i>Diomedea exulans gibsoni</i>	Gibson's Albatross	-	-	V, MM	n/a	There are no breeding colonies of Gibson's Albatross in Australian territory. This albatross visits Gibson's Albatross has been recorded foraging between Coffs Harbour, NSW, and Wilson's Promontory, Victoria. Gibson's Albatross is marine, pelagic and aerial.	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species marine pelagic. No habitat for this species occurs within the study area.	
Aves	Diomedidae	<i>Diomedea sanfordi</i>	Northern Royal Albatross	-	-	E, MM	n/a	The Northern Royal Albatross breeds in New Zealand waters. The main population (estimated at 6,500 to 7,000 pairs) nests on islands off the Chatham Islands, and up to 50 pairs nest at Tilaona Head on the South Island. Most the population spends the non-breeding period off both coasts of southern South America, especially off Chile and Argentina. It is a rare visitor to NSW waters, and is commonly recorded foraging within the waters of the Tasmanian and Royal Albatross primarily forages in inshore and offshore waters over the continental shelf to the shelf edge.	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche salvini</i>	Salvin's Albatross	-	-	V, MM	n/a	Salvin's Albatross breeds on islands off New Zealand. It ranges widely through the south Pacific. Buller's Albatross breed in New Zealand, but are regular visitors to Australian waters. Buller's Albatross are marine and pelagic, inhabiting subtropical and subantarctic waters of the southern Pacific Ocean (Marchant & Higgins 1990). They are frequently seen off the coast from Coffs Harbour, south to Tasmania and west to Eyre Peninsula. Buller's Albatross are marine and pelagic often seen over inshore, offshore and pelagic waters. They appear to congregate over currents and eddies.	-	Predicted to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche bulleri</i>	Buller's Albatross	-	-	V, MM	n/a	The Pacific Albatross is a seabird species. It occurs in subtropical and subantarctic waters of the South Pacific Ocean (Marchant & Higgins 1990). Habitat preferences are poorly known (Marchant & Higgins 1990). In Australia, the species occurs over inshore, offshore and pelagic waters (Blaber 1986; Carter 1977; Rogers 1969) and off the coast of south-east Tasmania. The Pacific Albatross prefers waters of the East Australian Current where sea surface temperatures are greater than 16°C (Casper 1969) and tends to fly in low or medium altitude using updrafts of sea surface winds (Casper 1969). The birds breed on sub-tropical and subantarctic islands and rock stacks in the New Zealand region, on sparsely vegetated slopes, cliff tops and ledges on rocky islands or stacks (Dawson 1973; Robertson 1974; Wright 1984).	-	Predicted to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche cauta</i>	Shy Albatross	-	V	V, M	n/a	Most adult Shy Albatross remain in the waters off southeast Australia all year round, and seldom venture more than 600km from the breeding colony. Breeding occurs on Albatross Island, Bass Strait, and Melbourne and Peira Branca, of southern Tasmania.	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche cauta cauta</i>	Shy Albatross	-	V	V	n/a	Most adult Shy Albatrosses remain in the waters off southeast Australia all year round, and seldom venture more than 600km from the breeding colony. Breeding occurs on Albatross Island, Bass Strait, and Melbourne and Peira Branca, of southern Tasmania.	-	Predicted to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche cauta steadi</i>	White-capped Albatross	-	-	V, MM	n/a	The White-capped Albatross is probably common off the coast of south-east Australia throughout the year. Breeding colonies occur on islands south of New Zealand. The species occurs both inshore and offshore and enters harbours and bays. The species is scarce in pelagic waters.	-	Predicted to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche eremita</i>	Chatham Albatross	-	-	E, MM	n/a	Breeding occurs in New Zealand only, usually nests on rocky ledges and steep slopes. At sea, the species is highly migratory, ranging widely in the southern oceans along the continental shelf in a marine zone. New adults from western South America were taken along the continental shelf at Campbell Island and the adjacent Isle de Jeanette Marie south of New Zealand, with a total population estimated at 24,600 pairs. It ranges widely in Australian seas. In NSW waters it is probably regularly overheard due to the difficulty of separating it from the Black-browed Albatross. The species is recorded in the Tasmanian region, but is not recorded in the Tasmanian waters peaks in winter during the non-breeding season. Occurs in both inshore and offshore waters including the continental shelf break and pelagic waters. Forages on fish, squid, crustacea, carrion and gelatinous organisms.	-	Predicted to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche impavida</i>	Campbell Albatross	-	-	V, MM	n/a	Black-browed Albatross are found over Antarctic, subantarctic and sub-tropical waters. They breed on subantarctic and Antarctic islands such as Iles Kerguelen, Heard Island and the McDonald Islands, and Macquarie Island. The species is common in the non-breeding period at the Bass Strait and NSW. It obtains most of its food while settled on the surface of the water by reaching down to seize a food item in the bill. It regularly trails fishing vessels to collect discarded items.	-	Predicted to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Diomedidae	<i>Thalassarche melanophris</i>	Black-browed Albatross	-	V	V, MM	n/a	Habitat is predominantly marine, usually pelagic, over tropical seas. Often recorded far from land, but occasionally over shelf waters, in places close to inshore and inland over continental coasts. Common in northern Australia. Breeding only occurs on offshore islands in northern Australia (Morcombe and Stewart 2013).	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species not recorded during surveys or previously within the locality. Pelagic species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Fregatidae	<i>Fregata ariel</i>	Lesser Frigatebird	-	-	MM	n/a	Habitat is predominantly pelagic, over tropical seas. Often recorded far from land, but occasionally over shelf waters, in places close to inshore and inland over continental coasts. Common in northern Australia. Breeding only occurs on offshore islands in northern Australia (Morcombe and Stewart 2013).	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species offshore marine. No habitat for this species occurs within the study area.	
Aves	Fregatidae	<i>Fregata minor</i>	Great Frigatebird	-	-	MM	n/a	Predominantly occurs over tropical seas, and is a predominantly pelagic; only occasionally foraging over inshore shelf waters. Soars high on thermal updrafts or on updrafts above cliffs of coastal mountains. Breeding occurs on Christmas Island, Phoenix Island, Christmas Island, from Point Charles WA to North Stradbroke Island in QLD (Morcombe and Stewart 2013).	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	Species offshore marine. No habitat for this species occurs within the study area.	
Aves	Haematopodidae	<i>Haematopus longirostris</i>	Pied Oystercatcher	-	E	-	Species	The species is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast, with fewer than 200 breeding pairs estimated to occur in the State. Pied Oystercatchers are occasionally recorded on Lord Howe Island but it is uncertain which species is involved. Favour intertidal flats of inlets and bays, open beaches and sandbanks. Feeds on molluscs, crustaceans, annelids and rock break. Absent from the Tasmanian coast. The blackball is used for nesting. The species is recorded in the Tasmanian region, but is not recorded in the Tasmanian waters. Nests are shallow scrapes in sand above the high tide mark, often amongst seaweed, shells and small stones.	-	-	27	Y	This species is typically associated with extensive mudflats and beach or rocky foreshore habitats, which are not present within the study area. The species within the locality are largely concentrated on the eastern side of the Hunter River.	
Aves	Hirundinidae	<i>Hirundo rustica</i>	Barn Swallow	-	-	MT	n/a	The Barn Swallow usually occurs in northern Australia, on Coocos-Keeling Island, Christmas Island (Stokes et al. 1984; Stokes 1988), Ashmore Reef (Higgins et al. 2006), and patchily along the northern coast of Queensland. The species has been recorded irregularly further south in Western Australia, in areas such as Derby and Carnarvon, and in South Australia near Koolunga, Rosty Downs, Nantawana and south of Immanooka (Higgins et al. 2006). Vagrants have also been recorded as far south as Sydney (Blakers et al. 1994; Gill 1970; Higgins 1969; Schodde & Mason 1999; Slater 1981). One unconfirmed report is from Lake Woomera, Victoria (Higgins et al. 2006). In Australia, the species is recorded in the Tasmanian region, but is not recorded in the Tasmanian waters. Birds are often sighted perched on overhead wires (Pizzey 1980; Blakers et al. 1984), and also in or over freshwater wetlands, paperbark Melaleuca woodland, mesophyll shrub thickets and tussock grassland (Schodde & Mason 1999).	-	NA	3	-	Beyond the accepted range of the species, with records in the area likely to be vagrant birds.	

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Aves	Jacobiidae	<i>Mediophaga gallinacea</i>	Comb-crested Jacana	-	V	-	Ecosystem	Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Shoek or sacca woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	-	-	10	Y	Moderate	There is suitable foraging habitat in the study area.
Aves	Laridae	<i>Anous stolidus</i>	Common Noddy	-	-	MM	n/a	Dispersed throughout the tropical regions of the Indian, Pacific and Atlantic Oceans, the Common Noddy usually stays near islands. The Common Noddy is found in tropical and sub-tropical seas off the west, north and east coasts of Australia, from the Aroobro Islands in WA to the islands of the Great Barrier Reef in QLD, as well as Norfolk and Lord Howe Islands. Some are seen almost annually in NSW as far south as Sydney. It also ranges across tropical parts of the Pacific, Indian and Southern Oceans. It is a common offshore tropical islander, often in large colonies of more than 100,000 nests. (Bridle, 2019)	-	-	-	-	None	Species offshore marine. No habitat for this species occurs within the study area.
Aves	Laridae	<i>Gelochelidon nilotica</i>	Gull-billed Tern	-	-	MW, M	n/a	This large tern inhabits shallow wetlands, including coastal or inland lakes, swamps and lagoons, as well as sheltered bays and estuaries, where they hawk for flying insects; dip into the water to take insects or small fish from the surface of the water or mud, or plunge into the water for fish. Gull-billed Terns are found in freshwater swamps, brackish and salt lakes, beaches and estuarine mudflats, floodwaters, sewage farms, irrigated croplands and grasslands. They are only rarely recorded in NSW. The Gull-billed Tern occurs on all continents except Antarctica (BirdLife Australia, 2018).	-	NA	32	-	High	Suitable foraging habitat within the study area above water bodies.
Aves	Laridae	<i>Hypoprogne caspia</i>	Caspian Tern	-	-	MW, M	n/a	Found in coastal and inland areas. In NSW, widespread east of the divide, mainly in coastal regions as well as the Riverina and Western regions, with occasional records elsewhere. Breeding has been recorded in the Merribe Lakes. Mostly found in sheltered coastal embayments, including areas with sandy or muddy margins. Usually forages in open wetlands, including areas and rivers.	-	NA	17	-	Known	Suitable foraging habitat within the study area above water bodies.
Aves	Laridae	<i>Sterna albinas</i>	Little Tern	-	E	-	Ecosystem/ species (breeding)	Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria. It breeds in spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months. Almost exclusively coastal, preferring sheltered environments; however may occur several kilometres from the sea in harbours, inlets and rivers (with occasional offshore islands or coral cays records)	-	-	33	Y	Moderate	Suitable foraging habitat present within the subject site. No suitable breeding habitat available, not mapped as a nesting site in the Little Tern Recovery Plan (OEH)
Aves	Meliphagidae	<i>Anthochaera phrygia</i>	Regent Honeyeater	-	CE	CE	Ecosystem/ species (breeding)	In NSW (confined to two known breeding areas: the Capricorn Valley and Bundra-Berriba region. Nonbreeding flocks occasionally seen in coastal areas foraging in flowering Scaevola, Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-ironbark woodland and riparian forests of River Sheak, with an abundance of mature trees, high canopy cover and abundance of mistlebees.	-	-	2	Y	Moderate	The species is known to forage intermittently on the coast with numbers increasing in winter. In inland areas, the species is known to forage in subject sites. Little foraging records are available, but it is largely clear that Box-ironbark, Ironbark, individual Swamp Mahogany trees which are profuse and reliable foragers. The species is likely to be in the locality and would be expected to traverse the subject site. The subject site does not occur in a key breeding area identified by the Regent Honeyeater Recovery Plan.
Aves	Meliphagidae	<i>Epithanura albilabris</i>	White-fronted Chat	-	V	-	Ecosystem	The White-fronted Chat is found across the southern half of Australia, from southernmost Queensland to southern Tasmania, and across to Western Australia as far north as Carnarvon. Found mostly in temperate to arid climates and very rarely sub-tropical areas, it occupies foothills and lowlands up to 1000m above sea level. In NSW, it occurs mostly in the southern half of the state, from the coast to the mountains. It is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes within low shrubs bordering wetland areas.	-	-	79	Y	Known	Recorded on site during baseline surveys.
Aves	Meliphagidae	<i>Grantiola picta</i>	Painted Honeyeater	-	V	V	Ecosystem	Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boxes, Brigalow and Box Gum woodlands and Box-ironbark forests. Specialist forager on the fruits of mistlebees, preferably of the <i>Amnema</i> genus. Nests in outer tree canopy.	-	-	-	-	Unlikely	Mistlebees are not present at densities greater than 5 plants per hectare. This is an inland species that is unlikely to occur on the coast.
Aves	Meliphagidae	<i>Meliphaga gularis</i>	Black-chinned Honeyeater (eastern subspecies)	-	V	-	Ecosystem	Occurs along the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions, though it is very rare in the latter. Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, particularly Muggah Ironbark (Eucalyptus sideroxylon), White-Box (E. albionis), Inland Grey Box (E. mellissae), Yellow Box (E. mellalodora), Bakery's Red Gum (E. blakelyi) and Forest Red Gum (E. Woodwardii).	-	-	13	-	Unlikely	The species is mainly an inland species that rarely does not occur on the coast.
Aves	Mercopidae	<i>Merops ornatus</i>	Rainbow Bee-eater	-	-	MT	n/a	Widespread across mainland Australia. Mainly inhabits open forests and woodlands and shrublands, often in proximity to permanent water. Also occurs in cleared/semi-cleared habitats including farmland and residential areas. Excavates a nest burrow in falling ground in banks of rivers, creeks, roadsides, cuttings, gravel pits or cliff faces. Southern populations migrate north in winter.	-	-	10	-	Moderate	Known to occur in open and urbanised habitats. Capable of exploiting a range of vegetation types for hawking insects.
Aves	Monarchidae	<i>Monarcha melanotus</i>	Black-faced Monarch	-	-	MT	n/a	Summer breeding migrant to the south-east. Occurs along the coast of NSW. Inhabits preference for eucalypt woodlands, coastal scrub and damy gullies. It may be found in more open woodland when migrating (Birds Australia, 2005). In New South Wales and the Australian Capital Territory, the species occurs around the eastern slopes and tablelands of the Great Divide, inland to Coult's Crossing, Armidale, Wilden Valley, Wollemi National Park, Wombeyan Caves and Canberra. The Black-faced Monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-forest, mesophyll (broadleaf) trickles/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest.	-	-	-	-	Unlikely	The species could potentially occur within rainforest habitat in the Hunter Wetland Centre, although there are no known records for this species within the study area.
Aves	Monarchidae	<i>Symphesachus trivirgatus</i> (Migratory)	Speckled Monarch	-	-	MT	n/a	The Speckled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. Prefers thick understorey in rainforest, wet gullies and water-side vegetation as well as mangroves. It is found in Australia, Indonesia, and Papua New Guinea. Its natural habitat is rainforest, but it also occurs in forest, sub-tropical or tropical mangrove forests, and subtropical or tropical moist montane forests.	-	-	-	-	Unlikely	The species could potentially occur within rainforest and mangrove habitats in the Hunter Wetland Centre, although there are no known records for this species within the study area.
Aves	Motacillidae	<i>Motacilla flava</i>	Yellow Wagtail	-	-	M	n/a	This species breeds in much of temperate Europe and Asia. It is resident in the milder parts of its range, such as western Europe, but northern and eastern populations migrate to Africa and south Asia. It inhabits open country near water, such as wet meadows and reeds in tussocks.	-	-	2	-	Low	Occasionally recorded at Heatham Swamp.
Aves	Muscicapidae	<i>Rhipidura rufifrons</i>	Rufous Fantail	-	-	MT	n/a	Found along NSW coast and inland. Inhabits rainforest, dense wet forests, swamp woodlands and riparian woodlands. It may be found in more open habitats or urban areas (Birds Australia, 2008).	-	-	-	-	Unlikely	The species could potentially occur within rainforest and mangrove habitats in the Hunter Wetland Centre, although there are no known records for this species within the study area.
Aves	Neotitidae	<i>Omphesocoma chrysogastra</i>	Varied Sittella	-	V	-	Ecosystem	Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature ironbark-eucalypt forests with dead branches, mallee and Acaacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cowbats in an upright tree fork high in the forest tree canopy, and often re-uses the same fork or tree in successive years.	-	-	39	Y	Moderate	The species could potentially occur within rainforest and mangrove habitats in the Hunter Wetland Centre, although there are no known records for this species within the study area.

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PMST Report# (OE 2019)	BioNet database "near" to the locality (10km) (OEH, 2019)	BAMC?	Likelihood of occurrence in subject site	Justification
Aves	Falconidae	<i>Diastor beryllina</i>	Eastern Bristlebird	-	E	E	Species	Occurs in three distinct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Habitat characterised by dense, low vegetation including heath and open woodland with a healthy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in the late winter/early spring. The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in low places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. Pines, light wooded country, usually open eucalypt woodland and grassy areas are preferred. The Scarlet Robin is found from south-east Queensland to south-west South Australia and also in Tasmania and south-west Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. In Victoria, they are found in open and forested areas with low scattered shrubs.	-	-	-	-	-	Not previously recorded within the locality. No suitable habitat present within the study area.
Aves	Petroicidae	<i>Meliphaga cucullata cucullata</i>	Hooded Robin (southern form)	-	V	-	Ecosystem	In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Bairambi. It also occurs in woodlands in the southern tablelands and the tablelands and the western slopes of the Great Dividing Range in the southern, central and New England tablelands, (habitat open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains (OEH 2012).	-	1	-	Moderate	There is only one record in the locality, which is consistent with the species being known to be rare on the coast. There is marginal foraging habitat for the species in the subject site.	
Aves	Petroicidae	<i>Petroica boodang</i>	Scarlet Robin	-	V	-	Ecosystem	The Wedge-tailed Shearwater breeds on the east and west coasts of Australia and on off-shore islands. The species is common in the Indian Ocean, the Coral Sea and the Tasman Sea. In Australia, Wedge-tailed Shearwaters have been observed feeding along the junction between the ocean and offshore water masses. Frigate species over shelf water walls and edges; rarely above inshore. Common visitor to the southern and eastern coast of Australia between summer and autumn (Gloriano and Stewart 2013).	-	9	Y	Moderate	Marginal habitat present in the open forests in the western portion of the subject site.	
Aves	Pomasturidae	<i>Pomasturus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	-	V	-	Ecosystem	The Southern Giant-Petrel breeds on six subantarctic and Antarctic islands in Australian territory. The water dispersal is circum-polar, extending north to the Tropic of Capricorn and sometimes beyond. The waters of southeastern Australia may be particularly important wintering grounds. The Northern Giant Petrel breeds in the sub-Antarctic, and visits areas of the Australian mainland and subantarctic islands during this period in offshore and inshore waters from around Fremantle (WA) to around Sydney.	-	38	-	Unlikely	Largely a woodland species preferring riparian woodlands. However, it is common in open grassy areas and may forage in the open forests fringing the wetlands within the study area.	
Aves	Procellariidae	<i>Adeliea carneipes</i>	Flesh-footed Shearwater	-	-	M	n/a	Range throughout the Pacific and Indian Oceans. There are two main breeding areas: one in the South West Pacific includes Lord Howe Island and New Zealand; the other along the coast of Western Australia (OEH 2012). Nests in forests near sandy soils.	-	-	-	None	Species offshore marine. No habitat for this species occurs within the study area.	
Aves	Procellariidae	<i>Adeliea pacifica</i>	Wedge-tailed Shearwater	-	-	M	n/a	The Wedge-tailed Shearwater breeds on the east and west coasts of Australia and on off-shore islands. The species is common in the Indian Ocean, the Coral Sea and the Tasman Sea. In Australia, Wedge-tailed Shearwaters have been observed feeding along the junction between the ocean and offshore water masses.	-	11	-	Unlikely	No suitable habitat for this species within the study area.	
Aves	Procellariidae	<i>Calonectris leucomegas</i>	Streaked Shearwater	-	-	MM	n/a	Frigate species over shelf water walls and edges; rarely above inshore. Common visitor to the southern and eastern coast of Australia between summer and autumn (Gloriano and Stewart 2013).	-	-	-	None	Species not recorded during surveys or previously within the locality. Species limited to oceanic habitats. No suitable habitat within the study area.	
Aves	Procellariidae	<i>Micronectes giganteus</i>	Southern Giant-Petrel	-	E	E, MM	n/a	The Southern Giant-Petrel breeds on six subantarctic and Antarctic islands in Australian territory. The water dispersal is circum-polar, extending north to the Tropic of Capricorn and sometimes beyond. The waters of southeastern Australia may be particularly important wintering grounds.	-	-	-	None	No habitat for this species occurs within the study area.	
Aves	Procellariidae	<i>Micronectes halli</i>	Northern Giant Petrel	-	V	V, M	n/a	The Northern Giant Petrel breeds in the sub-Antarctic, and visits areas of the Australian mainland and subantarctic islands during this period in offshore and inshore waters from around Fremantle (WA) to around Sydney.	-	-	-	None	No habitat for this species occurs within the study area.	
Aves	Procellariidae	<i>Pachyptila lutea subantarctica</i>	Fairy Prion (southern)	-	-	V	n/a	The fairy prion (southern) breeds on Macquarie Island and a number of other subantarctic islands outside of Australia. The subspecies digs burrows among rocks or low vegetation in which to nest. Burrows may be dug below mat forming herbs. Fairy Prion feed by plucking food from the ocean surface. Some individuals may migrate towards New Zealand and southern Australia in winter.	-	-	-	None	No habitat for this species occurs within the study area.	
Aves	Procellariidae	<i>Pterodroma solandri</i>	Providence Petrel	-	V	M	n/a	This is a marine species that breeds on offshore islands (DEWHA 2013). Ranges across eastern Pacific. Only known breeding sites are at Lord Howe Island and Phillip Island, offshore from Norfolk Island. Previously also bred on main Norfolk Island but extinct there by 1900.	-	1	-	None	No habitat for this species occurs within the study area.	
Aves	Falconidae	<i>Circus pinnatus</i>	Little Hawk	-	V	-	Ecosystem	Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feeds primarily on profusely-flowering eucalypt and a variety of other species including mistletoes and mistletoes. On the western slopes and tablelands Eucalyptus alba and E. marginata are common. It is a small (opening approx. 3 cm) hollow in living, smooth-barked eucalypts, especially Eucalyptus viminalis, E. blakelyi and E. deakata. Most breeding records are from the western slopes.	-	76	Y	Moderate	This species is largely an inland species, however, there is suitable foraging resources present within and adjacent to the subject site. There are numerous records in the locality.	
Aves	Falconidae	<i>Lathamus discolor</i>	Swift Parrot	-	E	CE	Ecosystem/ species (breeding)	Occurs on freshwater wetlands in northern and eastern Australia, mainly in coastal and subcoastal areas. Breeds in the coastal and subcoastal regions of NSW, with the highest densities in the south along the coast to the Hunter region of NSW - some recorded in south-eastern NSW potentially in response to unfavourable conditions (OEH 2012).	-	16	Y	Moderate	There is suitable foraging habitat in the study area. Important habitat area not mapped by OEH in study site. Important habitat occurs in the Wenakata SCA	
Aves	Falconidae	<i>Neophema pulchella</i>	Turquoise Parrot	-	V	-	Ecosystem	Occurs from coast to inland slopes, in coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands are important foraging habitat. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands are important nesting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	-	9	-	Unlikely	This species relies on grassland habitats for foraging and woodland habitats for breeding and roosting. The subject site lacks these habitats, with much of the grassland areas comprising exotic grassland.	
Aves	Rostratulidae	<i>Rostratula australis (Wentland)</i>	Australian Painted Shipe	-	E	E, M	Ecosystem	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and snails. Prefers fringes of swamps, dams and nearby open areas.	-	10	Y	Moderate	Suitable wetland habitat present within the study area for foraging. Could potentially roost on the track.	
Aves	Scopelidae	<i>Actitis hypoleucos</i>	Common Sandpiper	-	-	MW	n/a	Does not breed in Australia. However, it is found on the NT and QLD. Utilises a wide range of coastal and inland wetlands with varying salinity levels.	-	18	-	High	Species has been previously recorded within the study area. Suitable foraging habitat present within the coastal freshwater wetland and coastal saltmarsh and mangrove habitats.	
Aves	Scopelidae	<i>Arenaria interpres</i>	Ruddy Turnstone	-	-	MW	n/a	Widespread within Australia during its non-breeding period of the year (Bamford et al. 2009). It is found in most coastal regions, with occasional records of inland populations (Higgins & Davies 1996). It strongly prefers rocky shores or beaches where there are large deposits of rolling seaweed (C.D.T. Minyon 2002, pers. comm.). Usually found on coastal regions with exposed rock shores, shingle or gravel beaches. It can, however, be found on sand, coral or shell beaches, harbours, bays and dry ridges of sand or coral. It has occasionally been sighted in estuaries, around seaweed ponds and on mudflats.	-	20	-	Unlikely	Although marginal quality foraging habitat occurs within the study area, this species is not known from the locality and is considered unlikely to occur within the study area.	
Aves	Scopelidae	<i>Calcarius acuminata</i>	Sharp-tailed Sandpiper	-	-	MW	n/a	Migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats; many inland records are of birds on passage through coastal areas. It is found in coastal areas, including saltmarsh, grass, saltmarsh or other low vegetation.	-	611	-	Known	Observed during field surveys, additionally has a high number of records in locality including in close proximity to study area. Observed during field surveys within the proposal area within Typha Rushland and Coastal Saltmarsh.	



Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEI BioNet)	DPI Fisheries Fish Habitat Mapping	PMST Report <sup>1</sup> (OEI 2019)	BioNet database <sup>1</sup> (10km OEI, 2019)	BAMC <sup>2</sup>	Likelihood of occurrence in subject site	Justification
Aves	Scolopacidae	<i>Calidris cinerifrons</i>	Red Knot	-	-	E, MW	n/a	Rarely found along much of the NSW coast, where wader habitat is either scarce (excluding the Hunter Estuary). Many inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed seaward rock platforms or coral reefs. They are occasionally seen on mudflats and saltmarshes but rarely use freshwater swamps. They rarely use inland lakes or swamps (Higgins & Davies 1996).	-	Species or species habitat known to occur within 10 km	157	-	Moderate	Suitable foraging habitat is present within the study area though most records occur east of the study area associated with the North Arm of the Hunter River. Recent records of a small number of birds on ALJA within the Hunter Estuary (Higgins & Davies 1996). Confirmed important habitat area mapped by OEI.
Aves	Scolopacidae	<i>Calidris bairdii</i>	Culpeper Sandpiper	-	E	CE, MW	Ecosystem/ species (breeding)	Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and freshwater wetlands in the Murray-Darling Basin. Breeds in Siberia and migrates to Australia (as well as Africa and Asia) for the non-breeding period, arriving between August and November, and departing between March and mid-April (OEI 2012). It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts (OEI 2012).	-	Species or species habitat known to occur within 10 km	792	Y	High	Suitable foraging habitat is present in the study area in coastal saltmarsh and mangrove habitats. Confirmed important habitat area mapped by OEI. Present. There are numerous records for the species within the locality.
Aves	Scolopacidae	<i>Calidris melanotos</i>	Pectoral Sandpiper	-	-	MW	n/a	Widespread but scattered records across NSW, east of the divide and in the Riverina and Lower Western regions. Breeds in the northern hemisphere. In Australia, prefers shallow fresh to saline wetlands, including saltmarshes, mudflats, and artificial wetlands. Usually in coastal or near-coastal habitats, and prefers wetlands with open mudflats and low emergent or fringing vegetation such as grass or samphire.	-	NA	-	Low	Suitable foraging habitat present within study area within coastal saltmarsh/mangrove habitat types. Rarely recorded in the Hunter Estuary.	
Aves	Scolopacidae	<i>Calidris bairdii</i>	Great Knot	-	V	CE, MW	Ecosystem/ species (breeding)	In NSW, occurs in scattered sites along the coast to Narooma – It has been observed inland at some sites, including in the Hunter Estuary, and in the Riverina and Lower Western regions. Breeds in the northern hemisphere. In Australia, prefers shallow fresh to saline wetlands, including saltmarshes, mudflats, and artificial wetlands. Usually in coastal or near-coastal habitats, and prefers wetlands with open mudflats and low emergent or fringing vegetation such as grass or samphire.	-	Roosting known to occur within 10 km	33	Y	Moderate	Marginal quality habitat present within study area in Coastal saltmarsh and mangrove habitat. These habitats within the study area are generally lacking in large expanses of intertidal mudflats for foraging. The species is subject to large fluctuations in abundance in the Hunter Estuary, Australia. The subject site is not mapped as important habitat for the species.
Aves	Scolopacidae	<i>Calidris ruficollis</i>	Red-necked Stint	-	-	MW	n/a	Tasmanian coastal. The Red-necked Stint has been recorded in the Victorian and Tasmanian coasts. The Red-necked Stint has been recorded in all coastal regions, and found inland in all states when conditions are suitable. It may occur in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores.	-	Roosting known to occur within 10 km	190	-	Moderate	Not observed during field surveys. Preferred habitat present within the proposal area within Tynte, Rushland and Coastal Saltmarsh. Some records in the locality.
Aves	Scolopacidae	<i>Charadrius bitorquatus</i>	Double-banded Plover	-	-	MW	n/a	Found in both coastal and inland areas; eastern and southern Australia, mainly between the Tropic of Capricorn and the Tropic of Capricorn. Breeds in northern Queensland and southern Western Australia (Mason & Higgins 1983). The species breeds in the Hunter Estuary and Victoria, but numbers diminish to the north and west of these regions (C.D.T. Milton, 2002 pers. comm). Found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture.	-	Roosting known to occur within 10 km	-	-	Moderate	Low numbers of Double-banded Plovers have been recorded a few times within the Hunter Estuary (Hobson 2007). Suitable habitat present within the study area.
Aves	Scolopacidae	<i>Charadrius leschenaultii</i>	Greater Sandplover	-	-	V, MW	Ecosystem/ species (breeding)	Does not breed in Australia. In NSW, recorded between the northern rivers and the llawarra. With most records coming from the Clarence and Richmond estuaries. Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; forage on wet ground at low tide. Almost entirely restricted to coastal areas in NSW, occurring mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks (OEI 2012).	-	Roosting known to occur within 10 km	6	Y	Low	Considered an accidental summer migrant, rarely seen in the Hunter Estuary (Hobson 2007). Marginal foraging habitat present in the subject site.
Aves	Scolopacidae	<i>Gallinago hardwickii</i>	Latham's Shipe	-	-	MW	n/a	Occurs along the coast and west of the great dividing range. Non breeding visitor to Australia, inhabits permanent and ephemeral wetlands up to 2000 m asl. Typically in open, freshwater wetlands with low, dense vegetation (incl. swamps, flooded grasslands and heathlands). Can also occur in saline/brackish habitats and in modified or artificial habitats close to human activity.	-	Roosting known to occur within 10 km	169	-	High	Suitable habitat exists within the study area in densely vegetated wetlands.
Aves	Scolopacidae	<i>Gallinago megala</i>	Swinhoe's Shipe	-	-	MW	n/a	Swinhoe's Shipe is recorded in north Australia, particularly the Kimberley region, from October–April. It is a non-breeding migrant to Australia and occurs at the edges of wetlands, such as wet peaty fields, swamps and freshwater streams. The species is also known to occur in modified areas (including crops of rapeseed and wheat) and market gardens (Higgins & Davies 1996).	-	Species or species habitat known to occur within 10 km	-	-	Unlikely	Possible habitat within the study area but few records exist in Australia and considered unlikely.
Aves	Scolopacidae	<i>Gallinago stenura</i>	Pin-tailed Shipe	-	-	MW	n/a	The species distribution within Australia is not well understood. There are confirmed records from NSW, south-west Western Australia, Pilbara and the Top End. In NSW a single banded bird was reported near West Wyalong. During non-breeding period the Pin-tailed Shipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense sedge or grassland vegetation. It is also recorded in other, more open wetlands such as swamps, floodplains and floodplain wetlands. It is also commonly seen at estuary ponds, not normally in saline or inter-tidal wetlands (Higgins & Davies 1996).	-	Species or species habitat likely to occur within 10 km	-	-	Unlikely	Possible habitat within the study area but few records exist in Australia and considered unlikely.
Aves	Scolopacidae	<i>Heteroscolus brevipes</i> <i>Tringa brevipes</i>	Grey-tailed Tattler	-	-	MW, MM	n/a	Non-breeding visitor to Australia. Distributed along most of the coast from the Queensland border south to Tilla Lake and Victoria. It is more heavily distributed along coastal regions north of Sydney. The largest populations in Victoria are located at Corner Inlet, west to Westlport and Port Phillip Bays. Often found on sheltered coasts with reefs and rock platforms or with intertidal mudflats.	-	Roosting known to occur within 10 km	66	-	Unlikely	Records east of the study area primarily associated with saltwater habitats on the North Arm of the Hunter River (Hobson 2007).
Aves	Scolopacidae	<i>Limicola facinellus</i>	Broad-billed Sandpiper	-	V	MW	Ecosystem/ species (breeding)	The Broad-billed Sandpiper breeds in the northern hemisphere, moving south for the non-breeding season. The Broad-billed Sandpiper occurs in sheltered parts of the coast, favouring estuarine mudflats but also occasionally occur on saltmarshes, shallow freshwater lagoons, saltworks and sewage farms, and in areas with large soft intertidal mudflats, which may have shell or sandbanks nearby.	-	Roosting known to occur within 10 km	19	-	Low	There is suitable foraging habitat in the study area however few records exist within the Hunter Estuary, with no records in the study area. Considered an accidental visitor to the Hunter Estuary.
Aves	Scolopacidae	<i>Limosa lapponica baueri</i>	Bar-tailed Godwit (baueri)	-	-	V	n/a	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal mudflats, banks, mudflats, estuaries, wetlands, coastal lagoons, saltmarshes, and sometimes, in nearby saltmarsh. It has been sighted in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flat. It is rarely found on inland wetlands or in areas of short grass, such as farmland, paddocks and airstrips, although this is commonly recorded in paddocks at some locations overseas (Mason & Higgins 1983).	-	Species or species habitat known to occur within 10 km	1	-	Moderate	There is suitable foraging habitat in the study area. Confirmed important habitat area mapped by OEI. Assumed present.
Aves	Scolopacidae	<i>Limosa lapponica baueri</i>	Bar-tailed Godwit	-	-	V, MW	n/a	Has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands. Breeds in the north of Scandinavia, Russia and north-west Alaska. Found mainly in coastal habitats such as large intertidal mudflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays.	-	Species or species habitat known to occur within 10 km	793	-	Moderate	Some records associated with the study area but the species is mostly associated with habitats along the North Arm of the Hunter River.
Aves	Scolopacidae	<i>Limosa lapponica merzbieri</i>	Northern Siberian Bar-tailed Godwit	-	-	CE	n/a	The Siberian Godwit is a large migratory shorebird which breeds in northern Siberia, Russia between the Khatanga River and the delta of the Koyoma River. During the non-breeding period, the distribution of L. merzbieri is predominantly in the north and north-west of Western Australia and in south-eastern Asia.	-	Species or species habitat known to occur within 10 km	-	-	Unlikely	Out of range for the species.

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PMST Report <sup>1</sup> (OE 2019)	BioNet database <sup>2</sup> (10km OEH, 2019)	BAMC <sup>3</sup>	Likelihood of occurrence in subject site	Justification
Aves	Scopacidae	<i>Limosa limosa</i>	Black-tailed Godwit	-	V	MW	Ecosystem/ (breeding)	The Black-tailed Godwit is a migrant wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It is usually found in open areas, but has also been found around muddy lakes and swamps, wet fields and sewerage treatment works.	-	Roosting known to occur within 10 km	297	-	Moderate	There is suitable foraging habitat in the study area. Confirmed important habitat for OEH, but not present. There are numerous records for the species within the study area.
Aves	Scopacidae	<i>Numenius madagascariensis</i>	Eastern Curlew	-	-	CE, MW	n/a	Occurs primarily along the coast, found in all states, particularly the north, east, and south-east regions including Tasmania, rarely recorded inland. Associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, mangroves, and sometimes use the mangroves. The birds are also found in saltworks and sewage farms (Marchant & Higgins 1993). Records with Hunter Estuary concentrated at Stockton Sandspit and Kooragang Dykes.	-	Species or species habitat known to occur within 10 km	145	-	Moderate	Suitable foraging habitat is present in the study area in coastal saltmarsh and mangrove habitats. Confirmed important habitat area mapped by OEH. There are no records for the species within the study area, with most records associated with saline habitats east of the study area.
Aves	Scopacidae	<i>Numenius minutus</i>	Little Curlew	-	-	MW	n/a	Generally spend the post-breeding season in northern Australia. In NSW, most records are from the Great Dividing Range. Records from the Pacific coast are few and scattered records west of the Great Dividing Range. Recorded breeding in Siberia. Most often found feeding in short, dry grassland and sedge/land, including dry floodplains and backswamp plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of intertidal mudflats, saltmarshes, coastal swamps, recreational areas, ovals, racetracks and verges of roads and airfields are also used.	-	Species or species habitat likely to occur within 10 km	1	-	Unlikely	Considered an accidental summer migrant to the Hunter Estuary. Rarely recorded. No records associated with the study area.
Aves	Scopacidae	<i>Numenius phaeopus</i>	Wimbrel	-	-	MW	n/a	Migrant to Australia and New Zealand, with a primarily coastal distribution. There are also scattered inland records of Wimbrels in all regions. It is found in all states but is more common in the north. Often found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, or coral or rocky islets, or on intertidal reefs and platforms. It has been infrequently recorded using saline or brackish lakes near inland areas.	-	Roosting known to occur within 10 km	74	-	Low	Exclusively associated with saline habitats on the North Arm of the Hunter River, although some suitable roosting habitat associated with mangroves is present in the study area.
Aves	Scopacidae	<i>Phalaropus pugnax</i>	Ruff	-	-	MW	n/a	In NSW the species has been recorded at Kurrajit, Tomah, Cessnock, Bellambi, Kooragang Island, Broadwater Lagoon and Little Cattin Creek. The species has also been found around the Riverina, including Windouran Swamp, Wangangella, Fivebough Swamps and the Tulakool Saltworks. Most NSW records come from the Sydney region. In Australia the Ruff is found on generally fresh, brackish or saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, ponds, lagoons, saltmarshes, swampy fields and floodplains. They are also recorded in coastal wetlands, but also inland, but are most commonly found in coastal wetlands, salt sewage farms and saltworks. They are sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds.	-	Roosting known to occur within 10 km	1	-	Unlikely	Considered an accidental migrant to the Hunter Estuary. Single birds occasionally observed.
Aves	Scopacidae	<i>Tringa glareola</i>	Wood Sandpiper	-	-	MW, M	n/a	Breeds in Northern Hemisphere. Occurs in largest numbers in NW Australia, with all sites of regional importance within WA. In NSW there are records east of the Darling north from Newng and inland from the upper and lower Western regions. Uses well-vegetated, shallow, freshwater wetlands and are typically associated with wetlands supporting emergent aquatic plants or grass and taller fringing vegetation such as dense reeds/mushes, shrubs or trees. Also frequent flooded grasslands and irrigated crops. Rarely in brackish wetlands or saltmarsh. Known from artificial wetlands.	-	Roosting known to occur within 10 km	25	-	Low	Occasionally observed in freshwater swamps in the Hunter Estuary, but considered rare to the Hunter Estuary.
Aves	Scopacidae	<i>Tringa nebulosa</i>	Common Greenshank	-	-	MW	n/a	Does not breed in Australia, but occurs in all types of wetlands. In NSW has been recorded in most coastal regions and is widespread west of the Great Dividing Range, particularly in the north-west, Macquarie Marshes and areas between the Lachlan and Murray Rivers and Darling River drainage basin. The Hunter River estuary is an internationally important site for the species. In coastal areas typically occurs in sheltered habitats with large mudflats and saltmarsh/mangroves or seagrass.	-	Species or species habitat known to occur within 10 km	337	-	Known	Suitable foraging habitat within the study area.
Aves	Scopacidae	<i>Tringa stagnatilis</i>	Marsh Sandpiper, Little Green Shank	-	-	MW, M	n/a	Recorded in all regions of NSW but especially the central and south coasts and (inland) on the Darling River. It is a migrant species that breeds in the northern hemisphere. It is found in a variety of habitats, including swamps, lagoons, billabongs, saltmarshes, estuaries, pools on undulating floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bone-drain swamps and flooded inland lakes.	-	Roosting known to occur within 10 km	398	-	High	Common throughout the Hunter Estuary and suitable habitat present within the study area.
Aves	Scopacidae	<i>Xenus cinereus</i>	Terek Sandpiper	-	V	MW	Ecosystem/ species (breeding)	The two main sites for this species in NSW are the Richmond River and Hunter River estuaries. Inhabits coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks near intertidal mudflats, but also occurs in open intertidal mudflats. Roosts communally in mangroves or dead trees.	-	Roosting known to occur within 10 km	231	Y	High	Suitable foraging and roosting habitat present within the subject site. Confirmed important habitat area mapped by OEH.
Aves	Strigidae	<i>Ninox connexus</i>	Barking Owl	-	V	-	Ecosystem/ species (breeding)	Occurs from coast to inland slopes and plains, though is rare in dense, well-forested east of the Great Dividing Range and sparse in higher parts of the tablelands and in the arid zone. Inhabits a variety of habitats, including open woodlands, grasslands, heathlands, and open areas along watercourses. Roosts along creek lines in dense, tall understorey (fedge (e.g. in Acacia and Casuarina)) or dense eucalypt canopy. Nests in hollows of large, old eucalypts including Eucalyptus camaldulensis, Eucalyptus albens, Eucalyptus polyanthemos and Eucalyptus blakeyi. Birds and mammals important prey during breeding. Territories range from 30 to 200 hectares.	-	-	5	-	Known	Recorded on site during baseline surveys. A limited number of suitable habitat areas were identified, but recorded adjacent to the subject site in the study area. The species was recorded foraging across the study area as part of a larger home range but is unlikely to breed within the study area.
Aves	Strigidae	<i>Ninox strenua</i>	Powerful Owl	-	V	-	Ecosystem/ species (breeding)	Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers open areas with a dense understorey. Territories range from 100 to 240 ha that are at least 150 years old. Pairs have high fidelity to a particular number of home-bearing nest trees and defend a large home range of 400 - 1450 ha. Forages within open and closed woodlands as well as open areas.	-	-	148	-	Moderate	Potential foraging habitat present within the subject site, with the subject site forming part of a larger foraging home range. The species is well known from the locality, with numerous records and one near Pambalong (1000m from the subject site). The species was recorded on site during baseline surveys, but not observed in the subject site but recorded adjacent to the subject site in the study area. The species has potential to forage across the study area as part of a larger home range but is unlikely to breed within the study area.
Aves	Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis	-	-	MW, M	n/a	Occurs throughout eastern and northern Australia, east of the Kimberley and Eyre Peninsula. Inhabits a range of habitats from open woodlands to coastal wetlands. Top End, Central and Northern Territory. Preferred habitats from open woodlands to coastal wetlands, rivers, lagoons, floodplains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation. Breeds at limited locations, with most records from the Murray Darling Basin (NSW), western Riverina (VIC), southeast (SA), Channel Country (Qld SA) and lower Ord/Keep Rivers (WA).	-	NA	43	-	High	Spontaneously occur in the area, suitable habitat present within the study area.

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PNIST Report* (OEE 2019)	BioNet database "locality" (10km QOEH, 2019)	BAMC*	Likelihood of occurrence in subject site	Justification
Aves	Tyrionidae	<i>Tyto longimembris</i>	Eastern Grass Owl	-	V	-	Ecosystem	Eastern Grass Owls have been recorded occasionally in all inland states of Australia but are common in NSW. In NSW, they are most abundant in the north-east. Eastern Grass Owl numbers can fluctuate greatly, increasing especially during wet years. Eastern Grass Owls are found in areas of tall grass, including grass bascocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains.	-	-	23	Y	High	Foraging habitat present.
Aves	Tyrionidae	<i>Tyto novaehollandiae</i>	Masked Owl	-	V	-	Ecosystem/ species (breeding)	Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100 m. Dried stages are especially popular for roosting/ breeding habitat and also a limited resource due to natural attrition. Roosts and breeds in large (>40 cm) hollows in trees, shrubs, and dead trees. Home range between 500 ha and 1000 ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	-	-	50	Y	High	Foraging habitat present. A limited number of suitable hollows (entrances greater than 40cm) not observed in the subject site but recorded adjacent to the subject site in the study area. The species has potential to forage across the study area as part of a larger home range but is unlikely to breed within the study area.
Aves	Tyrionidae	<i>Tyto tenuirostris</i>	Sooty Owl	-	V	-	Ecosystem/ species (breeding)	Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum ( <i>Pseudocheirus peregrinus</i> ) or Sugar Glider ( <i>Petaurus breviceps</i> ). Nests in very large tree hollows.	-	-	15	Y	Moderate	Foraging habitat present. A limited number of suitable hollows (entrances greater than 40cm) not observed in the subject site but recorded adjacent to the subject site in the study area. The species has potential to forage across the study area as part of a larger home range but is unlikely to breed within the study area.
Fish	Eleotidae	<i>Agunoides adspersus</i>	Southern Purple Spotted Gudgeon	E	-	-	n/a	Southern Purple Spotted Gudgeons occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. The western population of the Southern Purple Spotted Gudgeon was previously widespread in the Murray, Murrumbidgee and Lachlan River systems and tributaries of the Darling, but has experienced a significant decline in recent times. Southern Purple Spotted Gudgeons are now extremely rare in inland NSW, having been recorded from this area only once since 1985.	Modelled distribution within 10 km of subject site, associated with Ironbank Creek.	-	-	Moderate	The Southern Purple Spotted Gudgeon occurs in NSW as two broad populations: an eastern population found in coastal catchments north of the Darling River (Richmond and Clarence River catchments), is very far north of the study area. It is unclear why the species distribution has been modelled for the Ironbank Creek catchment, except that records for the species exist for the Ironbank Creek catchment. The species distribution is approximately 20 km north of Sydney. These records are likely related to be outside of the natural range of the species (DPI, 2017).	
Fish	Lamnidae	<i>Lamna nasus</i>	Mackerel Shark, Porbeagle Shark	-	-	MM	n/a	Widespread in southern Australia from the Sydney region (New South Wales) to north of Perth (Western Australia). Elsewhere, the species occurs in the North Atlantic, and is circumglobal in the Southern Hemisphere (90-80°S). Porbeagle sharks undertake daily vertical migrations to feed on mesopelagic fishes and squid. They regularly dive to 600 m with a maximum recorded depth of 1024 m during the day. In 2019, they spend most of their time at depths of 200-500 m in the open ocean (DPI, 2017).	-	-	-	None	No habitat for this species occurs within the study area.	
Fish	Myxobatidae	<i>Menta affinis</i>	Reef Manta Ray	-	-	M	n/a	Known on Australian waters from about Perth, Western Australia, around the tropical north to the Solitary Islands, New South Wales; also Coos (Keeling) Islands and Christmas Island in the eastern Indian Ocean. Elsewhere the species is circumglobal in tropical waters. Often seen inshore around coral and rocky reefs in tropical and subtropical waters. manta rays individuals undertake seasonal migrations and aggregate at certain sites, presumably during times of high seasonal plankton productivity (Brav. D. J. 2017).	-	-	-	None	No habitat for this species occurs within the study area.	
Fish	Myxobatidae	<i>Menta birostris</i>	Giant Manta Ray	-	-	M	n/a	Widespread, although highly uncommon in Australian waters; also Coos (Keeling) Islands and Christmas Island and the eastern Indian Ocean. Elsewhere the species is circumglobal in tropical waters. Often seen inshore around coral and rocky reefs in tropical and subtropical waters. Giant Manta Rays aggregate around Ningaloo Reef during autumn and winter. (Bray, D. J. 2017)	-	-	-	None	No habitat for this species occurs within the study area.	
Fish	Serranidae	<i>Epinephelus diemelli</i>	Black Rockcod	V	-	V	n/a	Found in warm temperate/sub-tropical parts of south-western Pacific. Naturally occur along NSW Coast and Lord Howe Island. Adults generally found on rocky reefs, juveniles found in coastal rock pools and around rocky shores in estuaries. (DPI 2015).	-	-	-	Unlikely	This species is associated with rocky reefs, coastal rock pools, or rocky shores. It is considered unlikely to occur within the aquatic habitats associated with the study area.	
Mammalia	Burramyidae	<i>Cercartetus nanus</i>	Eastern Pygmy-possum	-	V	-	Species	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including box-ironbark) forest and woodland, to heath, where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum ( <i>Pseudocheirus</i> ) nests, and other natural refuges. Feeds on grasses, fungi, and invertebrates. Males are predicted to build female tree hollows, and females build and inhabit nests. Males have been found under the bark of eucalypts and in shredded bark in tree forks.	-	-	1	Y	Unlikely	There are very few records in the locality and the majority of the subject site is not represented by eucalypt forest. The majority of the subject site is considered to be marginal, but the species has potential to occur in the habitat within the study area during the recommended survey period but the species was not detected.
Mammalia	Dasyuridae	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	-	V	E	Ecosystem	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, Boulder fields and rocky cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	-	-	6	Y	Unlikely	The study area only contains low quality, highly fragmented habitat for this species. However, low number of records in the locality and is considered unlikely to utilise habitats within the study area as the majority of the study area traverses wetland habitats associated with the Hunter Wetlands National Park.
Mammalia	Dasyuridae	<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	-	Y	-	Species	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is found in the Blue Mountains, the Snowy Mountains, the Blue Mountains, the Blue Mountains divide. Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabits heath, swamps, rainforest and wet sclerophyll forest, foraging preferentially in rough barked trees of 25 cm DBH or greater. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span.	-	-	1	Y	Unlikely	Not detected during targeted survey. Possible foraging habitat present in forested areas with LOTS. No large hollows present in subject site. Indicates the species is unlikely to be reading within habitats in the subject site. Any potential foraging habitat within the study area was undetected during the recommended survey period but the species was not detected.
Mammalia	Dasyuridae	<i>Phascogale maculata</i>	Common Plaingale	-	V	-	Species	Coastal north-eastern NSW, coastal east Queensland and Arnhem Land. The species reaches its confirmed southern distribution limit on the NSW lower north coast however there are reports of its occurrence as far south as the central NSW coast west of Sydney. Common Plaingales inhabit rainforest, eucalypt forest, heathland, mallee, grassland and rocky areas where there is a high density of hollows. They are nocturnal and feed on insects and small vertebrates. They breed from October to January.	-	-	-	Y	Unlikely	Marginal quality habitat occurs within the Rain Forest in the study area but considered unsuitable due to its restricted extent and isolation from other suitable habitats for this species. The study site reaches the southern most distribution of the species, with a lack of record within the area. The closest record according to BioNet is in Fern Bar (recorded in 2018). All other records are over 50 km away.



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Mammalia	Delphinidae	<i> Sousa chinensis</i>	Indo-Pacific Humpback Dolphin	-	-	MM	n/a	The Indian Ocean humpback dolphin is known to occur within the Indian Ocean from South Africa to India. Humpback dolphins are coastal animals, venturing quite far landward into estuaries and mangroves within their distribution. Their marine habitats are often turbid waters and thus sound propagation and reception are crucial for navigation and social contact. Australian occurrences of Indo-Pacific humpback dolphins are concentrated in the southern coastal waters of Queensland. Australian records have been made offshore but only in association with shallow reef habitat (VanDyck, Gimber and Baker, 2013).	-	Species or species habitat likely to occur within 10 km	-	-	Unlikely	No habitat for this species occurs within the study area.
Mammalia	Emballonuridae	<i> Saccolaimus flaviventris</i>	Yellow-bellied Shearwater	-	V	-	Ecosystem	Migrates from tropics to SE Aus in summer. Forages across a range of habitats including those with wind and trees, from wet and dry sclerophyll forest, open woodland, Acacia scrubland, grasslands and desert. Roosts communally in large tree hollows and buildings (Churchill 2008).	-	-	17	Y	Known	Recorded on site during baseline surveys.
Mammalia	Macropodidae	<i> Petrogale penicillata</i>	Brush-tailed Rock-wallaby	-	E	V	Species	Occurs from the Shalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing inland. It is adjacent to rocky areas eating grasses and herbs as well as the foliage and shrubs and trees.	-	Predicted to occur within 10 km	-	-	None	No suitable offshore or rocky escarpment habitats within the subject site. No records in the locality.
Mammalia	Morciidae	<i> Mormopterus norfolkensis</i>	Eastern Freetail-bat	-	V	-	Ecosystem	Occurs in dry sclerophyll forest and woodshed east of the Great Dividing Range. Forages in natural tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	-	Species or species habitat known to occur within 10 km	188	-	Known	Recorded on site during baseline surveys. This species is not typically associated with artificial rock structures and most records are from tree hollow roosts. Call data near the M1 tunnel is probably from individuals foraging in the vicinity of the tunnel.
Mammalia	Muridae	<i> Pseudomys novaehollandiae</i>	New Holland Mouse	-	V	V	Ecosystem	Occurs in disjunct coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradie 1999). Populations may recolonise/increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with undisturbed vegetation density, and high floristic diversity in regenerating heath (Cook and Wilson 1999).	-	Species or species habitat known to occur within 10 km	17	-	Unlikely	The subject site does not support healthy vegetation or occur on vegetated sand dunes. No suitable habitat.
Mammalia	Petauridae	<i> Petaurus australis</i>	Yellow-bellied Glider	-	V	-	Ecosystem	Occurs in natural mature eucalypt forest especially in areas with high rainfall and nutrient rich soils. Forages in tall trees with hollows and crevices and roosts in tall, dry, open forest, in dry open forests in the north; moist coastal gullies and creek flats to tall montane forests in the south.	-	-	8	Y	Moderate	Preferred tall eucalypt forest habitat not well represented in the study area. However, the subject site is adjacent to coastal forest and may forage across parts of the subject site (mainly in the western portion) if in the area.
Mammalia	Petauridae	<i> Petaurus norfolkensis</i>	Squirrel Glider	-	V	-	Species	Occurs along the drier inland slopes as well as coastal habitats. Inhabits woodland and open forest with a Eucalyptus, Corymba or Angophora overstorey and a shrubby understorey of Acacia or Banksia or other nectar sources, and hollow-bearing trees for roost and nest sites (van der Ree and Stuckling 2008, Quin et al. 2004), with social groups moving between multiple hollows. Social groups include one or two adult males and females with offspring, and have home ranges of 5-10 ha within NSW (van der Ree and Stuckling 2008, Kavanagh 1984, Kavanagh 2004).	-	-	142	-	Moderate	No suitable hollows detected within the study area for roosting/breeding. Only general quality habitat fragmented for any habitat available within the study area within the forested habitat types. The habitats are marginal because they lack an abundance of suitable hollows. Although records occur in locality there are all associated with extensive tracts of vegetation. The subject site is not a suitable habitat type. Tapping surveys were undertaken in potential tall forest habitat within the study area during the recommended survey period but the species was not detected.
Mammalia	Phascogalidae	<i> Phascogale cinerea</i>	Koala	-	V	V	Ecosystem/ species (breeding)	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home ranges varies depending on habitat quality, from < 2 to several hundred hectares.	-	Species or species habitat known to occur within 10 km	842	-	Moderate	Preferred feed trees are present within the subject site but the habitat within the subject site is marginal and the species has a low likelihood of occurring in the subject site. The subject site is adjacent to coastal forest and may forage across parts of the subject site (mainly in the western portion) if in the area.
Mammalia	Potoroidae	<i> Potorous tridactylus</i>	Long-Nosed Potoroo	-	V	V	Ecosystem	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	-	Species or species habitat likely to occur within 10 km	-	-	Unlikely	The subject site does not occur on sandy substrates and lack thick ground cover. The site is marginal wet and dry sclerophyll forest available within the subject site.
Mammalia	Pseudocheilidae	<i> Petauroides volans</i>	Greater Glider	-	V	V	n/a	The greater glider is found in eucalypt forest from Mossman, Queensland, to Davesford, Victoria. The greater glider chooses habitat based on several factors. A large factor determining habitat choice is the presence of specific species of eucalypt. Distribution levels are higher in regions of montane forest containing manna gum (E. viminalis) and mountain gum (E. cairympleura). Eucalypt species in the greater glider's diet do not appear to require any particular soil type or soil pH. The greater glider in NSW is dominated by E. obliqua, with other factors determining population density and elevation. Optimal levels are 845 m above sea level.	-	Species or species habitat known to occur within 10 km	10	-	Unlikely	Suitable foraging and sheltering habitat in the preferred community, however this area of habitat is highly fragmented and restricted in extent. Species is also considered unlikely to occur in such close proximity to residential areas.
Mammalia	Pteropodidae	<i> Pteropus poliocephalus</i>	Grey-headed Flying-fox	-	V	V	Ecosystem/ species (breeding)	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation on woodlands, heath, scrub and forest (excluding sclerophyll forest, melaleuca and banksias). Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	-	Roosting known to occur within 10 km	538	Y	High	Suitable foraging habitat present within the subject site. No camps recorded in the study area. Camps are located in the Forest Hill area (approximately 8 km south of subject site. (https://www.environment.gov.au/webgis-framework/kapoor/ffc-wide/ffc-wide.jsp) (accessed 7/05/2019)
Mammalia	Vespertilionidae	<i> Chirodobus thyeri</i>	Large-eared Pied Bat	-	V	V	Species	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	-	Species or species habitat known to occur within 10 km	17	-	Known	Suitable foraging habitat present in study area in forested vegetation types. Several records in locality in close proximity to the proposed trail. Recorded during field surveys in 2019 near the M1 tunnel. There is potential that the subject site may be suitable foraging habitat. The tunnel lacks the depth and dampness required for stable temperatures and humidity required by the species for breeding.
Mammalia	Vespertilionidae	<i> Falstrelus tasmaniensis</i>	Eastern False Pipistrelle	-	V	-	Ecosystem	Occurs on southeast coast and ranges. Prefers tall (20 m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bank or in buildings. Forages in gaps and spaces within forest, with large foraging range (12 km foraging movements recorded) (Churchill 2008; Law et al 2008).	-	-	67	Y	Moderate	May forage in open areas between vegetation patches within the subject site. May flyover.
Mammalia	Vespertilionidae	<i> Miniopterus australis</i>	Little Bentwing-bat	-	V	-	Ecosystem/ species (breeding)	Occurs from Cape York to Sydney. Inhabits rainforests, wet and dry sclerophyll forests, paperbark swamps and vine thickets. Only one maternity cave known in NSW, shared with Eastern Bentwing-bats at Wall Hill, near Kempsey. Appears to depend on the large colony to provide the high humidity and stable temperatures required for stable temperatures and humidity required by the species for breeding. The M1 tunnel is unlikely to provide the necessary roost conditions to support breeding.	-	Species or species habitat known to occur within 10 km	369	-	Known	Recorded on site during baseline surveys. The M1 tunnel provides roosting habitat for the species, however, the M1 tunnel is unlikely to be a suitable breeding site, supported by the anabat data, which indicates that the sympatric species, Eastern Bentwing-bat (Miniopterus sclerocalus) roosts in the tunnel. The M1 tunnel is unlikely to provide the necessary roost conditions to support breeding.

Class	Family	Scientific Name	Common Name	FM Act	BC Act	EPBC Act	Credit Type	Habitat Association (OEH BioNet)	DPI Fisheries Fish Habitat Mapping	PWST Report* (OEZ 2019)	BioNet database records within 10km (OEH, 2019)	BAMC <sup>1</sup>	Likelihood of occurrence in subject site	Justification
Mammalia	Vespertilionidae	<i>Miniopterus schreibersi oceanensis</i>	Eastern Bentwing-bat	-	V	-	Ecosystem (breeding)	Generally, occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest structures. Only four known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	-	-	177	High	Known	Recorded on site during baseline surveys. The anabat data indicates that the species is not roosting in the M1 tunnel but may be foraging in the area around the M1 tunnel. This species has specific temperature and humidity requirements (up to 95% humidity; Churchill, 2008). The M1 tunnel is highly unlikely to be a suitable breeding cove as it does not have the depth to support stable temperatures or high humidity levels.
Mammalia	Vespertilionidae	<i>Myotis macroopus</i>	Southern Myotis	-	V	-	Species	Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in hilly/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings. Usually roosts in close proximity to water (Campbell 2011). Breeds November or December (Churchill 2008).	-	-	99	-	Known	Detectable in targeted surveys using Anabat detectors and observed in breeding/roosting habitat present within study area within coastal fresh water wetland vegetation types and M1 tunnel. Several records in the locality including some in close proximity to study area.
Mammalia	Vespertilionidae	<i>Scoteanax ruppelli</i>	Greater Broad-nosed Bat	-	V	-	Ecosystem	Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined roads. Feeds on insects and nectar. Roosts in hollows of trees and other man-made openings in dense habitats. Usually roosts in tree hollows or fissures but also under an existing bank or in the roofs of old buildings. Females congregate in maternal colonies in suitable hollow trees (Howe and Richards 2008; Churchill 2008).	-	-	84	Y	Moderate	Suitable foraging and roosting habitat present within the study area.
Mammalia	Vespertilionidae	<i>Vespadelus traughtoni</i>	Eastern Cave Bat	-	V	-	Species	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast from southern NSW, east of the ACT. A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs. Females roost in disused mine workings, occasionally in colonies of up to 500 individuals.	-	-	40	Y	High	The species is likely to forage in and around the study area. However surveys undertaken indicate M1 tunnel provides potential diurnal roosting habitat but not breeding habitat. Poor quality breeding but potential roosting habitat on occasion within home range. Nearest dataset record within Pamalating Nature Reserve, adjacent to the M1 tunnel.
Reptilia	Cheloniidae	<i>Caretta caretta</i>	Loggerhead Turtle	-	E	E,MM	Species	In Australia, the Loggerhead Turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia. Nesting populations are known from southern Queensland and Western Australia. Loggerhead Turtles are omnivorous, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 50 m.	-	Species or species habitat known to occur within 10 km	3	-	None	Species limited to oceanic habitats. No suitable habitat within the study area.
Reptilia	Cheloniidae	<i>Chelonia mydas</i>	Green Turtle	-	V	V,MM	n/a	Usually found in tropical and sub-tropical waters, but also occurs off the NSW coast, usually on the north and central coast with occasional records from the south. Key nesting areas occur in Queensland, Northern Territory and Western Australia waters but there are scattered records of nesting along the NSW coast. Eggs are laid in nests dug in beaches.	-	Foraging, feeding or related behaviour likely to occur within 10 km	1	-	None	Species limited to oceanic habitats. No suitable habitat within the study area.
Reptilia	Cheloniidae	<i>Eretmochelys imbricata</i>	Hawksbill Turtle	-	-	V,MM	n/a	Occurs in tropical, subtropical and temperate waters, and have been seen as far south as northern NSW. Key foraging and breeding grounds are located in WA, NT and QLD.	-	Foraging, feeding or related behaviour likely to occur within 10 km	2	-	None	Species limited to oceanic habitats. No suitable habitat within the study area.
Reptilia	Cheloniidae	<i>Natator depressus</i>	Flatback Turtle	-	-	V	n/a	Key foraging and breeding sites are located in northern tropical and subtropical waters, but has been recorded along the NSW coast.	-	Foraging, feeding or related behaviour likely to occur within 10 km	-	-	None	-
Reptilia	Derμοchelyidae	<i>Demochelys coriacea</i>	Leatherback Turtle	-	V	V,MM	Species	This species inhabits near and offshore marine waters, and rarely breeds in Australia although they are known to nest occasionally on a short stretch of the QLD central coast (Cogger 1998). A number of sightings in southern waters along the eastern seaboard suggest this species actively seeks temperate feeding grounds, rather than occurring only as stray vagrants.	-	Species or species habitat known to occur within 10 km	-	-	None	Species offshore marine. No habitat for this species occurs within the study area. This is a pelagic species and unlikely to occur within the subject site.
Reptilia	Elapidae	<i>Hoplocephalus bilineatus</i>	Pale-headed Snake	-	V	-	Species	A patchy distribution from north-east Queensland to the north-eastern quarter of NSW. In NSW it has historically been recorded from as far west as Murrumbidgee and Orlambone on the Darling Riverine Plains, across the north-west slopes, and from the north coast from Queensland to the south coast of New South Wales. The majority of records appear to be from sites of relatively low elevation. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest, the species can spend weeks at a time hidden in tree hollows. The species shelter during the day between loose bark and tree-trunks, or in hollow logs and stumps. It is a diurnal species and is active at dusk and dawn. It is a generalist predator of natural stone and rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees, within 200 m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	-	-	-	-	Unlikely	There are no records in the locality; dry forest habitats are marginal.
Reptilia	Elapidae	<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	-	E	V	Species	Coast and ranges from Southern Queensland to Gonford in NSW. Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day. At night it hunts frogs, lizards, birds and small mammals.	-	Predicted to occur within 10 km	-	Y	None	Not previously recorded within the locality. No suitable habitat present within the study area.
Reptilia	Elapidae	<i>Hoplocephalus stephensi</i>	Stephens Banded Snake	-	V	-	Species		-	-	-	Y	Unlikely	Not previously recorded within the locality. No suitable habitat present within the study area.

M = Marine  
MW = Migratory (wetland)  
MT = Migratory (terrestrial)  
V = Vagrant  
V = Vagrant (marine)  
E = Endangered  
CE = Critically endangered

\* Locality - based within 10 km radius of the subject sites records searched since 1 January 1980. Database searched 20/09/2020  
<sup>1</sup> MNES report displaying species or species habitat that are known to, likely to, or may occur within 10 km of the search area. -32.811984 151.662886; -32.81778 151.662886; -32.81748 151.665537; -32.81748 151.665537; -32.81748 151.665537  
<sup>2</sup> Potential candidate species filtered into the BAM credit calculator tool

Threatened flora

Family	Scientific Name	Common Name	BC Act	EPBC Act	Credit entry	Habitat Association	PMST Report <sup>4</sup> (DEE, 2019)	BioNet database records in the locality (OEH, 2019)	BAMC <sup>5</sup>	Likelihood of occurrence in study area	Justification
Apocynaceae	<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E	Species	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree <i>Leptospermum laevigatum</i> – Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Corymbia maculata</i> aligned open forest and woodland; and Bracelet Honeymyrtle <i>Melaleuca arillaris</i> scrub to open scrub.	Known	1	Potential	Moderate	The species may be present in the lowland rainforest, wet sclerophyll forests, established in the Hunter Wetland Centre. The tall alluvial Blue Gum forest at the Mimi connection is too degraded to support occurrences of this species.
Asteraceae	<i>Rutidosia heterogama</i>	Heath Wrinklewort	V	V	Species	Recorded from near Ceesnook to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes.Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides.	Known	30	-	Unlikely	Typically associated with heath woodlands and forests on sandstone, dominated by Scribbly Gums. For this reason, many of the records in the locality are located in the inland forests of the Sugarloaf Range. There is one record in the subject site at the Mimi end of the study area in Stockington, although it is noted that the record has an accuracy of 100 metres.
Convolvulaceae	<i>Wilsonia backhousei</i>	Narrow-leaved Wilsonia	V	-	Species	In NSW Narrow-leaf Wilsonia is found on the coast between Mimossa Rocks National Park and Wamberal north of Sydney (Nelson's Lake, Potato Point, Sussex Inlet, Wovly Gully, Parramatta River at Ermington, Covelly, Voyager Point, Wollongong and Royal National Park). It grows in all southern states. This is a species of the margins of salt marshes and lakes.	n/a	0	-	Nil	The subject site is not within the typical distributional range of this species, being known to be limited to just north of Sydney.
Elaeocarpaceae	<i>Tetratheca glandulosa</i>	-	V	-	Species	Restricted to the following Local Government Areas: Baukham Hills, Gosford, Hawkesbury, Hornsby, Kuring-gai, Pittwater, Ryde, Warringah, and Wyong. There are approximately 150 populations of this plant ranging from Sampsons Pass (Yengo NP) in the north to West Pymble (Lane Cove NP) in the south. The eastern limit is at Ingleside (Pittwater LGA) and the western limit is at East Kurrajong (Wollera NP). There are historical collections of this species south to Manly, Willoughby and Mosman, however these populations are now extinct. The current north-south range is approximately 65km. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymer, Lambert and Faulconbridge. Topographically, the plant occupies ridgelines, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heath and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgeloop Woodland (Map Unit 10a). Common woodland tree species include: <i>Corymbia gummifera</i> , <i>C. eximia</i> , <i>Eucalyptus haemastoma</i> , <i>E. punctata</i> , <i>E. racemosa</i> , and/or <i>E. sparsholii</i> , with an understory dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae.	n/a	1	-	Unlikely	No suitable habitat within the study area. Not known to occur within the Newcastle LGA
Elaeocarpaceae	<i>Tetratheca juncea</i>	Black-eyed Susan	V	V	Species	Regarded as extinct within the Sydney area, current range from Wyong north to Bulahdelah and inland 50 km to edge of Sugarloaf Range. Occurs predominantly in areas of over 1000 mm annual rainfall with dry sclerophyll forest, and sometimes heath and moist forest, with a preference for Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland.	Known	3119	Potential	Unlikely	No suitable heathy woodland habitat within the subject site, although there are small patches of marginal habitat at the Mimi connection.
Fabaceae - Faboideae	<i>Pultanea maritima</i>	Coast Headland Pea	V	-	Species	Occurs in New South Wales and Queensland. Within NSW, the species has been recorded from Newcastle north to Byron Bay on 16 headlands. Populations vary from a few plants to larger populations of many hundreds of individuals where the species is a major component of the Kangaroo Grass Headland community. Five sites occur within conservation reserves. The species occurs in grasslands, shrublands and heath on exposed coastal headlands and adjoining low coastal heath. Found on clay or sandy loam or clay loam over sandstone at altitude 5–30 m.	n/a	3	-	Nil	No suitable habitat within the study area.
Fabaceae - Mimosoideae	<i>Acacia bynoeana</i>	Bynoe's Wattle	E	V	Species	Endemic to central eastern NSW, currently known from only 24 locations, many of only 1-5 plants. Grows mainly in heathy dry sclerophyll forest on sandy soils, prefers open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. Flowers September to March, and fruit matures in November.	Likely	0	-	Unlikely	The species is associated with heathy woodlands and forests such as Scribbly Gum or Smooth-barked Apple forests on sandstone lithologies, with a strong Proteaceae understory like Banksia, Lomata, Perophila. Although a small area of Smooth-barked Apple forest is present at the Mimi end of the study area, this habitat is not present within the subject site.
Geraniaceae	<i>Pelargonium sp. aff. luteum</i> (G.W. Carr 10345)	Omeo Storksbill	E	E	Species	Omeo Storksbill <i>Pelargonium</i> sp. (G.W. Carr 10345), syn. <i>P. striatellum</i> , is a tufted perennial forb known from only three locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Likely	0	-	Nil	This species has a southern tablelands distribution and is not known to occur north of Sydney or on the coast.
Linderniaceae	<i>Lindernia alsnoides</i>	Noah's False Chickweed	E	-	Species	Recorded in coastal areas from Bulahdelah to Copernook and with occurrences further north at Shannon Creek west of Coots Crossing and also at Bungawalbyn. Grows in swamp forests and wetlands along coastal and hinterland creeks	n/a	1	-	Low	No individuals were noted during field survey and the occurrence of this habitat in the subject site is highly disturbed. There is only one record within the locality at Heatherbrae, recorded in 2009. Not predicted by either the PMST or the BAM credit calculator.
Malvaceae	<i>Commersonia prostrata</i>	Dwarf Kennarwang	E	E	Species	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum ( <i>Eucalyptus pauciflora</i> ) Woodland and EpheMERAL Wetland floor at Howes Lagoon; Blue leaved Stringybark ( <i>E. agglomerata</i> ) Open Forest at Tallong; and in Brittle Gum ( <i>E. mannifera</i> ) Low Open Woodland at Penrose; Scribbly Gum ( <i>E. haemostoma</i> ) / Swamp Mahogany ( <i>E. robusta</i> ) Ecotonal Forest at Tomago	Likely	1	-	Low	One record located to the east of the Hunter River on the Tomago Sandbeds. There is no suitable habitats on sands within the subject site.
Mauidiaceae	<i>Maundia triglochoides</i>	-	V	-	Species	Restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct. Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients (OEH 2012).	n/a	41	Potential	High	Previously recorded within the study area from 2008-2010 in the Typha wetlands to the west and east of the M1. Suitable habitat in the subject site, although this is marginal, representing disturbed fringes of highly modified wetlands.



Family	Scientific Name	Common Name	BC Act	EPBC Act	Credit entity	Habitat Association	PMST Report <sup>2</sup> (DEE, 2019)	BioNet database records in the locality (JOEY, 2019)	BAMC <sup>3</sup>	Likelihood of occurrence in study area	Justification
Myrtaceae	<i>Angophora inopina</i>	Charmhaven Apple	V	V	Species	E endemic to the Central Coast region of NSW. The known northern limit is near Kaurah where a disjunct population occurs. To the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. There is an unconfirmed record of the species near Bulaideah. Approximately 1250 ha of occupied habitat has been mapped in the Myung-southern Lake Macquarie area. Occurs most frequently in four main vegetation communities: (i) <i>Eucalyptus haemastoma</i> - <i>Corymbia gummifera</i> - <i>Angophora inopina</i> woodland/forest, (ii) <i>Hakea teretifolia</i> - <i>Banksia oblongifolia</i> wet heath, (iii) <i>Eucalyptus resinifera</i> - <i>Melaleuca sieberi</i> - <i>Angophora inopina</i> sedge woodland, (iv) <i>Eucalyptus capitellata</i> - <i>Corymbia gummifera</i> - <i>Angophora inopina</i> woodland/forest.	Known	564	Potential	Low	The species is associated with healthy woodlands and forests such as Scribbly Gum or Smooth-barked Apple forests on sandstone lithologies, with a strong Proteaceae understorey like <i>Banksia</i> , <i>Lomatia</i> , <i>Petrophile</i> . Although a small area of Smooth-barked Apple forest is present at the Mimi end of the study area, this habitat is not present within the subject site. All the occurrences for this species within the locality are located to the south of Holmesville and Edgeworth near the northern extent of Lake Macquarie.
Myrtaceae	<i>Callistemon linearifolius</i>	Netted Bottle Brush	V	-	Species	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. The species was more widespread in the past, and there are currently only 5-6 populations remaining from the 22 populations historically recorded in the Sydney area. Three of the remaining populations are reserved in Kur-ring-gal Chase National Park, Lion Island Nature Reserve and Spectacle Island Nature Reserve. The species has also been recorded from Yengo National Park. It mainly occurs in dry sclerophyll forest on the coast and adjacent ranges.	n/a	127	-	Moderate	This species is associated with Spotted Gum - Ironbark forests, which are located in proximity of the subject site at the Mimi/Stockington end of the alignment. However, the subject site does not support large areas of this habitat. The extent of Spotted Gum forest in the Hunter Wetland Centre is highly modified and well-planted into. The extent on the Mimi/Stockington end of the subject site is marginal. The records in the locality are concentrated in Beresfield around John Renshaw Dr/Wearkey's Drive intersection and in intact forests between Wakefield and Teralba at the northern end of Lake Macquarie.
Myrtaceae	<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	V	V	Species	Occurs from Raymond Terrace to Waterloo, with populations known from North Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Tenney Hills, Killara, North Head, Menial and the Royal NP. Occurs in exposed situations on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heath or low open woodland. It grows in shallow sandy soils overlying Hawkesbury sandstone.	Likely	0	-	Unlikely	The species is typically associated with healthy woodlands and forests such as Scribbly Gum or Smooth-barked Apple forests on sandstone lithologies, with a strong Proteaceae understorey like <i>Banksia</i> , <i>Lomatia</i> , <i>Petrophile</i> . Although a small area of Smooth-barked Apple forest is present at the Mimi end of the study area, this habitat is not present within the subject site.
Myrtaceae	<i>Eucalyptus glauca</i>	Slaty Red Gum	V	V	Species	Found only on the north coast of NSW and in separate districts: near Casino where it can be locally common, and further south from Toroe to Broke, west of Murrumbidgee. Grows in grassy woodland and dry eucalypt forest. Grows on deep, moderately fertile and well-watered soils.	Not predicted	0	Potential	Unlikely	There are no records within the locality of the subject site. The species is more typically associated with grassy riparian woodlands along freshwater creeks and streams rather than backswamps and estuarine environments. Although the species has potential in the open forests in the western part of the study area, the red gum trees along the alignment within the subject site are confirmed to be Forest Red Gums.
Myrtaceae	<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	-	V	V	Species	There are two separate meta-populations of <i>E. parramattensis</i> subsp. <i>decadens</i> . The Kurr Kurri meta-population is bordered by Cessnock-Kurri Kurri in the north and Murrumbidgee-Aberdare in the south. Large aggregations of the subspecies are located in the Tomalpin area. The Tomago Sandbeds meta-population is bounded by Salt Ash and Tanilba Bay in the north and Williamtown and Tomago in the south. The species generally occupies deep, low-nutrient sands, often these subject to periodic inundation or where water tables are relatively high. It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland. Often where this species occurs, it is a community dominant.	Known	132	Potential	Low	All records located to the east of the Hunter River on the Tomago Sandbeds. There is no suitable habitats on sands within the subject site.
Myrtaceae	<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V	Species	Scattered, disjunct populations in coastal areas from Jervis Bay to Port Macquarie, with most populations in the Gosford-Wyong areas. Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	Known	8	Potential	Low	All occurrences restricted to the north east of Lake Macquarie. Areas of forested swamp in the subject site are limited, being largely cleared, although there is potential for the species to occur in the study area in larger patches of Swamp Mahogany and Paperbark forests.
Myrtaceae	<i>Melaleuca groveana</i>	Grove's Paperbark	V	-	Species	Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands. Grove's Paperbark grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry shrubby open forest and woodlands.	n/a	0	Potential	Unlikely	No suitable habitat within the study area.
Myrtaceae	<i>Rhodamnia rubescens</i>	Scrub Turpentine	GE	-	Species	Widespread in warmer rainforest and on rainforest margins, mainly coastal, north from Batemans Bay. Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of <i>R. rubescens</i> typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	n/a	5	-	Unlikely	The areas of potential suitable habitat in the subject site is very limited. This includes the lowland rainforest patch within the Hunter Wetland Centre, which has been planted into and modified. This is a conspicuous species; no plants were observed during survey.
Myrtaceae	<i>Rhodomyrtus psidioides</i>	Native Guava	CE	-	Species	Occurs from Broken Bay, approximately 90 km north of Sydney, New South Wales, to Manjorrough in Queensland. Populations are typically restricted to coastal and sub-coastal areas of low elevation however the species does occur up to c. 120 km inland in the Hunter and Clarence River catchments and along the Border Ranges in NSW. Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	n/a	19	-	Unlikely	The areas of potential suitable habitat in the subject site is very limited. This includes the lowland rainforest patch within the Hunter Wetland Centre, which has been planted into and modified. This is a conspicuous species; no plants were observed during survey.
Myrtaceae	<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	E	V	Species	Occurs in narrow coastal strip from Bulaideah to Coriole State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	Known	6	-	Moderate	The areas of potential suitable habitat in the subject site is very limited. This includes the lowland rainforest patch within the Hunter Wetland Centre, which has been planted into and modified. Now withstanding, it is noted that this is a commonly planted species and has potential to be present.
Orchidaceae	<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	E	V	Species	The Thick Lip Spider Orchid is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Klamia and Queanbeyan are presumed extinct. It was also recorded in the Heskison area in the 1930s. The species occurs on the coast in Victoria from east of Melbourne to almost the NSW border. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil.	Likely	0	-	Nil	There is a lack of grassy woodland habitat in the subject site. The subject site is outside of the known and predicted distributions for the species.
Orchidaceae	<i>Corybas downlingii</i>	Red Helmet Orchid	E	-	Species	<i>Corybas downlingii</i> is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulaideah, Lake Macquarie and Freemans Waterhole areas. It is known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. The species inhabits sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200m. The species is pollinated by flies and flowers from June to August.	n/a	0	Potential	Nil	There is no suitable habitat within the subject site comprising sheltered gullies and southerly slopes in tall open forest on well-drained gravelly soil.

Family	Scientific Name	Common Name	BC Act	EPBC Act	Credit entity	Habitat Association	PMST Report <sup>2</sup> (DEC, 2019)	BioNet database records in the locality (OEH, 2019)	BAMC <sup>3</sup>	Likelihood of occurrence in study area	Justification
Orchidaceae	<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	Species	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with <i>Cryptostylis subulata</i> and <i>Cryptostylis erecta</i> . Soils include moist sands, moist to dry clay loam and occasionally accumulated eucalypt leaves. Flowers November-February.	Likely	0	Potential	Unlikely	This species requires a reasonably intact understorey. The subject site predominantly supports exotic vegetation and disturbed wetland margins with marginal to unsuitable habitat for this species.
Orchidaceae	<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum population in the Hunter Catchment	EP	-	Species	In NSW the species is restricted to the north-eastern quarter of the State, occurring chiefly in inland districts west to New Angledool and Waggett on the north western plains and north of the Hunter River, through the north western slopes, northern tablelands and north coast into south-eastern Queensland. A distinct population of fewer than 500 individuals though estimated to be as low as 90, which occurs in the Hunter Valley at the south-eastern distributional limit of the species' range. Typically grows in the hollows, fissures, trunks and forks of trees in dry sclerophyll forest or woodland, where its host trees typically occur on Permian Sediments of the Hunter Valley floor. It usually occurs singly or as a single clump, which can form large colonies on trees, between two and six metres from the ground.	n/a	1	-	Unlikely	The species is associated primarily with habitats west of the Dividing Range and the Central Hunter Valley. Typically represents the eastern limits of this species' distributional range. Highly unlikely to occur within the subject site. No epiphytic species recorded during field investigations.
Orchidaceae	<i>Diuris praecox</i>	Rough Doubletail, Newcastle Doubletail	V	V	Species	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Known from between Bateau Bay and Smiths Lake.	Likely	1369	Potential	Unlikely	There is no suitable grassy habitat for this species within the subject site. The species is also known to occur on lower slopes to ridgelines in healthy woodlands on sandstone and all records are restricted to within 10km of the coast. The records within the locality of the subject site are limited to Glenrock State Conservation Area.
Orchidaceae	<i>Phalys australis</i>	Southern Swamp Orchid	E	E	Species	Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie. Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	May occur	0	-	Unlikely	The areas of potential suitable habitat in the subject site is very limited. This includes the lowland rainforest patch within the Hunter Wetland Centre, which has been planted into and modified. This is a conspicuous species; no plants were observed during survey.
Orchidaceae	<i>Prasophyllum</i> sp. <i>Wyong</i> (c. <i>Phelis</i> ORG 5269)	A Leek-orchid	-	CE	Species	Endemic to NSW, it is known from near Ilford, Premier, Muswellbrook, Wyong, Yeoval, Inverell, Tenderfield, Curatubula and the Pilliga area. Most populations are small, although the Wyong population contains by far the largest number of individuals. Known to occur in open eucalypt woodland and grassland.	May occur	0	-	Unlikely	No open eucalypt woodland or derived/natural native grasslands within the subject site.
Orchidaceae	<i>Pterostylis gibbosa</i>	Illawarra Greenhood	E	E	Species	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yalata) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage.	May occur	0	-	Unlikely	The understorey within the subject site is highly disturbed and modified.
Orchidaceae	<i>Rhizanthella slateri</i>	Eastern Australian Underground Orchid	V	E	Species	The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available (DECC 2005b; c). Currently known only from 10 localities, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Flowers during October and November (Harden 1993).	May occur	0	-	Nil	Grows on sandy sites and known distribution does not include the Terraces, and east of Cessnock and Kulkura.
Orchidaceae	<i>Euphrasia arguta</i>	-	CE	CE	Species	<i>Euphrasia arguta</i> was rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008. Prior to this, it had not been collected for 100 years. Historically, <i>Euphrasia arguta</i> has only been recorded from relatively few places within an area extending from Sydney to Bathurst and north to Walcha. The Royal Botanic Gardens Specimen Register records an additional location reported and vouchered in 2002 from near the Hastings River; and <i>Euphrasia arguta</i> was also recorded from the Barrington Tops in 2012. Historic records of the species noted the following habitats: 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', and 'in meadows near rivers'.	Not predicted	0	-	Unlikely	There are no records within the locality of the subject site and the species was not predicted for the locality by the PMST database or the BAM credit calculator tool. The species is semi parasitic and attaches to roots of associated plants; the subject site is highly disturbed and a high proportion of the subject site is dominated by non-native grasses.
Poaceae	<i>Dichanthium setosum</i>	Bluegrass	V	V	Species	Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, extending to northern Queensland. It occurs widely on private property, including in the Inverell, Guyra, Amidale and Glen Innes areas. Associated with heavy basaltic black soils and red-brown loams with clay subsoil. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. (Often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched). It is open to question whether the species tolerates or is promoted by a certain amount of disturbance, or whether this is indicative of the threatening processes behind its depleted habitat.	Likely	0	-	Nil	The subject site does not support open forests and natural grasslands on heavy basaltic soils. The species is associated primarily with habitats west of the Dividing Range and the Central Hunter Valley.
Polygonaceae	<i>Muehlenbeckia costata</i>	Scrambling Lignum	V	-	Species	Scattered distribution from Queensland to the Blue Mountains in NSW. Records on the New England Tablelands and North West Slopes include Bald Rock north of Tenderfield, Warra and Butterleaf National Parks near Glen Innes and Mt Kaputar. Grows in coarse sandy soils and peat in heath, mallee and open eucalypt woodland on granite or acid volcanic outcrops at higher altitudes.	n/a	1	-	Nil	No suitable habitat within the study area.
Polygonaceae	<i>Pericaria elafior</i>	Tall Knotweed	V	V	Species	Tall Knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turliff, the Upper Avon River catchment north of Robes, the Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibragee State Forests). The species also occurs in Queensland. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbances.	Likely	0	Potential	Moderate	There is suitable habitat within the subject site, albeit marginal habitat on the disturbed fringes of wetlands. No individuals have been recorded in the locality.
Proteaceae	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	Species	Occurs between Moss Vale/Bargo and lower Hunter Valley, with most occurrences in Appin, Wedderburn, Picton and Bargo. Broad habitat range including heath, shrubby woodland and open forest on light clay or sandy soils, and often in disturbed areas such as on the fringes of tracks.	Known	57	-	Moderate	Marginal habitat for this species occurs within the open forests at the Mimi/Stockington end of the study area; it is noted that the known records in the locality are recorded in the intact woodlands and forest patches to the south of the study area in association with the footslopes and toes of the Sugarloaf Range.

Family	Scientific Name	Common Name	BC Act	EPBC Act	Credit entry	Habitat Association	PMST Report <sup>2</sup> (DEE, 2019)	BioNet database records in the locality (OEH, 2019)	BAMC <sup>3</sup>	Likelihood of occurrence in study area	Justification
Proteaceae	<i>Grevillea shirlessii</i>	-	V	V	Species	Known from two populations near Gosford, on tributaries of the lower Hawkesbury River north of Sydney (Mooney Mooney Creek and Mullet Creek). Both populations occur within the Gosford Local Government Area. There is also a naturalised population at Newcastle. Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils. Flowers mainly late winter to Spring (July-December), with seed released at maturity in October. Flowers are bird pollinated and seeds are dispersed by ants.	Not predicted	1	-	Unlikely	Marginal potential habitat within the tall Blue Gum forest patches in the western portion of the study area. However, no Grevilleas were noted during field survey and the occurrence of this habitat in the subject site is highly disturbed. There is only one record within the locality at Merewether. Not predicted by either the PMST or the BAM credit calculator.
Rhamnaceae	<i>Pomadernis queenslandica</i>	Scant Pomadernis	E	-	Species	Widely scattered but not common in north-east NSW and in Queensland. It is known from several locations on the NSW north coast and a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolala. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	n/a	0	Potential	Nil	The subject site is not within the typical distributional range of this species and there is no preferred habitat within the subject site.
Rubiaceae	<i>Asperula asperens</i>	Trailing woodruff	V	V	Species	It is found in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens / Wallis Lakes area / Forster (including Myall Lakes NP, New England NP, Wallingat NP and Darawink NP). Occurs in damp sites, often along river banks.	May occur	0	Potential	Unlikely	The subject site is highly disturbed although surrounding wetland and forested vegetation adjacent to the subject site are in better condition. The understorey in the subject site is dominated by blackberry, Kikuyu or other exotic grasses. Where there are small areas of native understorey on the edge of the subject site boundary, these areas are dominated by Typha or Phragmites. The degraded condition of the vegetation directly within the subject site makes the occurrence of this species unlikely.
Rutaceae	<i>Asterolasia elegans</i>	-	E	E	Species	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs, may also occur in the western part of Gosford LGA. 7 known populations. Occurs on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders in sheltered forests on mid- to lower slopes and valleys.	May occur	0	-	Nil	The subject site is not situated on Hawkesbury Sandstone or on rocky outcroppings on slopes. The subject site is outside of the known and predicted distributions for the species.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax	V	V	Species	Austral Toadflax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast.	May occur	0	-	Unlikely	No suitable grassland habitat present in the subject site.
Zanmicheliaceae	<i>Zanmichellia palustris</i>	-	E	-	Species	In NSW, the species is known from the lower Hunter and in Sydney Olympic Park. It grows in fresh or slightly saline stationary or slowly flowing water.	n/a	27	Potential	High	Suitable habitat exists within the subject site for this species, albeit limited to the disturbed fringes of brackish wetland. It was previously recorded in the wetlands within the Hunter Wetland Centre.

V = vulnerable

E = endangered

CE = critically endangered

<sup>1</sup> Locality - land within 10 km radius of the subject site; records searched since 1 January 1980. Database searched 20190509

<sup>2</sup> MNES report displaying species or species habitat that are known to, likely to, or may occur within 10 km of the search area. -32.811964 151.662885 -32.87178 151.696857, -32.850835 151.685654, -32.85478 151.618795, -32.85144 151.686654, -32.862371 151.691075, -32.874814 151.645537, -32.874814 151.645537. Report generated 20190130

<sup>3</sup> Potential candidate species filtered into the BAM credit calculator tool

<sup>4</sup> From the Threatened Species Data Collection or the BAM credit calculator tool

# Appendix B – Flora and fauna species lists



Class	Order	Family	Exotic	Scientific Name	Common Name	BC Status	EPBC Status	2016-2017	2019
1 Amphibia	Anura	Hylidae		<i>Litoria caerulea</i>	Green Tree Frog				x
2 Amphibia	Anura	Hylidae		<i>Litoria fallax</i>	Eastern Dwarf Tree Frog			x	
3 Amphibia	Anura	Myobatrachidae		<i>Crinia signifera</i>	Clicking Froglet			x	
4 Amphibia	Anura	Myobatrachidae		<i>Pseudophryne coriacea</i>	Red-backed Toadlet			x	
5 Aves	Anseriformes	Anatidae		<i>Anas castanea</i>	Chestnut Teal			x	
6 Aves	Anseriformes	Anatidae		<i>Anas superciliosa</i>	Pacific Black Duck			x	
7 Aves	Anseriformes	Anatidae		<i>Chenonetta jubata</i>	Australian Wood Duck			x	
8 Aves	Anseriformes	Anatidae		<i>Cygnus atratus</i>	Black Swan			x	
9 Aves	Caprimulgiformes	Apodidae		<i>Apus pacificus</i>	Forked-tailed Swift		M	x	x
10 Aves	Charadriiformes	Charadriidae		<i>Vanellus miles miles</i>	Masked Lapwing			x	
11 Aves	Charadriiformes	Lariidae		<i>Hydroprogne caspia</i>	Caspian Tern		M, Ma		x
12 Aves	Charadriiformes	Scolopacidae		<i>Calidris acuminata</i>	Sharp-tailed Sandpiper		M		x
13 Aves	Charadriiformes	Scolopacidae		<i>Tringa nebularia</i>	Common Greenshank		M		x
14 Aves	Ciconiiformes	Ardeidae		<i>Ardea ibis</i>	Cattle Egret		Ma	x	
15 Aves	Ciconiiformes	Ardeidae		<i>Ardea modesta</i>	Eastern Great Egret				x
16 Aves	Ciconiiformes	Ardeidae		<i>Egretta garzetta</i>	Little Egret				x
17 Aves	Ciconiiformes	Ardeidae		<i>Egretta novaehollandiae</i>	White-faced Heron			x	x
18 Aves	Ciconiiformes	Ciconiidae		<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E		x	x
19 Aves	Ciconiiformes	Threskiornithidae		<i>Platalea regia</i>	Royal Spoonbill				x
20 Aves	Ciconiiformes	Threskiornithidae		<i>Threskiornis molucca</i>	Australian White Ibis			x	x
21 Aves	Ciconiiformes	Threskiornithidae		<i>Threskiornis spinicollis</i>	Straw-necked Ibis				x
22 Aves	Columbiformes	Columbidae		<i>Geopelia humeralis</i>	Bar-shouldered Dove				x
23 Aves	Columbiformes	Columbidae		<i>Leucosarcia melanoleuca</i>	Wonga Pigeon			x	
24 Aves	Coraciiformes	Alcedinidae		<i>Dacelo novaeguineae</i>	Laughing Kookaburra			x	
25 Aves	Coraciiformes	Alcedinidae		<i>Todiramphus sanctus</i>	Sacred Kingfisher				x
26 Aves	Coraciiformes	Coraciidae		<i>Eurystomus orientalis</i>	Dollarbird			x	x
27 Aves	Cuculiformes	Cuculidae		<i>Cacomantis variolosus</i>	Brush Cuckoo				
28 Aves	Cuculiformes	Cuculidae		<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo			x	
29 Aves	Falconiformes	Accipitridae		<i>Circus approximans</i>	Swamp Harrier				x
30 Aves	Falconiformes	Accipitridae		<i>Elanus axillaris</i>	Black-shouldered Kite				x
31 Aves	Falconiformes	Accipitridae		<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V	Ma	x	
32 Aves	Falconiformes	Accipitridae		<i>Haliastur sphenurus</i>	Whistling Kite			x	x
33 Aves	Falconiformes	Accipitridae		<i>Hieraetus morphnoides</i>	Little Eagle	V		x	x
34 Aves	Falconiformes	Accipitridae		<i>Milvus migrans</i>	Black Kite			x	
35 Aves	Falconiformes	Falconidae		<i>Falco berigora</i>	Brown Falcon				x
36 Aves	Falconiformes	Falconidae		<i>Falco cenchroides</i>	Nankeen Kestrel				x
37 Aves	Falconiformes	Falconidae		<i>Falco longipennis</i>	Australian Hobby				x
38 Aves	Gruiformes	Rallidae		<i>Gallirallus philippensis</i>	Buff-banded Rail				x
39 Aves	Gruiformes	Rallidae		<i>Porphyrio porphyrio</i>	Purple Swamphen			x	
40 Aves	Passeriformes	Acanthizidae		<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			x	
41 Aves	Passeriformes	Acanthizidae		<i>Acanthiza pusilla</i>	Brown Thornbill				x
42 Aves	Passeriformes	Acanthizidae		<i>Gerygone levigaster</i>	Mangrove Gerygone				x
43 Aves	Passeriformes	Artamidae		<i>Artamus leucorhynchus</i>	White-breasted Woodswallow			x	
44 Aves	Passeriformes	Artamidae		<i>Cracticus nigrogularis</i>	Pied Butcherbird				x
45 Aves	Passeriformes	Artamidae		<i>Cracticus tibicen</i>	Australian Magpie			x	x
46 Aves	Passeriformes	Artamidae		<i>Cracticus torquatus</i>	Grey Butcherbird			x	x
47 Aves	Passeriformes	Campephagidae		<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				x
48 Aves	Passeriformes	Cisticolidae		<i>Cisticola exilis</i>	Golden-headed Cisticola				x
49 Aves	Passeriformes	Climacteridae		<i>Climacteris picumnus victoriae</i>	Brown Treecreeper	V			x
50 Aves	Passeriformes	Climacteridae		<i>Cormobates leucophaea</i>	White-throated Treecreeper				x
51 Aves	Passeriformes	Corcoracidae		<i>Corcorax melanorhamphos</i>	White-winged Chough				x

Class	Order	Family	Exotic	Scientific Name	Common Name	BC Status	EPBC Status	2016-2017	2019
52 Aves	Passeriformes	Corvidae		<i>Corvus coronoides</i>	Australian Raven			X	X
53 Aves	Passeriformes	Estrildidae		<i>Neochmia temporalis</i>	Red-browed Finch			X	X
54 Aves	Passeriformes	Estrildidae		<i>Taeniopygia bichenovii</i>	Double-barred Finch			X	X
55 Aves	Passeriformes	Hirundinidae		<i>Hirundo neoxena</i>	Welcome Swallow			X	X
56 Aves	Passeriformes	Maluridae		<i>Malurus cyaneus</i>	Superb Fairy-wren			X	X
57 Aves	Passeriformes	Megaluridae		<i>Megalurus timoriensis</i>	Tawny Grassbird			X	X
58 Aves	Passeriformes	Meliphagidae		<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill			X	X
59 Aves	Passeriformes	Meliphagidae		<i>Ephianura albibrons</i>	White-fronted Chat	V			
60 Aves	Passeriformes	Meliphagidae		<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater			X	X
61 Aves	Passeriformes	Meliphagidae		<i>Manorina melanocephala</i>	Noisy Miner			X	X
62 Aves	Passeriformes	Meliphagidae		<i>Manorina melanophrys</i>	Bell Miner			X	X
63 Aves	Passeriformes	Meliphagidae		<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater			X	X
64 Aves	Passeriformes	Meliphagidae		<i>Nesoptilotis leucotis</i>	White-eared Honeyeater			X	X
65 Aves	Passeriformes	Menuridae		<i>Menura novaehollandiae</i>	Superb Lyrebird			X	X
66 Aves	Passeriformes	Monarchidae		<i>Grallina cyanoleuca</i>	Magpie-lark			X	X
67 Aves	Passeriformes	Motacillidae		<i>Arthus novaeseelandiae</i>	Australasian Pipit			X	X
68 Aves	Passeriformes	Pachycephalidae		<i>Colluricincla harmonica</i>	Grey Shrike-thrush			X	X
69 Aves	Passeriformes	Pardalotidae		<i>Pardalotus punctatus</i>	Spotted Pardalote			X	X
70 Aves	Passeriformes	Psophodidae		<i>Psophodes olivaceus</i>	Eastern Whipbird			X	X
71 Aves	Passeriformes	Ptilonorhynchidae		<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird			X	X
72 Aves	Passeriformes	Rhipiduridae		<i>Rhipidura albiscapa</i>	Grey Fantail			X	X
73 Aves	Passeriformes	Rhipiduridae		<i>Rhipidura leucophrys</i>	Willie Wagtail			X	X
74 Aves	Passeriformes	Sturnidae	*	<i>Sturnus vulgaris</i>	Common Starling			X	X
75 Aves	Passeriformes	Timaliidae		<i>Zosterops lateralis</i>	Silvereye			X	X
76 Aves	Pelecaniformes	Pelecanidae		<i>Pelecanus conspicillatus</i>	Australian Pelican			X	X
77 Aves	Pelecaniformes	Phalacrocoracidae		<i>Microcarbo melanoleucos</i>	Little Pied Cormorant			X	X
78 Aves	Pelecaniformes	Phalacrocoracidae		<i>Phalacrocorax carbo</i>	Great Cormorant			X	X
79 Aves	Psittaciformes	Cacatidae		<i>Cacatua galerita</i>	Sulphur-crested Cockatoo			X	X
80 Aves	Psittaciformes	Cacatidae		<i>Cacatua tenuirostris</i>	Long-billed Corella			X	X
81 Aves	Psittaciformes	Cacatidae		<i>Calyptorhynchus funereus</i>	Yellow-tailed Black Cockatoo			X	X
82 Aves	Psittaciformes	Psittacidae		<i>Alisterus scapularis</i>	Australian King Parrot			X	X
83 Aves	Psittaciformes	Psittacidae		<i>Platycercus eximius</i>	Eastern rosella			X	X
84 Aves	Psittaciformes	Psittacidae		<i>Trichoglossus haematodus</i>	Rainbow Lorikeet			X	X
85 Aves	Strigiformes	Strigidae		<i>Ninox connivers</i>	Barking Owl	V			
86 Aves	Strigiformes	Strigidae		<i>Ninox novaeseelandiae</i>	Southern Boobook			X	X
87 Mammal	Canivora	Canidae	*	<i>Vulpes vulpes</i>	Red Fox			X	X
88 Mammal	Chiroptera	Emballonuridae		<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V			
89 Mammal	Chiroptera	Miniopteridae		<i>Miniopterus australis</i>	Little Bent-wing Bat	V		X <sup>1</sup>	X
90 Mammal	Chiroptera	Miniopteridae		<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V		X <sup>1</sup>	X
91 Mammal	Chiroptera	Molossidae		<i>Austronomus australis</i>	White-striped Free-tailed Bat	V		X <sup>1</sup>	X
92 Mammal	Chiroptera	Molossidae		<i>Mormopterus norfolkensis</i>	Eastern Free-tail-bat	V		X <sup>1</sup>	X
93 Mammal	Chiroptera	Molossidae		<i>Mormopterus ozimops ridei</i>	Ride's Free-tailed Bat			X <sup>1</sup>	X
94 Mammal	Chiroptera	Rhinolophidae		<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe Bat			X	X
95 Mammal	Chiroptera	Vespertilionidae		<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	X <sup>1</sup>	X
96 Mammal	Chiroptera	Vespertilionidae		<i>Chalinolobus gouldii</i>	Gould's Wattled Bat			X <sup>1</sup>	X
97 Mammal	Chiroptera	Vespertilionidae		<i>Chalinolobus morio</i>	Chocolate Wattled Bat			X <sup>1</sup>	X
98 Mammal	Chiroptera	Vespertilionidae		<i>Myotis macropus</i>	Southern Myotis	V		X <sup>1</sup>	X
99 Mammal	Chiroptera	Vespertilionidae		<i>Nyctophilus sp.</i>	a Long-eared Bat			X <sup>1</sup>	X
100 Mammal	Chiroptera	Vespertilionidae		<i>Vespadelus darlingtoni</i>	Large Forest Bat			X <sup>1</sup>	X

Class	Order	Family	Exotic	Scientific Name	Common Name	BC Status	EPBC Status	2016-2017	2019
101 Mammal	Chiroptera	Vespertilionidae		<i>Vespardelus pumilus</i>	Eastern Forest Bat			x <sup>1</sup>	
102 Mammal	Chiroptera	Vespertilionidae		<i>Vespardelus regulus</i>	Southern Forest Bat				x
103 Mammal	Chiroptera	Vespertilionidae		<i>Vespardelus vulturinus</i>	Little Forest Bat			x <sup>1</sup>	x
104 Mammal	Diprotodontia	Macropodidae		<i>Macropus giganteus</i>	Eastern Grey Kangaroo			x	
105 Mammal	Diprotodontia	Macropodidae		<i>Wallabia bicolor</i>	Swamp Wallaby			x	
106 Mammal	Diprotodontia	Petauridae		<i>Petaurus breviceps</i>	Sugar Glider				x
107 Mammal	Diprotodontia	Phalangeridae		<i>Trichosurus vulpecula</i>	Bush-tailed Possum				x
108 Mammal	Lagomorpha	Leporidae	*	<i>Oryctolagus cuniculus</i>	European Rabbit			x	x
109 Mammal	Rodentia	Muridae		<i>Rattus fuscipes</i>	Bush Rat				x
110 Mammal	Rodentia	Muridae	*	<i>Rattus rattus</i>	Black Rat			x	x
111 Reptilia	Squamata	Elapidae		<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake			x	
112 Reptilia	Squamata	Scincidae		<i>Ctenotus robustus</i>	Eastern Striped Skink			x	

<sup>1</sup> Detected from echolocation recording surveys to the west of Pambalong Nature Reserve

M = Migratory, V = Vulnerable, Ma = Marine

	Growth Form	Family	Exotic	Scientific name	Common Name	2016-2017	2019
1	Tree	Acanthaceae		<i>Avicennia marina</i>	Grey Mangrove		x
2	Tree	Casuarinaceae		<i>Casuarina glauca</i>	Swamp Oak	x	x
3	Tree	Ericaceae		<i>Trochocarpa laurina</i>	Tree Heath		x
4	Tree	Euphorbiaceae		<i>Mallotus philippensis</i>	Red Kamala		x
5	Tree	Fabaceae - Mimosoideae		<i>Pararchidendron pruinosum</i>	Snow Wood		x
6	Tree	Lauraceae		<i>Cryptocarya microneura</i>	Murrogun		x
7	Tree	Malvaceae		<i>Brachychiton acerifolius</i>	Kurrajong		x
8	Tree	Meliaceae		<i>Melia azedarach</i>	White Cedar		x
9	Tree	Moraceae		<i>Ficus rubiginosa</i>	Port Jackson Fig		x
10	Tree	Moraceae		<i>Ficus sp.</i>	-		x
11	Tree	Myrtaceae		<i>Acmena smithii</i>	Lilly Pilly		x
12	Tree	Myrtaceae		<i>Eucalyptus punctata</i>	Grey Gum		x
13	Tree	Myrtaceae		<i>Eucalyptus robusta</i>	Swamp Mahogany		x
14	Tree	Myrtaceae		<i>Eucalyptus saligna</i>	Sydney Blue Gum		x
15	Tree	Myrtaceae		<i>Eucalyptus siderophloia</i>	Grey Ironbark		x
16	Tree	Myrtaceae		<i>Eucalyptus tereticornis</i>	Forest Red Gum		x
17	Tree	Myrtaceae		<i>Syncarpia glomulifera</i>	Turpentine		x
18	Tree	Myrtaceae		<i>Tristaniopsis laurina</i>	Water Gum		x
19	Tree	Oleaceae		<i>Notelaea longifolia</i>	Large Mock-Olive		x
20	Tree	Phyllanthaceae		<i>Glochidion ferdinandi</i>	Cheese Tree		x
21	Tree	Podocarpaceae		<i>Podocarpus elatus</i>	Plum Pine		x
22	Tree	Proteaceae		<i>Macadamia sp.</i>	-		x
23	Tree	Rhamnaceae		<i>Alphitonia excelsa</i>	Red Ash	x	x
24	Tree	Salicaceae		<i>Scolopia braunii</i>	Flintwood		x
25	Tree	Sapindaceae		<i>Cupaniopsis anacardioides</i>	Tuckeroo		x
26	Tree	Sapindaceae		<i>Guioa semiglauca</i>	Guioa		x
27	Shrub	Cannabaceae		<i>Trema tomentosa var. aspera</i>	Peach-leaf Poison-bush		x
28	Shrub	Capparaceae		<i>Capparis arborea</i>	Native Pomegranate		x
29	Shrub	Celastraceae		<i>Elaeodendron australe</i>	-		x
30	Shrub	Chenopodiaceae		<i>Sarcocornia quinqueflora</i>	Samphire		x
31	Shrub	Chenopodiaceae		<i>Suaeda australis</i>	Seablite	x	x
32	Shrub	Eupomatiaceae		<i>Eupomatia laurina</i>	Bolwarra		x
33	Shrub	Fabaceae - Mimosoideae		<i>Acacia implexa</i>	Hickory Wattle		x
34	Shrub	Fabaceae - Mimosoideae		<i>Acacia longifolia</i>	-		x
35	Shrub	Malvaceae		<i>Commersonia fraseri</i>	Brush Kurrajong		x
36	Shrub	Moraceae		<i>Ficus coronata</i>	Sandpaper Fig		x
37	Shrub	Myrtaceae		<i>Backhousia citriodora</i>	-		x
38	Shrub	Myrtaceae		<i>Callistemon salignus</i>	Willow Bottlebrush		x
39	Shrub	Myrtaceae		<i>Melaleuca linariifolia</i>	Flax-leaved paperbark	x	
40	Shrub	Myrtaceae		<i>Melaleuca styphelioides</i>	Prickly-Leaved Tea Tree		x
41	Shrub	Phyllanthaceae		<i>Breynia oblongifolia</i>	Coffee Bush		x
42	Shrub	Pittosporaceae		<i>Hymenosporum flavum</i>	Native Frangipani		x
43	Shrub	Pittosporaceae		<i>Pittosporum multiflorum</i>	Orange Thorn		x
44	Shrub	Pittosporaceae		<i>Pittosporum revolutum</i>	Wild Yellow Jasmine		x
45	Shrub	Pittosporaceae		<i>Pittosporum undulatum</i>	Native Daphne		x
46	Shrub	Primulaceae		<i>Myrsine variabilis</i>	-		x
47	Shrub	Rosaceae		<i>Rubus parvifolius</i>	Native Raspberry		x
48	Shrub	Rubiaceae		<i>Psychotria loniceroides</i>	Hairy Psychotria		x
49	Forb	Amaranthaceae		<i>Alternanthera denticulata</i>	Lesser Joyweed		x
50	Forb	Apiaceae		<i>Centella asiatica</i>	Indian Pennywort	x	x
51	Forb	Araceae		<i>Spirodela sp.</i>	-	x	
52	Forb	Asteraceae		<i>Enydra woollsii</i>	-	x	
53	Forb	Commelinaceae		<i>Commelina cyanea</i>	-		x
54	Forb	Convolvulaceae		<i>Dichondra repens</i>	Kidney Weed		x
55	Forb	Euphorbiaceae		<i>Euphorbia drummondii</i>	Caustic Weed		x
56	Forb	Geraniaceae		<i>Geranium homeanum</i>	-	x	x
57	Forb	Geraniaceae		<i>Geranium solanderi</i>	Native Geranium		x
58	Forb	Juncaginaceae		<i>Cyenogeton procerum</i>	Water Ribbons	x	
59	Forb	Juncaginaceae		<i>Triglochin striata</i>	Streaked Arrowgrass	x	
60	Forb	Lamiaceae		<i>Plectranthus parviflorus</i>	Cockspur Flower		x
61	Forb	Onagraceae		<i>Ludwigia peploides</i>	Water Primrose	x	
62	Forb	Phormiaceae		<i>Dianella longifolia</i>	Blueberry Lily		x
63	Forb	Plantaginaceae		<i>Bacopa monnieri</i>	Bacopa	x	x
64	Forb	Plantaginaceae		<i>Plantago gaudichaudii</i>	Narrow Plantain		x
65	Forb	Polygonaceae		<i>Persicaria decipiens</i>	Slender Knotweed	x	x
66	Forb	Polygonaceae		<i>Persicaria hydropiper</i>	Water Pepper		x
67	Forb	Polygonaceae		<i>Persicaria lapathifolia</i>	Pale Knotweed	x	
68	Forb	Portulacaceae		<i>Portulaca spp.</i>	-		x
69	Forb	Primulaceae		<i>Samolus repens</i>	Creeping Brookweed		x
70	Other	Apocynaceae		<i>Parsonia straminea</i>	Common Silkpod		x
71	Other	Arecaceae		<i>Livistona australis</i>	Cabbage Fan Palm		x
72	Other	Bignoniaceae		<i>Pandorea baileyana</i>	Large-leaved Wonga Vine		x
73	Other	Bignoniaceae		<i>Pandorea pandorana</i>	Wonga Wonga Vine		x
74	Other	Cyatheaceae		<i>Cyathea australis</i>	Black Tree-fern		x
75	Other	Dicksoniaceae		<i>Calochlaena dubia</i>	Rainbow Fern		x
76	Other	Fabaceae - Faboideae		<i>Desmodium varians</i>	Slender Tick-trefoil		x
77	Other	Fabaceae - Faboideae		<i>Glycine tabacina</i>	-		x
78	Other	Fabaceae - Faboideae		<i>Hardenbergia violacea</i>	Purple Coral Pea		x
79	Other	Luzuriagaceae		<i>Geitonoplesium cymosum</i>	Scrambling Lily		x
80	Other	Menispermaceae		<i>Stephania japonica</i>	Snake Vine		x



	Growth Form	Family	Exotic	Scientific name	Common Name	2016-2017	2019
81	Other	Ranunculaceae		<i>Clematis glycinoides</i>	Headache Vine		x
82	Other	Rubiaceae		<i>Gynochthodes jasminoides</i>	Sweet Morinda		x
83	Other	Vitaceae		<i>Cayratia sp.</i>	-		x
84	Other	Vitaceae		<i>Cissus antarctica</i>	Kangaroo Vine		x
85	Other	Vitaceae		<i>Tetragium nitens</i>	-		x
86	Grass/Grass-like	Cyperaceae		<i>Bolboschoenus caldwellii</i>	-	x	
87	Grass/Grass-like	Cyperaceae		<i>Bulboschoenus fluviatilis</i>	Marsh Club-rush		x
88	Grass/Grass-like	Cyperaceae		<i>Carex appressa</i>	Tall Sedge		x
89	Grass/Grass-like	Cyperaceae		<i>Cyperus gracilis</i>	Slender Flat-sedge		x
90	Grass/Grass-like	Cyperaceae		<i>Cyperus polystachyos</i>	-		x
91	Grass/Grass-like	Cyperaceae		<i>Eleocharis sphacelata</i>	-	x	
92	Grass/Grass-like	Cyperaceae		<i>Schoenoplectus validus</i>	-	x	
93	Grass/Grass-like	Juncaeae		<i>Juncus kraussii</i>	Sea Rush	x	x
94	Grass/Grass-like	Juncaeae		<i>Juncus subsecundus</i>	-		x
95	Grass/Grass-like	Juncaeae		<i>Juncus usitatus</i>	-		x
96	Grass/Grass-like	Lomandraceae		<i>Lomandra filiformis</i>	Wattle Mat-rush		x
97	Grass/Grass-like	Lomandraceae		<i>Lomandra longifolia</i>	Spiny-headed Mat-rush		x
98	Grass/Grass-like	Poaceae		<i>Aristida ramosa</i>	Purple Wiregrass		x
99	Grass/Grass-like	Poaceae		<i>Cynodon dactylon</i>	Couch	x	x
100	Grass/Grass-like	Poaceae		<i>Entolasia marginata</i>	Bordered Panic		x
101	Grass/Grass-like	Poaceae		<i>Imperata cylindrica</i>	Blady Grass		x
102	Grass/Grass-like	Poaceae		<i>Lachnagrostis filiformis</i>	-	x	x
103	Grass/Grass-like	Poaceae		<i>Microlaena stipoides</i>	Weeping Grass		x
104	Grass/Grass-like	Poaceae		<i>Oplismenus imbecillis</i>	Creeping Beard Grass		x
105	Grass/Grass-like	Poaceae		<i>Paspalum distichum</i>	Water Couch		x
106	Grass/Grass-like	Poaceae		<i>Phragmites australis</i>	Common Reed	x	x
107	Grass/Grass-like	Poaceae		<i>Sporobolus creber</i>	Western Rat-tail Grass		x
108	Grass/Grass-like	Poaceae		<i>Sporobolus virginicus</i>	Sand Couch		x
109	Grass/Grass-like	Poaceae		<i>Themeda triandra</i>	Kangaroo Grass		x
110	Grass/Grass-like	Typhaceae		<i>Typha orientalis</i>	Broadleaf Cumbungi	x	x
111	Fern	Blechnaceae		<i>Blechnum neohollandicum</i>	-		x
112	Fern	Blechnaceae		<i>Blechnum patersonii</i>	Strap Water Fern		x
113	Fern	Dennstaedtiaceae		<i>Pteridium esculentum</i>	Common Bracken		x
114	Fern	Salviniaceae		<i>Azolla pinnata</i>	-	x	
115	Exotic	Asteraceae	*	<i>Ambrosia sp.</i>	-		x
116	Exotic	Asteraceae	*	<i>Aster subulatus</i>	Wild Aster		x
117	Exotic	Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle	x	x
118	Exotic	Asteraceae	*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane	x	x
119	Exotic	Asteraceae	*	<i>Cotula coronopifolia</i>	Water Buttons	x	
120	Exotic	Asteraceae	*	<i>Lactuca serriola</i>	Prickly Lettuce		x
121	Exotic	Asteraceae	*	<i>Onopordum acanthium</i>	Scotch Thistle		x
122	Exotic	Asteraceae	*	<i>Sonchus oleraceus</i>	Common Sowthistle		x
123	Exotic	Asteraceae	*	<i>Tagetes minuta</i>	Stinking Roger		x
124	Exotic	Brassicaceae	*	<i>Lepidium bonariense</i>	-		x
125	Exotic	Chenopodiaceae	*	<i>Atriplex prostrata</i>	-	x	x
126	Exotic	Chenopodiaceae	*	<i>Chenopodium sp.</i>	-	x	
127	Exotic	Fabaceae - Faboideae	*	<i>Trifolium repens</i>	White Clover	x	x
128	Exotic	Fabaceae - Mimosoideae	*	<i>Acacia saligna</i>	Golden Wreath Wattle	x	
129	Exotic	Malvaceae	*	<i>Sida rhombifolia</i>	Paddy's Lucerne	x	x
130	Exotic	Oxalidaceae	*	<i>Oxalis pes-caprae</i>	-		x
131	Exotic	Plantaginaceae	*	<i>Plantago lanceolata</i>	Lamb's Tongue		x
132	Exotic	Poaceae	*	<i>Briza sp.</i>	-		x
133	Exotic	Poaceae	*	<i>Cenchrus clandestinus</i>	Kikuyu Grass	x	x
134	Exotic	Poaceae	*	<i>Lagurus ovatus</i>	Hare's Tail Grass	x	
135	Exotic	Poaceae	*	<i>Melinis repens</i>	Red Natal Grass		x
136	Exotic	Poaceae	*	<i>Panicum maxicum</i>	Guinea Grass		x
137	Exotic	Poaceae	*	<i>Sporobolus africanus</i>	Parramatta Grass		x
138	Exotic	Solanaceae	*	<i>Solanum mauritianum</i>	Wild Tobacco Bush		x
139	Exotic	Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nightshade	x	x
140	Exotic	Verbenaceae	*	<i>Verbena bonariensis</i>	Purpletop		x
141	High threat weed	Amaranthaceae	*	<i>Alternanthera philoxeroides</i>	Alligator Weed	x	x
142	High threat weed	Asteraceae	*	<i>Bidens pilosa</i>	Cobblers Pegs	x	x
143	High threat weed	Asteraceae	*	<i>Bidens subalternans</i>	Greater Beggar's Ticks		x
144	High threat weed	Asteraceae	*	<i>Senecio madagascariensis</i>	Fireweed	x	x
145	High threat weed	Caprifoliaceae	*	<i>Lonicera japonica</i>	Japanese Honeysuckle		x
146	High threat weed	Commelinaceae	*	<i>Tradescantia fluminensis</i>	Trad		x
147	High threat weed	Fabaceae - Caesalpinoideae	*	<i>Senna pendula</i>	-		x
148	High threat weed	Juncaeae	*	<i>Juncus acutus</i>	Sharp Rush	x	x
149	High threat weed	Lauraceae	*	<i>Cinnamomum camphora</i>	Camphor Laurel		x
150	High threat weed	Ochnaceae	*	<i>Ochna serrulata</i>	Mickey Mouse Plant		x
151	High threat weed	Oleaceae	*	<i>Ligustrum lucidum</i>	Large-leaved Privet		x
152	High threat weed	Poaceae	*	<i>Chloris gayana</i>	Rhodes Grass		x
153	High threat weed	Poaceae	*	<i>Ehrharta erecta</i>	Panic Veldtgrass		x
154	High threat weed	Poaceae	*	<i>Eragrostis curvula</i>	African Lovegrass	x	
155	High threat weed	Poaceae	*	<i>Hyparrhenia rufa</i>	-		x
156	High threat weed	Poaceae	*	<i>Panicum repens</i>	Torpedo Grass		x
157	High threat weed	Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum		x
158	High threat weed	Rosaceae	*	<i>Rubus fruticosus sp. aggregat</i>	Blackberry	x	x
159	High threat weed	Verbenaceae	*	<i>Lantana camara</i>	Lantana	x	x
160	High threat weed	Verbenaceae	*	<i>Phyla nodiflora</i>	Lippia		x

# Appendix C – Vegetation integrity plot data

BBAM plot/transect data within the study area

Family	Exotic	Scientific name	Common Name	P4		P5		P6		P7	
				%	Ab	%	Ab	%	Ab	%	Ab
Fabaceae	*	<i>Acacia saligna</i>	Golden Wreath Wattle			2	1				
Rhamnaceae		<i>Alphitonia excelsa</i>	Red Ash							30	1
Amaranthaceae	*	<i>Alternanthera philoxeroides</i>	Alligator Weed							20	1000+
Chenopodiaceae	*	<i>Atriplex prostrata</i>	-	30	1000						
Salviniaceae		<i>Azolla pinnata</i>	-							40	1000+
Plantaginaceae		<i>Bacopa monnieri</i>	Bacopa			2	1000				
Asteraceae	*	<i>Bidens pilosa</i>	Cobblers Pegs							2	20
Cyperaceae		<i>Bolboschoenus caldwellii</i>	-	2	50	40	1000				
Casuarinaceae		<i>Casuarina glauca</i>	Swamp Oak	50	12					20	4
Poaceae	*	<i>Cenchrus clandestinus</i>	Kikuyu Grass	70	1000			2	500		
Apiaceae		<i>Centella asiatica</i>	Indian Pennywort							2	500
Chenopodiaceae	*	<i>Chenopodium sp.</i>	-	1	1						
Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle	3	10						
Asteraceae	*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane					2	50	2	50
Asteraceae	*	<i>Cotula coronopifolia</i>	Water Buttons	1	10	5	1000				
Juncaginaceae		<i>Cynogeton procerum</i>	Water Ribbons			5	1000	5	50	2	20
Poaceae		<i>Cynodon dactylon</i>	Couch	10	1000	1	500			2	1000+
Cyperaceae		<i>Eleocharis sphacelata</i>	-					5	200		
Asteraceae		<i>Enydra woollsii</i>	-					1	5		
Poaceae	*	<i>Eragrostis curvula</i>	African Lovegrass	1	10						
Geraniaceae		<i>Geranium homeanum</i>	-							20	3
Juncaceae	*	<i>Juncus acutus</i>	Sharp Rush			2	10				
Juncaceae		<i>Juncus kraussii</i>	Sea Rush			1	2				
Poaceae		<i>Lachnagrostis filiformis</i>	-	2	100						
Poaceae	*	<i>Lagurus ovatus</i>	Hare's Tail Grass	3	1000	5	1000				
Verbenaceae	*	<i>Lantana camara</i>	Lantana							5	1
Onagraceae		<i>Ludwigia peploides</i>	Water Primrose					5	100	20	1000+
Myrtaceae		<i>Melaleuca linariifolia</i>	Flax-leaved paperbark							60	15
Polygonaceae		<i>Persicaria decipiens</i>	Slender Knotweed					5	50		
Polygonaceae		<i>Persicaria lapathifolia</i>	Pale Knotweed					2	20		
Poaceae		<i>Phragmites australis</i>	Common Reed			80	1000				
Rosaceae	*	<i>Rubus fruticosus</i> sp. aggregate	Blackberry							2	2
Cyperaceae		<i>Schoenoplectus validus</i>	-					10	100	1	2
Asteraceae	*	<i>Senecio madagascariensis</i>	Fireweed	2	20	2	50	1	10		
Malvaceae	*	<i>Sida rhombifolia</i>	Paddy's Lucerne					1	20		
Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nightshade							1	1
Araceae		<i>Spirodela sp.</i>	-					40	1000+		
Chenopodiaceae		<i>Suaeda australis</i>	Seablite	2	50						
Fabaceae	*	<i>Trifolium repens</i>	White Clover			1	50				
Juncaginaceae		<i>Triglochin striata</i>	Streaked Arrowgrass			5	1000				
Typhaceae		<i>Typha orientalis</i>	Broadleaf Cumbungi			2	20	50	100	35	1000+

BAM plot data

Family	Exotic	Scientific name	Common Name	P1		P2		P3		P4		P5		P6	
				%	Ab	%	Ab	%	Ab	%	Ab	%	Ab	%	Ab
Fabaceae		<i>Acacia implexa</i>	Hickory Wattle												
Fabaceae		<i>Acacia longifolia</i>	-												
Myrtaceae		<i>Acmena smithii</i>	Lilly Pilly	0.5	1										
Rhamnaceae		<i>Alphitonia excelsa</i>	Red Ash	2	1										
Amaranthaceae		<i>Alternanthera denticulata</i>	Lesser Joyweed					10	700	0.2	100				
Amaranthaceae	*	<i>Alternanthera philoxeroides</i>	Alligator Weed												
Asteraceae	*	<i>Ambrosia</i> sp.	-												
Poaceae		<i>Aristida ramosa</i>	Purple Wiregrass												
Asteraceae	*	<i>Aster subulatus</i>	Wild Aster					0.2	10					0.1	1
Chenopodiaceae	*	<i>Atriplex prostrata</i>	-												
Acanthaceae		<i>Avicennia marina</i>	Grey Mangrove	1	1							60	200	10	1000
Myrtaceae		<i>Backhousia citriodora</i>	-												
Plantaginaceae		<i>Bacopa monnieri</i>	Bacopa												
Asteraceae	*	<i>Bidens pilosa</i>	Cobblers Pegs			0.5	50								
Asteraceae	*	<i>Bidens subalternans</i>	Greater Beggar's Ticks												
Blechnaceae		<i>Blechnum neohollandicum</i>	-	0.1	5										
Blechnaceae		<i>Blechnum patersonii</i>	Sirap Water Fern	0.2	20										
Malvaceae		<i>Brachychiton acerifolius</i>	Kurrajong	1	1										
Phyllanthaceae		<i>Breynia oblongifolia</i>	Coffee Bush	0.1	5										
Poaceae	*	<i>Briza</i> sp.	-												
Cyperaceae		<i>Bulboschoenus fluviatilis</i>	Marsh Club-rush												
Myrtaceae		<i>Callistemon salignus</i>	Willow Bottlebrush			0.2	1							10	50
Dicksoniaceae		<i>Calochlaena dubia</i>	Rainbow Fern			85	1000								
Capparidaceae		<i>Capparis arborea</i>	Native Pomegranate	0.1	2										
Cyperaceae		<i>Carex appressa</i>	Tall Sedge	1	1	10	2							0.1	1
Casuarinaceae		<i>Casuarina glauca</i>	Swamp Oak	0.2	20	0.1	1								
Vitaceae		<i>Cayratia</i> sp.	-			0.1	10								
Poaceae	*	<i>Cenchrus clandestinus</i>	Kikuyu Grass			0.1									
Apiaceae		<i>Centella asiatica</i>	Indian Pennywort												
Poaceae	*	<i>Chloris gayana</i>	Rhodes Grass							0.1	10				
Lauraceae	*	<i>Cinnamomum camphora</i>	Camphor Laurel												
Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle												
Vitaceae		<i>Cissus antarctica</i>	Kangaroo Vine												
Ranunculaceae		<i>Clematis glycinoides</i>	Headache Vine												
Commelinaceae		<i>Commelina cyanea</i>	-			0.1	1								
Malvaceae		<i>Commersonia fraseri</i>	Brush Kurrajong												
Asteraceae	*	<i>Coryza bonariensis</i>	Flaxleaf Fleabane					0.1	1						
Lauraceae		<i>Cryptocarya microneura</i>	Murrogun	0.1	1										
Sapindaceae		<i>Cupaniopsis anacardioides</i>	Tuckeroo	2	5										
Cyathaceae		<i>Cyathea australis</i>	Black Tree-fern			1	2								
Poaceae		<i>Cynodon dactylon</i>	Couch					70	1000	25	100			5	1000
Cyperaceae		<i>Cyperus gracilis</i>	Slender Flat-sedge												
Cyperaceae		<i>Cyperus polystachyos</i>	-											0.2	20
Fabaceae		<i>Desmodium varians</i>	Slender Tick-trefoil												
Phormiaceae		<i>Dianella longifolia</i>	Blueberry Lily	0.1	1										
Convolvulaceae		<i>Dichondra repens</i>	Kidney Weed	0.3	100										
Poaceae	*	<i>Ehrharta erecta</i>	Panic Weidgrass	0.1	1										
Celastraceae		<i>Elaeodendron australe</i>	Bordered Panic												
Poaceae		<i>Eriolasia marginata</i>	Grey Gum												
Myrtaceae		<i>Eucalyptus punctata</i>	Swamp Mahogany			50	8								
Myrtaceae		<i>Eucalyptus robusta</i>	Sydney Blue Gum												
Myrtaceae		<i>Eucalyptus saligna</i>	Grey Ironbark												
Myrtaceae		<i>Eucalyptus siderophloia</i>	Forest Red Gum												
Myrtaceae		<i>Eucalyptus tereticornis</i>	Caucasic Weed												
Euphorbiaceae		<i>Euphorbia drummondii</i>	Bolwarra	0.1	1										
Eupomatiaceae		<i>Eupomatia laurina</i>	Sandpaper Fig	0.1	2										



Family	Exotic	Scientific name	Common Name	P1		P2		P3		P4		P5		P6	
				%	Ab	%	Ab	%	Ab	%	Ab	%	Ab	%	Ab
Moraceae		<i>Ficus rubiginosa</i>	Port Jackson Fig	20	1										
Moraceae		<i>Ficus</i> sp.	-												
Luzuriagaceae		<i>Geitonoplesium cymosum</i>	Scrambling Lily												
Geraniaceae		<i>Geranium homeanum</i>	-			0.1	10								
Geraniaceae		<i>Geranium solanderi</i>	Native Geranium												
Phyllanthaceae		<i>Glochidion ferdinandii</i>	Cheese Tree												
Fabaceae		<i>Glycine tabacina</i>	-												
Sapindaceae		<i>Guioa semigiatica</i>	Guioa	10	50										
Rubiaceae		<i>Gynochthodes jasminoides</i>	Sweet Morinda	0.1	1										
Fabaceae		<i>Hardenbergia violacea</i>	Purple Coral Pea												
Pittosporaceae		<i>Hymenoporum flavum</i>	Native Frangipani	10	30										
Poaceae	*	<i>Hyparrhenia rufa</i>	-												
Poaceae		<i>Imperata cylindrica</i>	Blady Grass												
Juncaceae	*	<i>Juncus acutus</i>	Sharp Rush					0.1	1	0.2	3			0.1	2
Juncaceae		<i>Juncus kraussii</i>	Sea Rush									1		10	
Juncaceae		<i>Juncus subsecundus</i>	-					5	50						
Juncaceae		<i>Juncus usitatus</i>	-					0.1	1						
Poaceae		<i>Lachnagrostis filiformis</i>	-												
Asteraceae	*	<i>Lactuca serriola</i>	Prickly Lettuce												
Verbenaceae	*	<i>Lantana camara</i>	Lantana												
Brassicaceae	*	<i>Lepidium bonariense</i>	-												
Oleaceae	*	<i>Ligustrum lucidum</i>	Large-leaved Privet												
Areaceae		<i>Livistona australis</i>	Cabbage Fan Palm	0.2	1										
Lomandraceae		<i>Lomandra filiformis</i>	Wattle Mat-rush												
Lomandraceae		<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	0.1	1										
Caprifoliaceae	*	<i>Lonicera japonica</i>	Japanese Honeysuckle												
Proteaceae		<i>Macadamia</i> sp.	-	0.5	1										
Euphorbiaceae		<i>Mallotus philippensis</i>	Red Kamala	1	3										
Myrtaceae		<i>Melaleuca styphelioides</i>	Prickly-Leaved Tea Tree	1	1										
Meliaceae		<i>Melia azedarach</i>	White Cedar	5	1										
Poaceae	*	<i>Melinis repens</i>	Red Natal Grass												
Poaceae		<i>Microlaena stipoides</i>	Weeping Grass							0.1	10				
Primulaceae		<i>Myrsine variabilis</i>	-	0.1	1										
Oleaceae		<i>Notelea longifolia</i>	Large Mock-Olive	0.1	1										
Ochnaceae	*	<i>Ochna serrulata</i>	Mickey Mouse Plant	0.1	5										
Asteraceae	*	<i>Onopordum acanthium</i>	Scotch Thistle					0.1	1	0.1	10				
Poaceae		<i>Oplismenus imbecillis</i>	Creeping Beard Grass	0.1	1										
Oxalidaceae		<i>Oxalis pes-caprae</i>	-												
Bignoniaceae		<i>Pandorea baileyana</i>	Large-leaved Wonga Vine												
Bignoniaceae		<i>Pandorea pandorana</i>	Wonga Wonga Vine												
Poaceae	*	<i>Panicum maxicum</i>	Guinea Grass												
Poaceae	*	<i>Panicum repens</i>	Torpedo Grass	5	100										
Fabaceae		<i>Pararchidron pruinosum</i>	Snow Wood	0.3	1										
Apocynaceae		<i>Parsonia straminea</i>	Common Silkpod	5	25										
Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum												
Poaceae		<i>Paspalum distichum</i>	Water Couch							25	100			0.5	20
Polygonaceae		<i>Persicaria decipiens</i>	Slender Knotweed											1	20
Polygonaceae		<i>Persicaria hydropiper</i>	Water Pepper												
Poaceae		<i>Phragmites australis</i>	Common Reed												
Verbenaceae	*	<i>Phyla nodiflora</i>	Lippia					10	100						
Pittosporaceae		<i>Pittosporum multiflorum</i>	Orange Thorn	0.1	5										
Pittosporaceae		<i>Pittosporum revolutum</i>	Wild Yellow Jasmine												
Pittosporaceae		<i>Pittosporum undulatum</i>	Native Daphne	10	25										
Plantaginaceae		<i>Plantago gaudichaudii</i>	Narrow Plantain							0.1	1				
Plantaginaceae	*	<i>Plantago lanceolata</i>	Lamb's Tongue												
Lamiaceae		<i>Plectranthus parviflorus</i>	Cockspar Flower												
Podocarpaceae		<i>Podocarpus elatus</i>	Plum Pine	2	5										
Portulacaceae		<i>Portulaca</i> spp.	-							0.1	10				
Rubiaceae		<i>Psychotria loniceroides</i>	Hairy Psychotria	0.5	1										

Family	Exotic	Scientific name	Common Name	P1		P2		P3		P4		P5		P6	
				%	Ab	%	Ab	%	Ab	%	Ab	%	Ab	%	Ab
Dennstaedtiaceae		<i>Pteridium esculentum</i>	Common Bracken												
Rosaceae	*	<i>Rubus fruticosus</i> sp. aggregate	Blackberry		0.1	10									
Rosaceae		<i>Rubus parvifolius</i>	Native Raspberry	0.1	1				0.1	1					
Primulaceae		<i>Samolus repens</i>	Creeping Brookweed									0.1	20		
Chenopodiaceae		<i>Sarcocornia quinqueflora</i>	Samphire									40	1000	15	1000
Salicaceae		<i>Scolopia braunii</i>	Flintwood	0.2	5										
Asteraceae	*	<i>Senecio madagascariensis</i>	Fireweed						0.1	4					
Fabaceae	*	<i>Senna pendula</i>	-												
Malvaceae	*	<i>Sida rhombifolia</i>	Paddy's Lucerne											0.1	1
Solanaceae	*	<i>Solanum mauritianum</i>	Wild Tobacco Bush												
Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nightshade												
Asteraceae	*	<i>Sonchus oleraceus</i>	Common Sowthistle												
Poaceae	*	<i>Sporobolus africanus</i>	Parramatta Grass						0.1	1					
Poaceae		<i>Sporobolus creber</i>	Western Rat-tail Grass												
Poaceae		<i>Sporobolus virginicus</i>	Sand Couch									1	200	10	1000
Menispermaceae		<i>Stephania japonica</i>	Snake Vine	0.1	1										
Chenopodiaceae		<i>Suaeda australis</i>	Seablite									1	50		
Myrtaceae		<i>Syncarpia glomulifera</i>	Turpentine	2	1										
Asteraceae	*	<i>Tagetes minuta</i>	Stinking Roger												
Vitaceae		<i>Tetrastigma nitens</i>	-	0.1	1										
Poaceae		<i>Themeda triandra</i>	Kangaroo Grass												
Commelinaceae	*	<i>Tradescantia fluminensis</i>	Trad	2	100	50									
Cannabaceae		<i>Trema tomentosa</i> var. <i>aspera</i>	Peach-leaf Poison-bush												
Fabaceae	*	<i>Trifolium repens</i>	White Clover								0.1	20			
Myrtaceae		<i>Tristaniopsis laurina</i>	Water Gum												
Ericaceae		<i>Trochocarpa laurina</i>	Tree Heath	0.2	1	2									
Typhaceae		<i>Typha orientalis</i>	Broadleaf Cumbungi								50	1000			
Verbenaceae	*	<i>Verbena bonariensis</i>	Purpletop											0.1	1

Family	Exotic	Scientific name	Common Name	P7		P8		P9		P10		P11	
				%	Ab	%	Ab	%	Ab	%	Ab	%	Ab
Fabaceae		<i>Acacia implexa</i>	Hickory Wattle					0.1	1				
Fabaceae		<i>Acacia longifolia</i>	-					0.1	2				
Myrtaceae		<i>Acmena smithii</i>	Lilly Pilly			0.1	1						
Rhamnaceae		<i>Alphitonia excelsa</i>	Red Ash										
Amaranthaceae		<i>Alternanthera denticulata</i>	Lesser Joyweed	0.1	10								
Amaranthaceae	*	<i>Alternanthera phioxeroides</i>	Alligator Weed										
Asteraceae	*	<i>Ambrosia</i> sp.	-	1	100			1	100				
Poaceae		<i>Aristida ramosa</i>	Purple Wiregrass										
Asteraceae	*	<i>Aster subulatus</i>	Wild Aster					0.1	10	0.1	10	0.1	5
Chenopodiaceae	*	<i>Atriplex prostrata</i>	-					0.1	20	0.1	20		
Acanthaceae		<i>Avicermia marina</i>	Grey Mangrove										
Myrtaceae		<i>Backhousia citriodora</i>	-							0.1	2		
Plantaginaceae		<i>Bacopa monnieri</i>	Bacopa										
Asteraceae	*	<i>Bidens pilosa</i>	Cobblers Pegs	0.1	20	1	80						
Asteraceae	*	<i>Bidens subalternans</i>	Greater Beggar's Ticks			0.5	80						
Blechnaceae		<i>Blechnum neohollandicum</i>	-										
Blechnaceae		<i>Blechnum patersonii</i>	Strap Water Fern										
Malvaceae		<i>Brachychiton acerifolius</i>	Kurralong										
Phyllanthaceae		<i>Bryonia oblongifolia</i>	Coffee Bush					0.1	1				
Poaceae	*	<i>Briza</i> sp.	-	0.1	10								
Cyperaceae		<i>Bulboschoenus fluviatilis</i>	Marsh Club-rush										
Myrtaceae		<i>Callistemon salignus</i>	Willow Bottlebrush									0.1	20
Dicksoniaceae		<i>Calochlaena dubia</i>	Rainbow Fern	50	1000								
Capparidaceae		<i>Capparis arborea</i>	Native Pomegranate										
Cyperaceae		<i>Carex appressa</i>	Tail Sedge	0.3	20								
Casuarinaceae		<i>Casuarina glauca</i>	Swamp Oak	40	100								
Vitaceae		<i>Cayratia</i> sp.	-					0.1	10				
Poaceae	*	<i>Cenchrus clandestinus</i>	Kikuyu Grass	5	1000	2	1000					1	100
Apiaceae		<i>Centella asiatica</i>	Indian Pennywort	0.1	20								
Poaceae	*	<i>Chloris gayana</i>	Rhodes Grass										
Lauraceae	*	<i>Cinnamomum camphora</i>	Camphor Laurel			10	10						
Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle	0.1	1								
Vitaceae		<i>Cissus antarctica</i>	Kangaroo Vine			0.5	10						
Ranunculaceae		<i>Clematis glycinoides</i>	Headache Vine					0.1	20				
Commelinaceae		<i>Commelina cyanea</i>	-	0.1	20	0.1	20	0.1	20			0.1	10
Malvaceae	*	<i>Commersonia fraseri</i>	Brush Kurralong	0.1	2		2						
Asteraceae		<i>Conyza bonariensis</i>	Flaxleaf Fleabane	0.1	2	0.1	2						
Lauraceae		<i>Cryptocarya microneura</i>	Murrogon										
Sapindaceae		<i>Cupaniopsis anacardioides</i>	Tuckeroo										
Cyathaceae		<i>Cyathea australis</i>	Black Tree-fern										
Poaceae		<i>Cynodon dactylon</i>	Couch					0.1	30	20	100	0.1	30
Cyperaceae		<i>Cyperus gracilis</i>	Slender Flat-sedge					0.1	2				
Cyperaceae		<i>Cyperus polystachyos</i>	-										
Fabaceae		<i>Desmodium varians</i>	Slender Tick-trefoil					0.1	2				
Phormiaceae		<i>Dianella longifolia</i>	Blueberry Lily										
Convolvulaceae		<i>Dichondra repens</i>	Kidney Weed			0.1	20	0.1	10				
Poaceae	*	<i>Ehrharta erecta</i>	Panic Veldgrass										
Celastraceae		<i>Eleoedendron australe</i>	Bordered Panic			1	100						
Poaceae		<i>Enblasia marginata</i>	Grey Gum					2	2				
Myrtaceae		<i>Eucalyptus punctata</i>	Swamp Mahogany										
Myrtaceae		<i>Eucalyptus robusta</i>	Sydney Blue Gum			60	3						
Myrtaceae		<i>Eucalyptus saligna</i>	Grey Ironbark					5	8				
Myrtaceae		<i>Eucalyptus siderophloia</i>	Forest Red Gum					30	15				
Euphorbiaceae		<i>Euphorbia tereticornis</i>	Caucasic Weed							0.1	4		
Eupomatiaceae		<i>Eupomatia drummondii</i>	Bolwarra										
Moraceae		<i>Ficus coronata</i>	Sandpaper Fig										

Family	Exotic	Scientific name	Common Name	P7		P8		P9		P10		P11	
				%	Ab	%	Ab	%	Ab	%	Ab	%	Ab
Moraceae		<i>Ficus rubiginosa</i>	Port. Jackson Fig										
Moraceae		<i>Ficus</i> sp.	-					0.1	1				
Luzuriagaceae		<i>Geitonoplesium cymosum</i>	Scrambling Lily					0.1	5				
Geraniaceae		<i>Geranium homeanum</i>	-										
Geraniaceae		<i>Geranium solanderi</i>	Native Geranium			0.1	30	0.1	2				
Phyllanthaceae		<i>Glochidion ferdinandii</i>	Cheese Tree			1	20						
Fabaceae		<i>Glycine tabacina</i>	-	0.1	20	0.1	10	0.1	10				
Sapindaceae		<i>Guioa semiglaucula</i>	Guioa										
Rubiaceae		<i>Gynochthodes jasminoides</i>	Sweet Morinda										
Fabaceae		<i>Hardenbergia violacea</i>	Purple Coral Pea					0.1	20				
Pittosporaceae		<i>Hymenoporum flavum</i>	Native Frangipani										
Poaceae	*	<i>Hyparrhenia rufa</i>	-					0.2	20				
Poaceae		<i>Imperata cylindrica</i>	Blady Grass					0.5	100				
Juncaceae	*	<i>Juncus acutus</i>	Sharp Rush										
Juncaceae		<i>Juncus subsecundus</i>	Sea Rush							0.1	3		2
Juncaceae		<i>Juncus usitatus</i>	-	0.1	10								
Poaceae		<i>Lactinagrostis filiformis</i>	-										
Asteraceae	*	<i>Lactuca serriola</i>	Prickly Lettuce			0.1	1						
Verbenaceae	*	<i>Lantana camara</i>	Lantana	0.1	1	10	30	10	20				
Brassicaceae	*	<i>Lepidium bonariense</i>	-			1	50			0.2	15	0.5	30
Oleaceae	*	<i>Ligustrum lucidum</i>	Large-leaved Privet			0.1	1						
Areaceae		<i>Livistona australis</i>	Cabbage Fan Palm										
Lomandraceae		<i>Lomandra filiformis</i>	Wattle Mat-rush					0.1	7				
Lomandraceae		<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			0.2	3						
Caprifoliaceae	*	<i>Lonicera japonica</i>	Japanese Honeysuckle			1	10						
Proteaceae		<i>Macadamia</i> sp.	-										
Euphorbiaceae		<i>Mallotus philippensis</i>	Red Kamala										
Myrtaceae		<i>Melaleuca styphelioides</i>	Prickly-Leaved Tea Tree										
Meliaceae		<i>Melia azedarach</i>	White Cedar										
Poaceae	*	<i>Melinis repens</i>	Red Natal Grass					5	1000				
Poaceae		<i>Microlaena stipoides</i>	Weeping Grass					0.2	30				20
Primulaceae		<i>Myrsine variabilis</i>	-										
Oleaceae		<i>Notelaea longifolia</i>	Large Mock-Olive										
Ochnaceae	*	<i>Ochma serulata</i>	Mickey Mouse Plant										
Asteraceae	*	<i>Onopordum acanthium</i>	Scotch Thistle		0.1	20							
Poaceae		<i>Oplismenus imbecillis</i>	Creeping Beard Grass										
Oxalidaceae	*	<i>Oxalis pes-caprae</i>	-			0.1	5						
Bignoniaceae		<i>Pandorea baileyana</i>	Large-leaved Wonga Vine			0.1	1						
Bignoniaceae		<i>Pandorea pandorana</i>	Wonga Wonga Vine			0.2	2						
Poaceae	*	<i>Panicum maximum</i>	Guinea Grass			2	1000						
Poaceae	*	<i>Panicum repens</i>	Torpedo Grass										
Fabaceae		<i>Pararchidendron pruinosum</i>	Snow Wood										
Apocynaceae		<i>Parsonsia straminea</i>	Common Silkpod										
Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum	5	100	1	100			10	500		
Poaceae		<i>Paspalum distichum</i>	Water Couch							0.1	20		
Polygonaceae		<i>Persicaria decipiens</i>	Slender Knotweed									0.1	50
Polygonaceae		<i>Persicaria hydropiper</i>	Water Pepper									0.1	20
Poaceae		<i>Phragmites australis</i>	Common Reed							45	1000		
Verbenaceae	*	<i>Phyla nodiflora</i>	Lippia										
Pittosporaceae		<i>Pittosporum multiflorum</i>	Orange Thorn										
Pittosporaceae		<i>Pittosporum revolutum</i>	Wild Yellow Jasmine			0.1	1						
Pittosporaceae		<i>Pittosporum undulatum</i>	Native Daphne					2	10				
Plantaginaceae		<i>Plantago gaudichaudii</i>	Narrow Plantain										
Plantaginaceae	*	<i>Plantago lanceolata</i>	Lamb's Tongue	0.1	2	0.3	50					0.1	10
Lamiaceae		<i>Plectranthus parviflorus</i>	Cocksbur Flower										
Podocarpaceae		<i>Podocarpus elatus</i>	Plum Pine										
Portulacaceae		<i>Portulaca</i> spp.	-										
Rubiaceae		<i>Psychotria loniceroides</i>	Hairy Psychotria										



Family	Exotic	Scientific name	Common Name	P7		P8		P9		P10		P11	
				%	Ab	%	Ab	%	Ab	%	Ab	%	Ab
Dennstaedtiaceae		<i>Pteridium esculentum</i>	Common Bracken										
Rosaceae	*	<i>Rubus fruticosus</i> sp. aggregate	Blackberry		0.5	50							
Rosaceae		<i>Rubus parvifolius</i>	Native Raspberry		0.1	2						1	5
Primulaceae		<i>Sarcocolla quinqueflora</i>	Creeping Brookweed										
Chenopodiaceae		<i>Sarcocolla quinqueflora</i>	Samphire							0.1	10		
Salicaceae		<i>Scolopia braunii</i>	Flintwood										
Asteraceae	*	<i>Senecio madagascariensis</i>	Fireweed	0.1	20					0.1	2	0.1	2
Fabaceae	*	<i>Senna pendula</i>	-										
Malvaceae	*	<i>Sida rhombifolia</i>	Paddy's Lucerne	0.1	20	100		0.2	50				
Solanaceae	*	<i>Solanum mauritianum</i>	Wild Tobacco Bush	0.1	2	2		0.5	2				
Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nighthshade	0.1	2	2		0.1	2	0.1	2	0.1	2
Asteraceae	*	<i>Sonchus oleraceus</i>	Common Sowthistle							0.1	20		
Poaceae	*	<i>Sporobolus africanus</i>	Parramatta Grass										
Poaceae		<i>Sporobolus creber</i>	Western Rat-tail Grass							0.1	10		
Poaceae		<i>Sporobolus virginicus</i>	Sand Couch	1	50								
Menispermaceae		<i>Stephania japonica</i>	Snake Vine			0.3	20						
Chenopodiaceae		<i>Suaeda australis</i>	Seablite										
Myrtaceae		<i>Syncarpia glomulifera</i>	Turpentine										
Asteraceae	*	<i>Tagetes minuta</i>	Stinking Roger			0.1	2						
Vitaceae		<i>Tetragium nitens</i>	-										
Poaceae		<i>Themeda triandra</i>	Kangaroo Grass					10	50				
Commelinaceae	*	<i>Tradescantia fluminensis</i>	Trad			0.1	50						
Cannabaceae		<i>Trema tomentosa</i> var. <i>aspera</i>	Peach-leaf Poison-bush			0.1	3						
Fabaceae	*	<i>Trifolium repens</i>	White Clover	0.1	20	0.1	20						
Myrtaceae		<i>Tristaniopsis laurina</i>	Water Gum										
Ericaceae		<i>Trochocarpa laurina</i>	Tree Heath										
Typhaceae	*	<i>Typha orientalis</i>	Broadleaf Cumbungi	0.1	5	0.1	10					80	2000
Verbenaceae	*	<i>Verbena bonariensis</i>	Purpletop	0.1	10	0.1	10	0.1	10	0.1	10	0.1	20

# Appendix D – BAM calculator import data



# Appendix E – Biodiversity credit report



# BAM Biodiversity Credit Report (Like for like)

## Proposal Details

Assessment Id  
00015461/BAAS17058/19/00015462

Proposal Name  
Richmond Vale Rail Trail recreational pathway - Shortland to Tarro

BAM data last updated \*

04/07/2019

Assessor Name  
Cecilia Phu

Assessor Number  
BAAS17058

BAM Data version \*  
12

Proponent Names

Report Created  
04/07/2019

BAM Case Status  
Open

Assessment Revision

Assessment Type

Date Finalised

1

Part 4 Developments (General)

To be finalised

\* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

## Potential Serious and Irreversible Impacts

Nil

Species
Chalinolobus dwyeri / Large-eared Pied Bat
Chalinolobus dwyeri / Large-eared Pied Bat
Chalinolobus dwyeri / Large-eared Pied Bat
Chalinolobus dwyeri / Large-eared Pied Bat

Assessment Id

Proposal Name

00015461/BAAS17058/19/00015462

Richmond Vale Rail Trail recreational pathway - Shortland to

# BAM Biodiversity Credit Report (Like for like)

**Calidris ferruginea** / Curlew Sandpiper

**Calidris ferruginea** / Curlew Sandpiper

## Additional Information for Approval

PCTs With Customized Benchmarks

No Changes

Predicted Threatened Species Not On Site

Name

**Dasyurus maculatus** / Spotted-tailed Quoll

## Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	Number of credits to be retired
1528-Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast.	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	0.2	6.00
1568-Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	Not a TEC	0.2	4.00
1598-Forest Red Gum grassy open forest on floodplains of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	0.8	22.00

## BAM Biodiversity Credit Report (Like for like)

1718-Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.4	8.00
1727-Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.6	9.00
1747-Grey Mangrove low closed forest	Not a TEC	0.3	9.00
1737-Typha rushland	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.9	34.00

### 1528-Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast.

#### Like-for-like credit retirement options

Name of offset trading group	Trading group	HBT	IBRA region
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions This includes PCT's: 669, 670, 770, 845, 886, 887, 1068, 1201, 1275, 1302, 1525, 1527, 1528, 1529, 1533, 1534, 1535, 1541, 1545	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo.  or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

# BAM Biodiversity Credit Report (Like for like)

<b>Like-for-like credit retirement options</b>			
Class	Trading group	HBT	IBRA region
<b>1568-Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast</b>	North Coast Wet Sclerophyll Forests This includes PCT's: 487, 613, 661, 684, 686, 692, 693, 694, 695, 699, 747, 748, 752, 812, 1073, 1208, 1217, 1222, 1237, 1244, 1245, 1257, 1259, 1260, 1261, 1265, 1266, 1282, 1284, 1285, 1504, 1561, 1562, 1563, 1566, 1567, 1568, 1569, 1572, 1573, 1575, 1579, 1841, 1843, 1915	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo.  or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
<b>Like-for-like credit retirement options</b>			
Name of offset trading group	Trading group	HBT	IBRA region
<b>1598-Forest Red Gum grassy open forest on floodplains of the lower Hunter</b>			



## BAM Biodiversity Credit Report (Like for like)

	<p>Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions This includes PCT's: 42, 1591, 1598, 1603, 1605, 1691, 1692, 1749</p>	-	Yes	<p>Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.</p>
<p><b>1718-Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast</b></p>	<p><b>Like-for-like credit retirement options</b></p> <p>Name of offset trading group Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 837, 839, 971, 1064, 1092, 1227, 1230, 1231, 1232, 1235, 1649, 1715, 1716, 1717, 1718, 1719, 1721, 1722, 1723, 1724, 1725, 1730, 1795, 1798</p>	Trading group -	HBT Yes	<p>IBRA region Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.</p>

# BAM Biodiversity Credit Report (Like for like)

		Like-for-like credit retirement options			
		Name of offset trading group	Trading group	HBT	IBRA region
<b>1727-Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast</b>		Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 915, 916, 917, 918, 919, 1125, 1230, 1232, 1234, 1235, 1236, 1726, 1727, 1728, 1729, 1731, 1800, 1808	-	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo.  or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
		Like-for-like credit retirement options			
		Name of offset trading group	Trading group	HBT	IBRA region
<b>1737-Typha rushland</b>		Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 780, 781, 782, 828, 1071, 1735, 1736, 1737, 1738, 1739, 1740, 1741, 1742, 1911	-	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo.  or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

# BAM Biodiversity Credit Report (Like for like)

<b>1737 -Typha rushland</b>
<b>1747-Grey Mangrove low closed forest</b>

Like-for-like credit retirement options			
Class	Trading group	HBT	IBRA region
Mangrove Swamps This includes PCT's: 915, 916, 917, 918, 919, 920, 1747	Mangrove Swamps - ≥ 50% - < 70% cleared group (including Tier 6 or higher).	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo.  or  Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

## Species Credit Summary

Species	Area	Credits
<b>Calidris ferruginea</b> / Curlew Sandpiper	0.9	56.00
<b>Chalinolobus dwyeri</b> / Large-eared Pied Bat	1.6	54.00
<b>Limosa limosa</b> / Black-tailed Godwit	0.9	37.00
<b>Litoria aurea</b> / Green and Golden Bell Frog	3.3	95.00
<b>Myotis macropus</b> / Southern Myotis	0.7	14.00

# BAM Biodiversity Credit Report (Like for like)

<b>Xenus cinereus</b> / Terek Sandpiper			0.9	37.00
<b>Calidris ferruginea</b> / Curlew Sandpiper	1737_intact	<b>Like-for-like credit retirement options</b>		
		Spp	IBRA region	
		<b>Calidris ferruginea</b> /Curlew Sandpiper	Any in NSW	
	1747_intact	<b>Like-for-like credit retirement options</b>		
		Spp	IBRA region	
		<b>Calidris ferruginea</b> /Curlew Sandpiper	Any in NSW	
<b>Chalinolobus dwyeri</b> / Large-eared Pied Bat	1568_intact	<b>Like-for-like credit retirement options</b>		
		Spp	IBRA region	
		<b>Chalinolobus dwyeri</b> /Large-eared Pied Bat	Any in NSW	
	1598_intact	<b>Like-for-like credit retirement options</b>		



## BAM Biodiversity Credit Report (Like for like)

Spp	IBRA region
<b>Chalinolobus dwyeri</b> /Large-eared Pied Bat	Any in NSW
<b>Like-for-like credit retirement options</b>	
Spp	IBRA region
<b>Chalinolobus dwyeri</b> /Large-eared Pied Bat	Any in NSW
<b>Like-for-like credit retirement options</b>	
Spp	IBRA region
<b>Chalinolobus dwyeri</b> /Large-eared Pied Bat	Any in NSW
<b>Like-for-like credit retirement options</b>	
Spp	IBRA region
<b>Limosa limosa</b> /Black-tailed Godwit	Any in NSW

1718_intact	<b>Like-for-like credit retirement options</b>
1727_intact	<b>Like-for-like credit retirement options</b>
1737_intact	<b>Like-for-like credit retirement options</b>

## BAM Biodiversity Credit Report (Like for like)

<p><b>Limosa limosa/</b> Black-tailed Godwit</p>	<p>1737_intact</p>	
	<p>1747_intact</p>	<p><b>Like-for-like credit retirement options</b></p>
	<p>Spp</p>	<p>IBRA region</p>
	<p><b>Limosa limosa/</b>Black-tailed Godwit</p>	<p>Any in NSW</p>
<p><b>Litoria aurea/</b> Green and Golden Bell Frog</p>	<p>1528_intact</p>	
	<p>Spp</p>	<p>IBRA region</p>
	<p><b>Litoria aurea/</b>Green and Golden Bell Frog</p>	<p>Any in NSW</p>
<p>1568_intact</p>	<p><b>Like-for-like credit retirement options</b></p>	
	<p>Spp</p>	<p>IBRA region</p>
	<p><b>Litoria aurea/</b>Green and Golden Bell Frog</p>	<p>Any in NSW</p>

## BAM Biodiversity Credit Report (Like for like)

Litoria aurea/ Green and Golden Bell Frog	1598_intact	<b>Like-for-like credit retirement options</b>	
		Spp	IBRA region
		Litoria aurea/Green and Golden Bell Frog	Any in NSW
1718_intact	<b>Like-for-like credit retirement options</b>		
	Spp	IBRA region	
	Litoria aurea/Green and Golden Bell Frog	Any in NSW	
1727_intact	<b>Like-for-like credit retirement options</b>		
	Spp	IBRA region	
	Litoria aurea/Green and Golden Bell Frog	Any in NSW	
1737_intact	<b>Like-for-like credit retirement options</b>		
	Spp	IBRA region	
	Litoria aurea/Green and Golden Bell Frog	Any in NSW	

# BAM Biodiversity Credit Report (Like for like)

	<b>Litoria aurea</b> /Green and Golden Bell Frog	Any in NSW
1747_intact	<p><b>Like-for-like credit retirement options</b></p> <p>Spp</p> <p><b>Litoria aurea</b>/Green and Golden Bell Frog</p>	<p>IBRA region</p> <p>Any in NSW</p>
1568_intact	<p><b>Myotis macropus</b>/Southern Myotis</p> <p>Spp</p> <p><b>Myotis macropus</b>/Southern Myotis</p>	<p>IBRA region</p> <p>Any in NSW</p>
1598_intact	<p><b>Like-for-like credit retirement options</b></p> <p>Spp</p> <p><b>Myotis macropus</b>/Southern Myotis</p>	<p>IBRA region</p> <p>Any in NSW</p>



# BAM Biodiversity Credit Report (Like for like)

Myotis macropus/ Southern Myotis	1598_intact	
	1718_intact	<p><b>Like-for-like credit retirement options</b></p> <p>Spp IBRA region</p> <p><b>Myotis macropus</b>/Southern Myotis Any in NSW</p>
	1727_intact	<p><b>Like-for-like credit retirement options</b></p> <p>Spp IBRA region</p> <p><b>Myotis macropus</b>/Southern Myotis Any in NSW</p>
Xenus cinereus/ Terek Sandpiper	1737_intact	<p><b>Like-for-like credit retirement options</b></p> <p>Spp IBRA region</p> <p><b>Xenus cinereus</b>/Terek Sandpiper Any in NSW</p>
	1747_intact	<p><b>Like-for-like credit retirement options</b></p>

## BAM Biodiversity Credit Report (Like for like)

	Spp	IBRA region
	<b>Xenus cinereus</b> /Terek Sandpiper	Any in NSW

# Appendix F – Assessments of significance (MNES)

The proposal traverses the Hunter Wetlands National Park, which is associated with a number of biodiversity values protected as Matters of National Environmental Significance (MNES) under the EPBC Act.

Under the EPBC Act an action will require approval from the minister if the action has, will have, or is likely to have, a significant impact on an MNES. Assessments of significance have been prepared for the following MNES listed below, with reference to the relevant significant impact criteria from the EPBC Act significant impact guidelines 1.1 (DotE, 2013). In the following tables, the significant impact criteria have been reproduced verbatim, followed by the assessment response.

## ***Threatened ecological communities***

- Lowland Rainforest of Subtropical Australia (CEEC)
- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (EEC)

Note that the Saltmarsh TEC is listed as vulnerable and does not need to be further assessed (DotE, 2013).

## ***Critically endangered and endangered species***

- Eastern Curlew (CE, Mi)
- Curlew Sandpiper (CE, Mi)
- Red Knot (E, Mi)
- Australasian Bittern (E)

## ***Vulnerable threatened species***

- Large-eared Pied Bat
- Green and Golden Bell Frog
- Bar-tailed Godwit (Mi)

## ***Migratory birds (wetland specialists)***

- Latham's Snipe
- Marsh Sandpiper
- Sharp-tailed Sandpiper
- Common Greenshank
- Glossy Ibis
- \*Eastern Curlew (CE)
- \*Curlew Sandpiper (CE)
- \*Red Knot (E)
- \*Bar-tailed Godwit (V)

(\*) these species were assessed as threatened species.

## ***Wetlands of international importance***

- Hunter Estuary Wetlands Ramsar Site

# Critically endangered and endangered ecological communities

## Lowland Rainforest of Subtropical Australia

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

### **Reduce the extent of an ecological community,**

The current extent of Lowland Rainforest within protected areas in NSW is 1988 hectares (TSSC, 2011). A maximum of 0.18 hectares of Lowland Rainforest would be removed as a result of the proposal, with 10.054 ha of Lowland Rainforest being retained within the locality. This is 0.009% of the total ecological community extent within NSW and 1.79% within the locality.

The proposal would result in a minor reduction in the extent of the ecological community within the study area, however is unlikely to threaten its viability or persistence, since the area to be impacted upon is an isolated patch, prone to edge effects, and planted with non-endemic native species.

### **Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines,**

The alignment for the proposal generally follows the route of existing pathways, which are utilised by the Hunter Wetland Centre. Removal of vegetation along these pathways will therefore reduce connectivity to a minor extent. Given the disturbance footprint is between 6-10 metres within the community, the proposal is unlikely to fragment the habitat such that the movement of flora and fauna species within the locality is impeded.

No areas of Lowland Rainforest will be isolated from other areas of habitat as a result of the proposal.

### **Adversely affect habitat critical to the survival of an ecological community,**

The community occurs within the Hunter Wetland Centre as a small patch that is presently maintained as part of the centre grounds. Native non-endemic plantings have been established in this patch that do not reflect the natural composition of this community. There are large mature trees within the patch but there are no remnant trees that would represent residual "pre-clearing" vegetation (sensu TSSC, 2011). Whilst connected to other surrounding native vegetation communities, the occurrence of this ecological community in the study area is not linked to other patches of the ecological community.

The community is naturally distributed much further north of the study area, being primarily located from Maryborough QLD to the Clarence River in Grafton. There are isolated occurrences between the Clarence River and Hunter River, such as the Bellinger and Hastings valleys (TSSC, 2011). Regional mapping databases do not identify subtropical rainforest within the Hunter Wetlands Centre; there is a possibility that the community may have been established at the Hunter Wetlands Centre through planting efforts over a period of time, rather than occurring naturally at this location.

The vegetation to be removed for the proposal consist of 0.18 hectares of the community along a disturbed edge following an existing pathway. Considering this, and considering the above, this area of habitat is not considered critical to the survival of the community.



## Lowland Rainforest of Subtropical Australia

**Modify or destroy abiotic (non-living) factors (such as water, nutrients or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns,**

The proposal is unlikely to modify or destroy abiotic factors necessary for the ecological community's survival due to the subject site restriction to the existing pathway and limited development footprint impact within the community.

**Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionality important species, for example through regular burning or flora or fauna harvesting,**

This ecological community is not subject to regular burning or flora and fauna harvesting. Due to the minimal fragmentation extent as documented above, a change in species composition will be unlikely. Due to the limited area impacted within the community, species composition is unlikely to be significantly changed by the proposal. Exotic species encroachment may occur due to the high accessibility of the trail and edge effects already impacting the ecological community. The proposal is unlikely to cause a substantial change in the species composition, since the area to be impacted upon is an isolated patch, prone to edge effects, and planted with non-endemic native species.

**Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:**

**(i) assisting invasive species, that are harmful to the listed ecological community, to become established, or**

The 2019 floristic survey revealed that the composition of the Lowland rainforest has been previously modified by planting of non-endemic native species and the minor encroachment of weeds which has been facilitated by edge effects due to an adjacent walkway. Removal of further vegetation within the disturbance footprint for the proposal may further increase edge effects which could facilitate the spread of weeds and further modification of the community within the study area. Ongoing management of weeds pre and post construction will therefore be required to prevent further degradation of the CEEC.

Due to the minor extent of vegetation clearing proposed for the development, it is unlikely that the composition of the ecological community in retained areas will be adversely modified such that there will be a substantial reduction in the quality or integrity of the ecological community.

**(ii) causing regular mobilisation of fertilisers, herbicides, or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or**

Mobilisation of pollutants into the ecological community could occur during construction and operational phases of the proposal. Potential impacts could include, but is not limited to:

- Fuel spills from plant and machinery
- Spills of construction materials such as concrete
- Runoff of sediment and construction materials during construction and herbicides within maintenance phases

Mitigation measures to address these impacts include:

- Following the Construction Environment Management Plan as outlined within this document
- Install and maintain sedimentation fences during construction as to minimise runoff into the study area
- Documenting all use of herbicides, pesticides and chemicals used in accordance with any future Vegetation Management Plans and the *Pesticides Act 1999*, such that there is no adverse impact

### Lowland Rainforest of Subtropical Australia

- Monitoring of the ecological community to assess adjacent vegetation condition by using techniques such as photo monitoring points

Provided that mitigation measures are put in place during construction and maintenance of the trail, it is unlikely that mobilisation of potential pollutants will negatively impact upon the ecological community.

#### **Interfere with the recovery of an ecological community**

The proposal is unlikely to interfere with the recovery of the ecological community. The proposal would result in a minor reduction in the extent of the ecological community within the study area, however is unlikely to threaten its viability or persistence, since the area to be impacted upon is an isolated patch, prone to edge effects, and planted with non-endemic native species.

#### **Conclusion of Assessment**

The proposal is unlikely to result in a significant impact on the Lowland Rainforest, pursuant to the EPBC Act given:

- The proposal has been located and designed to minimise impacts on the local occurrence. Only a thin strip of disturbed edge habitat will be removed which represents a small percentage of the local occurrence of the TEC.
- The proposal will result in minor fragmentation of this vegetation within the study area.
- The proposal will not impact on habitat that is critical to the survival of the community.
- Mitigation measures will be implemented to avoid/minimise impacts on higher quality adjoining areas that will be retained.
- The proposal is unlikely to affect the recovery of the TEC.

### Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

#### **Reduce the extent of an ecological community,**

Coastal Swamp Oak Forest occurs in a narrow strip along the east coast from Curtis Island in Queensland to near Bermagui in NSW, so its overall extent of occurrence is not limited, but it has a 'limited' area of occupancy of around 32,000 hectares nationwide.

A maximum of 0.60 hectares of Swamp Oak Forest would be removed as a result of the proposal, with 841.261 hectares of Swamp Oak Forest occurring elsewhere within the locality. This is 0.001% of the total ecological community extent and 0.07% of the extent within the locality. The subject site within this community is already modified from historical activities such as construction of the Richmond Vale railway.

The vegetation that may be indirectly impacted represents a very small portion of the EEC which is mapped within the locality. Given the small area of modified and degraded vegetation within the proposal area that will be removed, any indirect impacts to a small area of this community is unlikely to impact the long-term survival of the community within the locality.

#### **Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines,**

The regrowth of vegetation within the now disused Richmond Vale railway corridor has increased connectivity between the Swamp Oak Forest on either side of the proposal area. Removal of this vegetation will therefore reduce connectivity to a minor extent. Given the disturbance footprint is 20 metres, the proposal is unlikely to further fragment the habitat such that the movement of flora and fauna species will be restricted within the locality.

**Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community**

No areas of Swamp oak Floodplain Forest will be isolated from other areas of habitat as a result of the proposal.

**Adversely affect habitat critical to the survival of an ecological community,**

The ecological community occurs along a riparian edge close to tributaries of the Hunter River. The proposal footprint does not encroach on this riparian edge nor will the proposal impede hydrological flows upstream. The Swamp Oak Forest is classified as a GDE, therefore depending on the current hydrological flows to continue to survive. Because the proposal does not impact upon any upstream flows, seed dispersal capabilities, pollinator movements or the riparian edge itself, it is unlikely that the proposal will adversely affect the habitat critical to its survival.

**Modify or destroy abiotic (non-living) factors (such as water, nutrients or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns,**

The proposal is unlikely to modify or destroy abiotic factors necessary for an ecological community's survival due to the existing historical footprint within the study area. The trail will be developed on the existing rail embankment, and is therefore unlikely to have further significant effects on abiotic factors such as hydrological flow as well as ground and surface water levels. The proposal footprint does not impede on this riparian edge or its hydrological flows upstream. The Swamp Oak Forest is classified as a GDE, therefore depending on the current hydrological flows to continue to survive

**Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionality important species, for example through regular burning or flora or fauna harvesting,**

Many extant occurrences of this ecological community are known to be highly weed-infested and species poor. This community is largely defined by the dominance of *Casuarina glauca* (Swamp Oak) in the canopy, with remaining diagnostics related to the locational characters of the community rather than compositional characters (TSSC, 2018).

Within the study area, the occurrences of this community are consistent with the described listing advice and is generally species-poor with weed affected understorey in many areas of its onsite occurrence. The proposal may have potential to increase the cover and or richness of weeds in the understorey (see discussion in following section) but is unlikely to substantially remove the canopy layer of the occurrences within the study area. The proposal is therefore unlikely to substantially modify the composition of the community.

**Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:**

**(i) assisting invasive species, that are harmful to the listed ecological community, to become established, or**

The 2019 floristic survey identified a high number of exotic species within the ecological community. It is highly likely that invasive species encroachment will be increased with the proposal where disturbance within the ecological community occurs. It is possible for exotic species encroachment to occur due to:

- Seed introduction from plant/machinery
- Introduction in construction materials
- Disturbance of existing exotic species and therefore seed on site
- Disturbance of soil seed bank within the development footprint

To mitigate these impacts, both in the short- and long-term:

- The Construction Environment Management Plan should be prepared and implemented

## Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community

- A vegetation management plan should be produced to address weed management within the subject site

### **(ii) causing regular mobilisation of fertilisers, herbicides, or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or**

Mobilisation of pollutants into the ecological community could occur during construction and operational phases of the proposal. Potential impacts could include, but is not limited to:

- Fuel spills from plant and machinery
- Spills of construction materials such as concrete
- Runoff of sediment and construction materials during construction and herbicides within maintenance phases

Mitigation measures to address these impacts include:

- Prepare and implement a Construction Environment Management Plan as outlined within this document
- Install and maintain sedimentation fences during construction to minimise runoff into the study area
- Documenting all use of herbicides, pesticides and chemicals used in accordance with any future Vegetation Management Plans and the *Pesticides Act 1999* and ensure there are no adverse impacts
- Monitoring of the ecological community to assess adjacent vegetation condition by using techniques such as photo monitoring points

Provided that mitigation measures are put in place during construction and maintenance of the trail, it is unlikely that mobilisation of potential pollutants will negatively impact upon the ecological community.

### **Interfere with the recovery of an ecological community**

The priority actions for the recovery of this community include protecting and restoring existing occurrences, communicating its values to the community and research and monitoring programs (TSSC, 2018).

The proposal incorporates designs that minimise the clearing of the ecological community and further opportunities to minimise clearing will be identified during detailed design. Establishing signage that provides information about the biodiversity values of the area and monitoring would be incorporated into the mitigation measures for the proposal. Considering the small area of vegetation removal (0.18 ha) in conjunction with the above, the proposal is not considered to interfere with the recovery of the ecological community.

### **Conclusion of Assessment**

The proposal is unlikely to result in a significant impact on Swamp Oak Floodplain Forest, pursuant to the EPBC Act given:

- The proposal has been located and designed to minimise impacts on the local occurrence. Only a thin strip of disturbed edge habitat will be removed which represents a small percentage of the local occurrence of the TEC.
- The proposal will result in minor fragmentation of this vegetation within the study area.
- The proposal will not impact on habitat that is critical to the survival of the community.
- Mitigation measures will be implemented to avoid/minimise impacts on higher quality adjoining areas that will be retained.
- The proposal is unlikely to affect the recovery of the TEC.



# Critically endangered and endangered threatened species

## *Calidris ferruginea* (Eastern Curlew)

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

### **Lead to a long-term decrease in the size of an important population of a species**

The Hunter Estuary is an internationally important site for the Eastern Curlew as it supports more than 1% of the population (Brereton and Taylor-Wood, 2010). The 1% threshold for the species is 380 individuals (Bamford *et al.*, 2008), although maximum counts for the species have recorded between 800 and 1000 Eastern Curlews in the Hunter Estuary up until the late 1990s (Herbert, 2007). The Hunter Estuary population is considered an important population for the Eastern Curlew.

However, within the Hunter Estuary at large, Eastern Curlews confine their foraging and roosting activities to the saline parts, particularly sites in and around the North Arm of the Hunter River. Kooragang Dykes and Stockton Sandspit regularly record the most numbers of individuals and are key foraging sites for the local population, with Windeyeres Reach the preferred nocturnal roost location. According to Herbert (2007) the Eastern Curlew has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre). This is likely due to the species preference for large intertidal mudflats and sandflats, often with beds of seagrass. In contrast, Hexham Swamp for example, has undergone drainage works and closure of tidal floodgates that have prevented tidal inundation (Herbert, 2007), and potential habitat within the study area is therefore considered marginal for the species.

Although an important population of the Eastern Curlew occurs in the locality, given the absence of records within the study area and low quality of the potential habitat that occurs there, the proposal is not predicted to result in a decrease to the size of the population.

### **Reduce the area of occupancy of an important population**

The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation, of which 0.9 ha of native vegetation and 18.1 ha of exotic grassland intersect with important habitat mapping by OEH for the Eastern Curlew. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. The exotic grassland is not considered suitable habitat for the Eastern Curlew. Hexham Swamp has also been impacted by drainage works and closure of tidal floodgates that have prevented tidal inundation and further reduced the habitat suitability for species such as the Eastern Curlew.

Although an important population of the Eastern Curlew exists within the Hunter Estuary, the species has not been recorded within the study area and adjacent important wetland sites (such as Hexham Swamp, Pambalong Nature Reserve or the Hunter Wetlands Centre) (Herbert, 2007). Although marginal potential foraging habitat exists within the study area, the absence of records and alteration to tidal regimes suggest that this habitat is of low quality to the species and they preferentially focus activities at other important sites within the estuary (such as Stockton Sandspit and Fullerton Cove). Removal of 0.9 ha of low quality potential habitat is therefore considered unlikely to impact on the area of occupancy available to the Eastern Curlew, with broad extents of high quality habitat associated with the Hunter Estuary Ramsar site and broader Hunter Wetlands National Park available to the species.

## *Calidris ferruginea* (Eastern Curlew)

### **Fragment an existing important population into two or more populations**

Given the Eastern Curlew is not known to occupy the study area or adjacent important wetland sites, the proposal is not considered to cause fragmentation to the local population. The Eastern Curlew is considered a highly mobile species, capable of undertaking long migrations and moving between areas of suitable habitat to access preferred foraging and roosting sites. For example, Eastern Curlews foraging at Stockton Sandspit are known to move to their preferred roosting site at Windeyers Reach. The 0.9 ha of low quality potential habitat to be removed is unlikely to result in any fragmentation to the local population.

### **Adversely affect habitat critical to the survival of a species**

Although marginal potential foraging habitat exists within the study area, the absence of records of the species in the subject site and its immediate surrounds, and alteration to tidal regimes suggest that this habitat is of low quality to the species and they preferentially focus activities at other important sites within the estuary (such as Stockton Sandspit and Fullerton Cove).

The habitat within the study area is therefore not considered habitat critical to the survival of the species and it is reasonable to conclude that the removal of 0.9 ha of native vegetation will not constitute an adverse impact to habitat critical to the survival of the Eastern Curlew.

### **Disrupt the breeding cycle of an important population**

As the habitat is not considered critical habitat for the local population, and the Eastern Curlew has not been recorded using habitat associated with the study area or surrounding important wetland sites (Herbert, 2007), the proposal is not considered likely to disrupt the breeding cycle of the important population.

### **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

As the habitat is not considered critical habitat for the local population, and the Eastern Curlew has not been recorded using habitat associated with the study area or surrounding important wetland sites (Herbert, 2007), the proposal is not considered to alter the quality or extent of habitat for the species or cause it to decline.

### **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat**

Foxes (*Vulpes vulpes*) were observed within the proposal area during field surveys. Given that existing tracks utilised by foxes already occur within the proposal area, it is unlikely that the proposal would increase the abundance of this species.

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus* sp. aggregate (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15). Of these, *Juncus acutus* (Sharp Rush), Alligator Weed and *Tradescantia fluminensis* (Trad) would have the highest effect on migratory species due to their capacity to change habitat conditions in aquatic and saline conditions.

### ***Calidris ferruginea* (Eastern Curlew)**

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible.
- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas.
- Implementing soil erosion and sediment control measures.
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation.
- Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds.

#### **Introduce disease that may cause the species to decline, or**

There are no diseases associated with the species that the proposal would likely introduce such that it would cause a decline.

#### **Interfere with the recovery of the species**

The proposal is not considered to result in a negative impact to the species or interfere with the recovery of the species as there are no anticipated impacts expected to the Eastern Curlew.

#### **Conclusion of Assessment**

- The Hunter Estuary is known to support an important population of the Eastern Curlew (up to 1000 birds or >1% of the East Asian Australasian Flyway).
- Within the Hunter Estuary, the Eastern Curlew population confines its activity to saline sites, particularly Stockton Sandspit and Fullerton Cover.
- According to Herbert (2007) the Eastern Curlew has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre).
- The absence of records of the species at these locations suggests habitat within the study area is low quality for the species, and individuals are unlikely to occur there.
- Removal of 0.9 ha of marginal potential habitat for Eastern Curlew is therefore unlikely to result in a significant impact to the species.

Considering the above, the proposal is therefore unlikely to result in a significant impact to the Eastern Curlew.

### ***Calidris ferruginea* (Curlew Sandpiper)**

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

#### **Lead to a long-term decrease in the size of an important population of a species**

Curlew sandpipers are a common summer migrant found throughout the Hunter Estuary, primarily in saline habitats (Herbert, 2007). Though the Hunter Estuary has previously been thought to support up to 4000 individuals (when the species is in Australia), declining counts suggest that this has not been the case for several years (Brereton and Taylor-Wood, 2010).

### ***Calidris ferruginea* (Curlew Sandpiper)**

The frequency of counts exceeding 200 birds has declined since 1999, with the total NSW population thought to be approximately 2500 individuals (NSW Scientific Committee, 2011b). It has even been suggested that the changes within the estuary (particularly to tidal regimes) may have resulted in much of the previously suitable habitat for the species being no longer available (ARS, 2006).

The areas of habitat mapped as important for the Curlew Sandpiper by OEH are largely associated with known sites for wetland and migratory bird species in the Hunter Estuary including Hexham Swamp, the Hunter Wetlands Centre, Pambalong Nature Reserve, Minmi Sewage Treatment works, Market Swamp and Antennae wetland (Herbert, 2007). Of these locations, Curlew Sandpiper have been recorded at Hexham Swamp, the Hunter Wetlands Centre and Pambalong Nature Reserve.

There are 782 OEH BioNet Atlas records within 10 km of the study area, primarily within the Hunter Wetlands National Park, where suitable habitat for the species occurs. Curlew Sandpiper records within the broader Hunter Estuary are concentrated at a few key locations such as Fullerton Cove and Stockton Sandspit, where records of 400+ birds have been described (Herbert, 2007). Comparatively small numbers of individuals have been recorded at locations in close proximity to the study area, including the Hunter Wetlands Centre (1-5), Hexham Swamp (10) and Pambalong Nature Reserve (6-20), none of which have been identified as a key foraging location for the species (Herbert, 2007).

The locations relevant to the proposal (that occur in or adjacent to the subject site) are not thought to support a large number of birds from the local population utilising the Hunter Estuary at large. Herbert (2007) states that a maximum of 5 individual Curlew Sandpipers are 'occasionally recorded' at the Hunter Wetlands Centre, a maximum of 10 individuals are 'rarely recorded' at Hexham Swamp and up to 20 individuals have been observed at Pambalong Nature Reserve.

The number of individuals using potential habitat in and adjacent to the study area is therefore estimated to be fewer than 20 individuals that may occasionally utilise habitat within the study area on a seasonal and intermittent basis.

Although a large population of the Curlew Sandpiper occurs in the locality, given the low number of records within the study area and low quality of the potential habitat that occurs there, the proposal is not predicted to result in a decrease to the size of the population.

#### **Reduce the area of occupancy of an important population**

There is over 7000 ha of habitat mapped within the Hunter Wetland National Park. Of this, 75.2 hectares of potential Curlew Sandpiper habitat occurs within the study area, associated with PCTs 1747, 1746, 1737 and 1808. The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation, of which 0.9 ha of native vegetation and 18.1 ha of exotic grassland intersect with important habitat mapping by OEH for the Curlew Sandpiper. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. The exotic grassland is not considered suitable habitat for the Curlew Sandpiper, which usually forages in soft substrate associated with intertidal sandy or soft mud substrates.



### ***Calidris ferruginea* (Curlew Sandpiper)**

Within the study area, 0.9 hectares of this potential native habitat will be subject to direct disturbances associated with widening the existing cleared alignment associated with the HWC Chichester rising main and Richmond Vale railway. The direct change in habitat available to the local Curlew Sandpiper population (i.e. the loss of 0.9 hectares of potential native habitat) as a result of the proposal is not considered to reduce the area of occupancy for the local Curlew Sandpiper population due to the following reasons:

- The habitat being removed is located along the edge of the existing, historically disturbed alignment, and occurs adjacent to primarily exotic grassland vegetation and is therefore considered low quality habitat for the Curlew Sandpiper.
- The habitat in and directly adjacent to the study area (including the Hunter Wetlands Centre, Hexham Swamp and Pambalong Nature Reserve), is thought to occasionally attract only a small number of Curlew Sandpipers (up to 20) (Stuart, 2017), suggesting that only a small fraction of the local population may occasionally use the site rather than relying on it as a key foraging location.
- The Hunter Wetlands National Park consists of over 6000 hectares, with the majority of the local Curlew Sandpiper population recorded consistently and in large numbers (>200 individuals) at several key locations outside the study area such as Fullerton Cove, Stockton Sandspit, Ash Island and Deep Pond (Stuart, 2017).

This indicates that the potential habitat in and around the study area where small numbers of individuals have occasionally been recorded, is not preferred habitat for the species within the broader landscape of the Hunter Estuary. As the majority of the population does not frequent the site, the change to available habitat, through both direct and indirect impacts, is considered to be minor and relevant to a small number of individuals that may occasionally utilise the site. It is therefore reasonable to conclude that the change in habitat available to the local population as a result of the proposal is negligible.

#### **Fragment an existing important population into two or more populations**

The species is capable of undertaking large migrations, and is not sedentary within the foraging or roosting grounds it visits in the Hunter Estuary. The occasional records of individuals at Hexham Swamp, the Hunter Wetlands Centre and Pambalong Nature Reserve, indicate that individuals visit these locations on occasion as part of a broader network of preferred sites in the Hunter Estuary and beyond. The proposal is unlikely to cause any restrictions to such movements, and therefore will not fragment or isolate the population. Individuals utilising habitat associated with the study area and surrounds, will still be able to access this habitat.

#### **Adversely affect habitat critical to the survival of a species**

The potential Curlew Sandpiper habitat that would be modified as a result of the proposal includes 0.9 hectares of potential habitat that will be removed within the subject site and an increase in disturbance associated with human recreational use of the track to the remaining 75.2 hectares within the study area.

The potential habitat in and adjacent to the study area may be utilised occasionally by a small number of individuals (<20) for foraging and/or roosting, based on previous records in the area (Stuart, 2017). However, given the broader landscape context, where favoured foraging and roosting habitat for the species appears to be located at other sites within the Hunter Estuary (Stuart, 2017), modification to this habitat is unlikely to represent critical habitat for the survival of the species. Extensive areas of suitable habitat within the Hunter Estuary would support the local population.

### ***Calidris ferruginea* (Curlew Sandpiper)**

Given the low number of individuals thought to be utilising the site, the impacts of increased disturbance are considered to be low, and appropriately controlled with mitigation measures such as fencing and signage that will further reduce the likelihood of any impacts to birds that may occasionally visit habitat surrounding the track.

The habitat within the study area is therefore not considered habitat critical to the survival of the species and it is reasonable to conclude that the removal of 0.9 ha of native vegetation will not constitute an adverse impact to habitat critical to the survival of the Curlew Sandpiper.

#### **Disrupt the breeding cycle of an important population**

The Curlew Sandpiper is a migratory species that does not breed in Australia. However, the habitat used by the species along their migratory pathway is considered a critical component in allowing the species to complete its life cycle successfully. Access to habitat to forage and rest while in Australia, is important to allow individuals to build up enough energy reserves to undertake the return journey north.

Although such habitat exists in the Hunter Estuary, the habitat within the study area is not considered critical habitat for the local population.

It is reasonable to conclude that the proposal is therefore not likely to disrupt the breeding cycle of the population using the site.

#### **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

Approximately 0.9 hectares of potential habitat for the Curlew Sandpiper would be directly impacted (removed) as a result of this proposal, a small fraction of the 75.2 hectares within the study area and a negligible amount in the context of the Hunter Wetlands National Park as a whole, which is over 6000 hectares and contains extensive suitable habitat for the Curlew Sandpiper. Furthermore, this habitat has already been subjected to historical disturbance, as it is located along the existing, cleared alignment and as a result is not considered to be preferred habitat for the species.

The habitat used by the vast majority of the local population of Curlew Sandpipers occurs elsewhere in the Hunter Estuary, with only occasional records of a small number of individuals (<20) recorded using the available habitat in and adjacent to the subject site (Stuart, 2017). This suggests that any loss or modification to available Curlew Sandpiper habitat within the study area is likely to impact on only a small number of individuals that may occasionally visit the site.

Although the proposal will transect areas of potential habitat, given the mobility of Curlew Sandpipers this is not considered likely to isolate areas of available habitat and individuals are considered capable of easily moving between patches of suitable habitat within the landscape.

The primary modification to potential Curlew Sandpiper habitat associated with the proposal is the increased potential for disturbance associated with human recreational use of the site. However, given the site does not appear to represent preferred habitat within the Hunter Estuary and only a small number of individuals are thought to occasionally utilise the site (Stuart, 2017), it is reasonable to conclude that the proposal will not result in displacement of the local population. The existing track through the site is already used as an access track for walkers and birdwatchers, and already subject to some human disturbance.

## ***Calidris ferruginea* (Curlew Sandpiper)**

### **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat**

Foxes (*Vulpes vulpes*) were observed within the proposal area during field surveys. Given that existing tracks utilised by foxes already occur within the proposal area, it is unlikely that the proposal would increase the abundance of this species.

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus sp. aggregate* (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15). Of these, *Juncus acutus* (Sharp Rush), Alligator Weed and *Tradescantia fluminensis* (Trad) would have the highest effect on migratory species due to their capacity to change habitat conditions in aquatic and saline conditions.

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible.
- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas.
- Implementing soil erosion and sediment control measures.
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation.
- Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds.

### **Introduce disease that may cause the species to decline, or**

There are no diseases associated with the species that the proposal would likely introduce such that it would cause a decline.

### **Interfere with the recovery of the species**

The proposal is not considered to result in a negative impact to the species or interfere with the recovery of the species as there are no anticipated impacts expected to the Curlew Sandpiper.

### **Conclusion of Assessment**

- The Hunter Estuary is known to support a large number of Curlew Sandpipers on a regular basis which are likely to constitute an important population of the species.
- Within the Hunter Estuary, records for the Curlew Sandpiper are concentrated east of the study area at locations such as Fullerton Cove and Stockton Sandspit.
- According to Herbert (2007), the Curlew Sandpiper has occurred occasionally in low numbers at significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre).

### *Calidris ferruginea* (Curlew Sandpiper)

- The low number of records utilising the area suggests that the habitat is marginal for the species.
- Removal of 0.9 ha of marginal potential habitat for the Curlew Sandpiper is therefore unlikely to result in a significant impact to the species.

Considering the above, the proposal is therefore unlikely to result in a significant impact to the Curlew Sandpiper.

### *Calidris canutus* (Red Knot)

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

#### **Lead to a long-term decrease in the size of an important population of a species**

The Hunter Estuary has been known to support over 1000 individual Red Knots (Herbert, 2007) (0.5% of the East Asian Australasian Flyway population). Individuals tend to arrive in the Hunter Estuary in September, foraging for a short time before the majority move further south to Victoria (Herbert, 2007).

Although the Hunter Estuary at times supports a large population of the species, Red Knot appear to confine their activities to key locations such as Kooragang Dykes where they are most often observed, Stockton Spit and occasionally at Fullerton Cove Beach and Ash Island (Herbert, 2007). The Red Knot had not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre) as of 2007 (Herbert, 2007), however recent records in the Atlas of Living Australia suggests a small number of individuals may occasionally visit the Hexham Swamp.

The proposal involves the removal of 0.9 ha of native vegetation considered potential habitat for the Red Knot. However, given that a small number of records for the species occur in the study area and important wetlands nearby, it appears that this habitat is not favoured by the species within the broader Hunter Estuary and it is reasonable to conclude that its removal will not lead to a decrease in the size of the population.

#### **Reduce the area of occupancy of an important population**

Within the 177.3 hectare study area, 75.2 hectares of potential Red Knot habitat occurs, associated with PCTs 1747, 1746, 1737 and 1808. The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation, of which 0.9 ha of native vegetation and 18.1 ha of exotic grassland intersect with important habitat mapping by OEH for the Red Knot. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. The exotic grassland is not considered suitable habitat for the Red Knot, which usually forages in soft substrate near the water edge on intertidal mudflats or sandflats exposed by low tide (TSSC, 2016a).

Although the Hunter Estuary appears to support a large population of Red Knots, it appears that the species does not favour the habitat within the study area and adjacent important wetland sites (such as Hexham Swamp, Pambalong Nature Reserve or the Hunter Wetlands Centre) (Herbert, 2007), with only a few individuals recently recorded at Hexham Swamp (ALA, 2019), although marginal potential foraging habitat exists within the study area, the absence of records and alteration to tidal regimes suggest that this habitat is of low quality and the species preferentially focus activities at other important sites east of the study area

### ***Calidris canutus* (Red Knot)**

where extensive sandflats and mudflats are likely to provide increased foraging opportunities (such as Stockton Sandspit, Fullerton Cove and Ash Island). Removal of 0.9 ha of low quality potential habitat is therefore considered unlikely to impact on the area of occupancy available to the Red Knot, with broad extents of high quality habitat associated with the Hunter Estuary Ramsar site and broader Hunter Wetlands National Park available to the species.

#### **Fragment an existing important population into two or more populations**

Given only a small number of recently recorded individuals of the Red Knot population occur within the study area or adjacent important wetland sites, the proposal is not considered to cause fragmentation to the local population. Red Knots are highly mobile, capable of undertaking long migrations and moving between areas of suitable habitat to access preferred foraging and roosting sites. The 0.9 ha of low quality potential habitat to be removed is unlikely to result in any fragmentation to the local population.

#### **Adversely affect habitat critical to the survival of a species**

Habitat within the Hunter Estuary represents a key stopover point for the Red Knot for individuals travelling further south. Although marginal potential foraging habitat exists within the study area, the absence of records and alteration to tidal regimes suggest that this habitat is of low quality and the species preferentially focus activities at other important sites east of the study area where extensive sandflats and mudflats are likely to provide increased foraging opportunities (such as Stockton Sandspit, Fullerton Cove and Ash Island).

It is reasonable to conclude that the removal of 0.9 ha of native vegetation will not constitute an adverse impact to habitat critical to the survival of the species.

#### **Disrupt the breeding cycle of an important population**

The Red Knot is a migratory species that does not breed in Australia. However, the habitat used by the species along their migratory pathway is considered a critical component in allowing the species to complete its life cycle successfully. Access to habitat to forage and rest while in Australia, is important to allow individuals to build up enough energy reserves to undertake the return journey north.

Although such habitat exists in the Hunter Estuary, the habitat within the study area is not considered critical habitat for the local population, and the Red Knot has not been recorded using habitat associated with the study area in large numbers on a regular basis.

It is reasonable to conclude that the proposal is therefore not likely to disrupt the breeding cycle of the population using the site.

#### **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

As described above, the total amount of native vegetation representing potential habitat for the Red Knot to be removed is 0.9 ha. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. Removal of this habitat is therefore not considered to reduce or isolate the availability or quality of habitat available to the species such that it is likely to decline.

Within the study area, there is 75.2 hectares of suitable habitat for the Red Knot associated with PCTs 1747, 1746, 1737 and 1808. This habitat may be subject to increased disturbance associated with the increased human activity through the area once the trail is completed. However, given the low number of records of the species using the site, and the low quality of the habitat there, it is unlikely that such disturbance would reduce the quality of habitat to the extent the species is likely to decline. Furthermore, if any birds are utilising the area,



## **Calidris canutus (Red Knot)**

disturbance will be minimised through appropriate mitigation measures (described in Section 7.3).

### **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat**

Foxes (*Vulpes vulpes*) were observed within the proposal area during field surveys. Given that existing tracks utilised by foxes already occur within the proposal area, it is unlikely that the proposal would increase the abundance of this species.

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus sp. aggregate* (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15). Of these, *Juncus acutus* (Sharp Rush), Alligator Weed and *Tradescantia fluminensis* (Trad) would have the highest effect on migratory species due to their capacity to change habitat conditions in aquatic and saline conditions.

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible
- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas
- Implementing soil erosion and sediment control measures.
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation.

Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds.

### **Introduce disease that may cause the species to decline, or**

There are no diseases associated with the species that the proposal would likely introduce such that it would cause a decline.

### **Interfere with the recovery of the species**

The proposal is not considered to result in a negative impact to the species or interfere with the recovery of the species as there are no anticipated impacts expected to the Red Knot as part of this proposal.

### **Conclusion of Assessment**

- The Hunter Estuary is known to support a large population of Red Knots at certain times on their migration from the northern hemisphere to foraging grounds further south.
- Within the Hunter Estuary, records of the Red Knot are primarily associated with saline sites such as Stockton Sandspit and Fullerton Cove and Ash Island.

### *Calidris canutus* (Red Knot)

- The Red Knot had not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre) until recently, with a small number of individuals recorded in the Atlas of Living Australia in 2018.
- The absence of records of the species at these locations suggests habitat within the study area is low quality for the species, and individuals are unlikely to occur there on a regular basis.
- Removal of 0.9 ha of marginal potential habitat for the Red Knot is therefore unlikely to result in a significant impact to the species.

Considering the above, the proposal is therefore unlikely to result in a significant impact to the Red Knot

### *Botaurus poiciloptilus* (Australasian Bittern)

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

#### **Lead to a long-term decrease in the size of an important population of a species**

The Australasian Bittern is solitary and cryptic, hence rarely observed (Herbert, 2007). The population is considered to be declining due to a reduction in the area of occupancy of the species associated with the clearing or modification of wetlands for development (TSSC, 2019).

Over half to two thirds of the national population is estimated to occur in NSW, an estimated 660-1660 mature individuals (NSW Scientific Committee, 2011a).

Herbert (2007) considers that there is sufficient habitat within the Hunter Estuary to support a significant population of the species, including breeding habitat, although breeding has not been recorded. Most of the records within Hunter Estuary occur at Hexham Swamp, where modifications to the tidal regime have tended to increase the potential habitat for bitterns in the form of increasing the area of *Phragmites* and *Typha* dominated freshwater swamps (Herbert, 2007).

The area of potential habitat for the population within the study area includes approximately 93 hectares. Approximately 6.8 hectares of this vegetation will be removed as part of the proposal. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. Removal of 6.8 hectares is unlikely to result in any direct impacts to the Australasian Bittern that would decrease the size of an important population of the species.

#### **Reduce the area of occupancy of an important population**

Within the 177.3 hectare study area, 92.9 hectares of potential habitat for Australasian Bittern occurs, associated with PCTs 1808, 1737, 1747 and 1727. The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation, of which 1.7 ha represents potential habitat for the Australasian Bittern. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated

### ***Botaurus poiciloptilus* (Australasian Bittern)**

Hunter Estuary Ramsar site. The exotic grassland is not considered suitable habitat for the Australasian Bittern.

Within the study area, 1.7 hectares of this potential native habitat will be subject to direct disturbances associated with widening the existing cleared alignment associated with the HWC Chichester rising main and Richmond Vale railway. The direct change in habitat available to the Australasian Bittern population (i.e. the loss of 1.7 hectares of marginal potential native habitat) as a result of the proposal is not considered to significantly reduce the area of occupancy for the local Australasian Bittern population.

#### **Fragment an existing important population into two or more populations**

The Australasian Bittern is capable of moving between habitats as suitability changes, often over several hundreds of kilometres (TSSC, 2019). As such, the proposal is unlikely to cause any fragmentation to the important population. Given that the existing cleared areas associated with installation of the HWC Chichester rising main and Richmond Vale railway already transect the habitat, the widening of this track is unlikely to add any further restrictions to Bittern movements.

#### **Adversely affect habitat critical to the survival of a species**

Habitat critical to the survival of the species is considered any habitat where the species is known to occur (TSSC, 2019). As such, the habitat surrounding the study site associated with Hexham Swamp and the Hunter Wetlands Centre would constitute critical habitat for the species.

However, 1.7 hectares of potential habitat subject to removal is located at the edge of a previously disturbed alignment and is therefore considered to be marginal for this shy and cryptic species. It is therefore reasonable to conclude that the 1.7 hectares of habitat being removed is not critical to the survival of the species.

#### **Disrupt the breeding cycle of an important population**

The Australasian Bittern breeds from October to February in solitary pairs. It prefers to build nests adjacent to relatively deep, densely vegetated freshwater swamps and pools under dense cover over shallow water (TSSC, 2019).

Although 1.7 hectares of potential habitat will be removed, its location at the edge of a previously disturbed alignment and is not considered suitable breeding habitat for this shy and cryptic species. It is therefore reasonable to conclude that the 1.7 hectares of habitat being removed is not likely to disrupt the breeding cycle of the species.

#### **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

Approximately 1.7 hectares of potential habitat for the Australasian Bittern would be directly impacted (removed) as a result of this proposal, a small fraction of the 92.9 hectares within the study area and a negligible amount in the context of the Hunter Wetlands National Park as a whole, which is over 6000 hectares and contains extensive suitable habitat for the Australasian Bittern (TSSC, 2019). Furthermore, this habitat has already been subjected to historical disturbance, as it is located along the existing, cleared alignment and as a result is not considered to be preferred habitat for the species.

Although the proposal will transect areas of potential habitat, given the mobility of species this is not considered likely to isolate areas of available habitat and individuals are considered capable of easily moving between patches of suitable habitat within the landscape.

### ***Botaurus poiciloptilus* (Australasian Bittern)**

The primary modification to potential habitat for the Australasian Bittern associated with the proposal is the increased potential for disturbance associated with human recreational use of the site. However, given the species is considered shy and cryptic, it is unlikely to utilise the habitat at the edge of the alignment in preference to the dense areas of vegetation elsewhere.

The proposal is therefore not expected to result in impacts to the Australasian Bittern that would cause the species to decline.

#### **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat**

Foxes (*Vulpes vulpes*) were observed within the proposal area during field surveys. Given that existing tracks utilised by foxes already occur within the proposal area, it is unlikely that the proposal would increase the abundance of this species.

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus sp. aggregate* (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15). Of these, *Juncus acutus* (Sharp Rush), Alligator Weed and *Tradescantia fluminensis* (Trad) would have the highest effect on migratory species due to their capacity to change habitat conditions in aquatic and saline conditions.

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible.
- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas.
- Implementing soil erosion and sediment control measures.
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation.

Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds.

#### **Introduce disease that may cause the species to decline, or**

There are no diseases associated with the species that the proposal would likely introduce such that it would cause a decline.

#### **Interfere with the recovery of the species**

The proposal is not considered to result in a negative impact to the species or interfere with the recovery of the species as there are no anticipated impacts expected to the Australasian Bittern.

## *Botaurus poiciloptilus* (Australasian Bittern)

### Conclusion of Assessment

- The Hunter Estuary is likely to support an important population of the Australasian Bittern.
- Extensive habitat within the Hunter Estuary exists for the local population, which is capable of undertaking large movements between areas of suitable habitat.
- The 1.7 hectares of potential habitat for the species that is being removed is not considered critical habitat due to its location at the edge of a previously disturbed alignment likely to be unsuitable for this shy and cryptic species that prefers dense vegetation.
- Removal of this habitat is not considered likely to have an adverse effect on the species.



## Vulnerable threatened species

### ***Chalinolobus dwyeri* (Large-eared Pied Bat)**

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

#### **Lead to a long-term decrease in the size of an important population of a species**

The recovery plan for *Chalinolobus dwyeri* (Large-eared Pied Bat) defines important populations of the species as large populations occurring in areas dominated by sandstone escarpments (DERM, 2011). In NSW, important populations are thought to be concentrated in the sandstone escarpments of the Sydney basin and northwest slopes (DERM, 2011).

Although the study area is located within the Sydney basin, it does not contain any sandstone escarpments suitable for supporting a large population of the species.

The site was found to contain suitable roosting habitat associated with the M1 tunnel (Section 6.1.2). This was confirmed by survey, which concluded that a small number of individuals may utilise the crevices in the tunnel walls and ceiling for roosting and the surrounding habitat for foraging. The crevices do not appear to be sufficiently deep to create stable microclimates required for breeding, suggesting that even if a small population of bats utilise the study area for roosting and foraging, this habitat is unlikely to be suitable for breeding. The structure of maternity roosts is very specific (DERM, 2011) and not consistent with the roosting habitat identified on site.

In light of these considerations, the study area is not considered suitable for supporting an important population and the proposal would therefore not contribute to a decrease in the size of an important population of the species.

#### **Reduce the area of occupancy of an important population**

The study area is not considered suitable to support an 'important population' of *Chalinolobus dwyeri* (Large-eared Pied Bat), therefore the proposal would not reduce the area of occupancy of an important population.

#### **Fragment an existing important population into two or more populations**

The study area is not considered suitable to support an 'important population' of *Chalinolobus dwyeri* (Large-eared Pied Bat), therefore the proposal would not fragment an existing important population into two or more populations.

#### **Adversely affect habitat critical to the survival of a species**

The most critical threat to the survival of this species is destruction of, or interference with, subterranean roosts and maternity sites, which are considered critical habitat for the ongoing survival of the species (DERM, 2011). As no habitat for maternity roosts was identified in the study area, it can be concluded that no critical habitat to the survival of the species is present within the study area.

Although roosting habitat was identified, this is not considered to represent critical habitat as it is not consistent with the specific maternity roost conditions required by the species (DERM, 2011). Although the species is considered dependent on roost sites for shelter, *Chalinolobus dwyeri* (Large-eared Pied Bat) is thought to roost predominantly in caves and overhangs in sandstone cliffs (DERM, 2011), therefore the potential habitat identified in the M1 tunnel is likely to represent marginal roosting habitat. This conclusion is supported by acoustic data, which confirmed only a low number of potential calls at the tunnel entrances, suggesting that the habitat may be utilised occasionally by a small number of individuals. The location, size and utilisation patterns of the roosting habitat therefore suggest that it is not critical to the survival of either the small number of potential individuals using it or the species as a whole.

## ***Chalinolobus dwyeri* (Large-eared Pied Bat)**

### **Disrupt the breeding cycle of an important population**

The study area is not considered suitable to support an 'important population' of *Chalinolobus dwyeri* (Large-eared Pied Bat), and no suitable breeding habitat was identified within the study area, therefore the proposal would not disrupt the breeding cycle of an important population.

### **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

The potential habitat for *Chalinolobus dwyeri* (Large-eared Pied Bat) includes roosting habitat and foraging habitat. As described above, the species is known to prefer caves and overhangs in sandstone cliffs (DERM, 2011) and the roosting habitat identified in the study area is likely to represent marginal habitat that may be utilised periodically by a small number of individuals. This habitat is not being removed or destroyed by the proposal but it may be modified. Installation of artificial lighting at night and increased numbers of cyclists and pedestrians passing through the tunnel may impose additional disturbances to bats utilising the tunnel. These modifications are not considered to be significant enough to result in a decline of the species however, given that the habitat subject to disturbance is neither critical breeding habitat or likely to support a large number of individuals of the species.

The proposal would involve the permanent removal of a linear strip of vegetation associated with an existing track, which contains approximately 1.6 ha of marginal potential foraging habitat for the species. This removal would not result in increased fragmentation to the landscape, and is a very small fraction of available habitat in the broader landscape, and the study area is surrounded by large extents of contiguous native woodland vegetation that would represent higher quality foraging habitat for the species. As *Chalinolobus dwyeri* (Large-eared Pied Bat) is a highly mobile species, capable of foraging over large distances, removal of this vegetation is not considered likely to impact on individuals utilising the study area and surrounds for foraging or contribute to a species decline.

### **Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

Other species considered harmful to *Chalinolobus dwyeri* (Large-eared Pied Bat) include introduced predators (cats, foxes and rats), livestock and feral animals such as goats, which have been found to disturb roosts in sandstone escarpment areas (DERM, 2011). Invasive predators, including foxes and cats are likely to be present in the existing urban environment and the project is unlikely to increase the incidence of these predators to the area. No livestock are present on the site and the impacts of feral goats are considered negligible given that disturbance by goats is associated with bat colonies in sandstone escarpments (DERM, 2011), which are not present at the site.

The proposal is therefore not considered to result in an invasive species harmful to *Chalinolobus dwyeri* (Large-eared Pied Bat) becoming established in the species' habitat.

### **Introduce disease that may cause the species to decline, or**

There are no known diseases which affect *Chalinolobus dwyeri* (Large-eared Pied Bat). Pathogens such as Phytophthora may occur within the locality given that the annual rainfall for the area is greater than 600 mm (McDougall and Summerell, 2003). Where present, Phytophthora can result in the dieback or modification of native vegetation and therefore could damage potential foraging habitat for *Chalinolobus dwyeri* (Large-eared Pied Bat), which may contribute to a reduction or modification to the foraging range of individuals using the site but is unlikely to directly result in a species decline.

### ***Chalinolobus dwyeri* (Large-eared Pied Bat)**

In order to minimise the potential for the spread or introduction of Phytophthora, hygiene measures in accordance with national best practice guidelines for Phytophthora (DEH, 2006) should be adopted during the clearing of vegetation and incorporated into the CEMP for the proposal. Measures to prevent the introduction or spread of Phytophthora would include the decontamination of personnel and plant equipment prior to entering the construction site and when traversing between areas of vegetation within the project corridor.

These measures relate to the vegetation clearing and construction stages of the project only and should accompany measures that ensure plant and machinery does not enter any areas of retained vegetation outside of the project corridor. It is envisaged that once the bypass has been completed, these measures would no longer be required.

With the adoption of appropriate mitigation measures, the risk of spread of Phytophthora would be minimised. The proposal is considered unlikely to contribute to the introduction of a disease that would cause the species to decline.

#### **Interfere substantially with the recovery of the species**

The proposal is not considered to result in a negative impact to the species or interfere with the recovery actions identified in The National Recovery Plan for the Large-eared Pied Bat (DERM, 2011), which include:

- Identify priority roost and maternity sites for protection
- Implement conservation and management strategies for priority sites
- Educate the community and industry to understand and participate in the conservation of the Large-eared Pied Bat
- Research to augment biological and ecological data to enable conservation management
- Determine the meta-population dynamics throughout the distribution of the Large-eared Pied Bat

The proposal presents an opportunity to contribute to community education and increased awareness of the species, and the increased visitation along to the area would provide educational opportunities for the public about the surrounding habitats and the species that depend on them.

#### **Conclusion of Assessment**

The proposal would not have a significant impact on *Chalinolobus dwyeri* (Large-eared Pied Bat) due to the following considerations:

- The habitat is not considered suitable to support an important population of the species, therefore no impacts to important populations of the species will occur.
- No habitat critical to the survival of the species will be adversely affected.
- No habitat will be modified such that the species is likely to decline as a result.
- No invasive species that are harmful to the species are likely to become established in its habitat as a result of the proposal.
- No diseases that would cause the species to decline are likely to be introduced as a result of the proposal.
- The proposal does not interfere with the recovery of the species, and provides an opportunity for community education.

### ***Litoria aurea* (Green and Golden Bell Frog)**

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

#### **Lead to a long-term decrease in the size of an important population of a species**

According to the EPBC Act referral guidelines for this species, all populations of the Green and Golden Bell Frog are to be treated as 'important populations' (DEWHA, 2009).

Within NSW, the distribution of the species is described as 'coastal lowland areas of eastern NSW from approximately 50 km south of the NSW Queensland border and extending south into northeast Victoria'. There are 7236 records within 10 km of the site, the majority of which is from the Kooragang Island key population (OEH, 2018c). The high number of recordings is significant due to the major decline (90%) in the population from previously known areas of distribution (DEC, 2005).

Historically, the Green and Golden Bell Frog was commonly recorded in areas around Shortland and in Hexham Swamp but have suffered a contraction in their numbers over the years (DEC, 2005). This population is known as the Sandgate/Hexham Swamp key population and is distinct from the Kooragang Island key population due to the geographical separation of the Hunter River South Channel.

Although accessible records within the study area are from 1990 or earlier (OEH, 2018c), the Sandgate/Hexham Swamp key population has been detected since that time in a peripheral area to Hexham Swamp (on the 2HD radio transmitter tower lands at Sandgate as well as at the nearby former waste disposal facility lands) (DEC, 2005; DECC, 2007). This population is not always detectable and there has been some conjecture as to whether it is still extant. Surveys completed in 2019 for this BDAR did not detect the species, however the conditions at the time of survey were unfavourable and outside the preferred survey period.

The recovery plan for the species acknowledges that the Sandgate/Hexham Swamp key population is transient nature and takes the view that the population is still extant and merely occupying other components of the extensive potential habitat comprising parts of the Hexham Swamp wetland (DEC, 2005). Considering this, the species is assumed to be present within the study area, albeit in a transient manner.

The proposal would result in the removal of a thin strip of approximately 3.3 ha of ephemeral or semi-permanent wet areas and similarly suitable habitat. Adjacent areas of this vegetation type which provide potential breeding habitat would not be affected by the proposal.

It is unlikely that the proposed works would have an adverse effect on the lifecycle of this species, or on the adjacent areas of potential Green and Golden Bell Frog habitat given the temporary nature of impacts on potential breeding habitat. Considering the transient nature of this key population, the size of the available habitat within the study area, and the small area of impact along existing cleared corridors, the proposal is unlikely to lead to a long-term decrease in the size of this population.

Mitigation measures would be implemented to prevent impacts to potential breeding habitat including sedimentation and pollution control, management of pathogen risks, and avoiding construction within the Summer breeding season. These measures would be coordinated in a Green and Golden Bell Frog management plan that would be prepared as a subplan to the CEMP (Section 7).

#### **Reduce the area of occupancy of an important population**

The proposal will be constructed within an existing cleared corridor that may be traversed by individuals frogs from time to time. The proposal will clear approximately 3.3 ha of potential habitat for the species along the edges of this cleared corridor. Once construction is completed, the proposed pathway is unlikely to impede movement, exclude or otherwise reduce the area of occupancy of the species.

## ***Litoria aurea* (Green and Golden Bell Frog)**

### **Fragment an existing important population into two or more populations**

The proposal will be constructed within an existing cleared corridor that may be traversed by individuals frogs from time to time. The proposal will clear approximately 3.3 ha of potential habitat for the species along the edges of this cleared corridor. During construction, the proposal will include a temporary frog exclusion fence, designed to prevent the species from moving into the construction area and getting injured. Once construction is completed, the proposed pathway is unlikely to impede movement, exclude or otherwise fragment the population into two or more populations.

### **Adversely affect habitat critical to the survival of a species**

The habitat critical to the survival of the species includes all ephemeral or semi-permanent wet areas. The PCT's which have been described within the study area and are suitable for this habitat include:

- PCT 1808- Common Reed on the margins of estuaries and brackish lagoons along the New South Wales coastline
- PCT 1737- Typha Rushland
- PCT 1746- Saltmarsh Estuarine Complex
- PCT 1747- Grey Mangrove low closed forest
- PCT 1727 - Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast

The proposal is unlikely to affect wetland habitats within the study area as only 3.3 ha of edge habitat along an existing cleared corridor will be removed, with surrounding wetland habitats to be retained. Existing hydrological flows may be temporarily disturbed during construction but mitigation measures such as flow diversions, and design measures such as culverts and boardwalks will be implemented to minimise these impacts.

Construction impacts, outlined in Section 7 will be minimised through the implementation of mitigation measures such as:

- Avoiding construction during breeding season
- Ensuring pathogen and machine hygiene protocols
- Installation of frog fencing to exclude the species during construction

### **Disrupt the breeding cycle of an important population**

Breeding events and other associated reproductive behaviours of the Green and Golden Bell Frog have been recorded from late winter to early autumn but generally between September and February with a peak around January-February after heavy rain/storm events, (DEC, 2005). For this reason, as described in Section 7, the construction of the pathway within the suitable habitat will be avoided in the breeding period and after heavy rainfall events on the either edge of this season. Hydrological processes will remain in the current condition to ensure no disruption to the requirements of breeding habitat such as salinity and avoid disruption of the fidelity of the species to a breeding site (DEC, 2005).

### **Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

The proposal would result in the removal of a thin strip of approximately 3.3 ha of ephemeral or semi-permanent wet areas and similarly suitable habitat. Adjacent areas of this vegetation type which provide potential breeding habitat would not be affected by the proposal.

The proposal is unlikely to modify or decrease the quality or availability of habitat to the extent that the species is likely to decline.



## ***Litoria aurea* (Green and Golden Bell Frog)**

### **Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

The key invasive species that is a significant threat to Green and Golden Bell Frog is *Gambusia* (*Gambusia holbrooki*). The known presence of *Gambusia* within the study area and adjacent wetland habitats is currently unknown. *Gambusia* is a predatory fish that feeds on Green and Golden Bell Frog tadpoles, and is also listed as a Key Threatening Process (KTP) under the *Fisheries Management Act 1994* (DPI, 2019a). There are very few effective control measures to prevent the spread of *Gambusia*, due to the habitat range and high fecundity of the species (CW CMA, 2010). The main risks of introduction of *Gambusia* into waterways are from the use of live bait in recreational fishing (which is illegal in NSW), or from stocking fish in aquaria or ponds. The construction of the proposed pathway is unlikely to pose a risk to Green and Golden Bell Frog of introducing or spreading *Gambusia*.

A number of high threat exotic species have been identified within the study area, including *Juncus acutus*, *Alternanthera philoxeroides* and *Tradescantia fluminensis*. These species are suited to moist and/or saline soils, and can further encroach within the Green and Golden Bell Frog habitat if mitigation measures and controls are not implemented prior to construction of the proposal.

The CEMP (Section 7) ensures that pathogen and machine hygiene controls will be conducted, to prevent further encroachment of these identified species and introduction of other invasive species suited the characteristics of the species habit.

### **Introduce disease that may cause the species to decline, or**

Chytrid fungus (*Batrachochytrium dendrobatidis*) is a major concern for the species due to its contribution to the extinction of four other frog species (DSEWPaC, 2012a), high infection rate and known infection of the Green and Golden Bell Frog. Control measures for preventing the spread of Chytrid fungus include (NSW NPWS, 2001):

- Footwear must be thoroughly cleaned and disinfected at the commencement of fieldwork and between each sampling site.
- Equipment such as nets, balances, callipers, bags, scalpels, headlamps, torches, wetsuits and waders etc. that are used at one site must be cleaned and disinfected before re-use at another site.
- Where necessary, vehicle tyres should be sprayed/flushed with a disinfecting solution in high-risk areas.
- Frogs should only be handled when necessary, by qualified professionals.

The proposal will need to follow these protocols with strict adherence, due to potential impact on the assumed population within the study area. Operational mitigation measures such as signage and possible boot washdown areas when entering the Hunter Wetland end of the trail could be implemented.

### **Interfere substantially with the recovery of the species**

The draft recovery plan (DEC, 2005) for the Green and Golden Bell frog identifies some processes which may inhibit the recovery of the species, including:

- The destruction and alteration of wetlands
- Stormwater pollution
- Altered habitat
- Introduction of predators and pathogens
- Broad scale application of herbicides
- Isolation and fragmentation

### ***Litoria aurea* (Green and Golden Bell Frog)**

There is a risk during construction for the proposal to exacerbate or facilitate the above key threatening processes and thus interfere with the recovery of the species. For this reason, a suite of controls and mitigation measures will be implemented under a CEMP to manage construction risks, such as management of construction chemicals, machinery washdown procedures, erosion and soil controls, use of temporary barriers to minimise unintentional damage of surrounding vegetation etc.

#### **Conclusion of Assessment**

The proposal is unlikely to have a significant impact on the vulnerable Green and Golden Bell Frog for the following reasons:

- The population is known to be transient and may occur across a larger area such that construction activities could have a high probability of avoiding interactions with individuals.
- The proposal would remove 3.3 ha of edge vegetation along an existing cleared corridor.
- The majority of areas of potential habitat within the study area would not be impacted by the proposal.
- Most suitable breeding habitat in the study area occurs outside of the construction footprint.
- Construction would be conducted outside of the breeding season, therefore avoiding impacts to the species lifecycle.
- Mitigation measures would be put in place to minimise and manage risks such as introduction and/or spread of invasive species and pathogens during construction.
- The proposal is unlikely to isolate the population, or create a permanent barrier that would fragment the population into two populations.

### ***Limosa lapponica baueri* (Bar-tailed Godwit)**

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

#### **Lead to a long-term decrease in the size of an important population of a species**

The Hunter Estuary was previously thought to be an internationally important site for the Bar-tailed Godwit, supporting more than 1% of the population. However, since 1997/98, the Hunter Estuary Wetland Ramsar site has not supported more than 1% of the population on a regular basis and is therefore not considered internationally important based on the 1% threshold definition.

However, large numbers of Bar-tailed Godwits are still recorded regularly within the Hunter Estuary such that the area at large is likely to represent an important site for the species. However, within the broader Hunter Estuary, Bar-tailed Godwits confine their foraging and roosting activities to the saline parts, particularly sites in and around the North Arm of the Hunter River. Kooragang Dykes and Stockton Sandspit regularly record the most numbers of individuals and are key foraging sites for the local population, with Windeyeres Reach the preferred nocturnal roost location. According to Herbert (2007) the Bar-tailed Godwit has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre). This is likely due to the species preference for large intertidal mudflats and sandflats, often with beds of seagrass. In contrast, Hexham Swamp for example, has undergone drainage works and closure of tidal floodgates that have prevented tidal inundation (Herbert, 2007), and potential habitat within the study area is therefore considered marginal for the species.

Although an important population of the Bar-tailed Godwit occurs in the locality, given the absence of records within the study area and low quality of the potential habitat that occurs there, the proposal is not predicted to result in a decrease to the size of the population.

## ***Limosa lapponica baueri* (Bar-tailed Godwit)**

### **Reduce the area of occupancy of an important population**

Within the 177.3 hectare study area, 75.2 hectares of potential Bar-tailed Godwit habitat occurs, associated with PCTs 1747, 1746, 1737 and 1808. The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation, of which 0.9 ha of native vegetation and 18.1 ha of exotic grassland intersect with important habitat mapping by OEH for the Bar-tailed Godwit. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. The exotic grassland is not considered suitable habitat for the Bar-tailed Godwit, which usually forages in soft substrate near the water edge or in shallow water associated with intertidal sandy or soft mud substrates (TSSC, 2016b).

Although the Hunter Estuary appears to support a large population of Bar-tailed Godwits, the species has not been recorded within the study area and adjacent important wetland sites (such as Hexham Swamp, Pambalong Nature Reserve or the Hunter Wetlands Centre) (Herbert, 2007). Although marginal potential foraging habitat exists within the study area, the absence of records and alteration to tidal regimes suggest that this habitat is of low quality to the species and they preferentially focus activities at other important sites within the Hunter Estuary (such as Stockton Sandspit and Fullerton Cove).

Given the Bar-tailed Godwit is not known to occupy the study area or adjacent important wetland sites, the proposal is not considered to reduce the area of occupancy available to the local population.

### **Fragment an existing important population into two or more populations**

Although a large population of Bar-tailed Godwit exists within the Hunter Estuary, the species has not been recorded within the study area and adjacent important wetland sites (such as Hexham Swamp, Pambalong Nature Reserve or the Hunter Wetlands Centre) (Herbert, 2007). Records of the species are concentrated east of the study area, primarily associated with the North Arm of the Hunter River.

Given the Bar-tailed Godwit is not known to occupy the study area or adjacent important wetland sites, the proposal is not considered to cause fragmentation to the local population.

### **Adversely affect habitat critical to the survival of a species**

Although marginal potential foraging habitat exists within the study area, the absence of records of the species in the subject site and its immediate surrounds, and alteration to tidal regimes suggest that this habitat is of low quality to the species and they preferentially focus activities at other important sites within the estuary (such as Stockton Sandspit and Fullerton Cove).

The habitat within the study area is therefore not considered habitat critical to the survival of the species and it is reasonable to conclude that the removal of 0.9 ha of native vegetation will not constitute an adverse impact to habitat critical to the survival of the Bar-tailed Godwit.

### **Disrupt the breeding cycle of an important population**

As the habitat is not considered critical habitat for the local population, and Bar-tailed Godwit has not been recorded using habitat associated with the study area or surrounding important wetland sites (Herbert, 2007), the proposal is not considered likely to disrupt the breeding cycle of the local population.

### ***Limosa lapponica baueri* (Bar-tailed Godwit)**

#### **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

As the habitat is not considered critical habitat for the local population, and the Bar-tailed Godwit has not been recorded using habitat associated with the study area or surrounding important wetland sites (Herbert, 2007), the proposal is not considered to alter the quality or extent of habitat for the species or cause it to decline.

#### **Result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat**

Foxes (*Vulpes vulpes*) were observed within the proposal area during field surveys. Given that existing tracks utilised by foxes already occur within the proposal area, it is unlikely that the proposal would increase the abundance of this species.

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus* sp. aggregate (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15). Of these, *Juncus acutus* (Sharp Rush), Alligator Weed and *Tradescantia fluminensis* (Trad) would have the highest effect on migratory species due to their capacity to change habitat conditions in aquatic and saline conditions.

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible.
- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas.
- Implementing soil erosion and sediment control measures.
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation.

Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds.

#### **Introduce disease that may cause the species to decline, or**

There are no diseases associated with the species that the proposal would likely introduce such that it would cause a decline.

#### **Interfere with the recovery of the species**

The proposal is not considered to result in a negative impact to the species or interfere with the recovery of the species as there are no anticipated impacts expected to the Bar-tailed Godwit.

## *Limosa lapponica baueri* (Bar-tailed Godwit)

### Conclusion of Assessment

- The Hunter Estuary is known to support a large number of Bar-tailed Godwit on a regular basis which are likely to constitute an important population of the species.
- Within the Hunter Estuary, the Bar-tailed Godwit population confines its activity to saline sites, particularly Stockton Sandspit and Fullerton Cover.
- According to Herbert (2007), the Bar-tailed Godwit has not been recorded at any of the significant wetlands associated with the study area (such as Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre).
- The absence of records of the species at these locations suggests habitat within the study area is low quality for the species, and individuals are unlikely to occur there.
- Removal of 0.9 ha of marginal potential habitat for the Bar-tailed Godwit is therefore unlikely to result in a significant impact to the species.

Considering all the above, the proposal is considered unlikely to have a significant impact on the Bar-tailed Godwit.



## Migratory species

The following assessment has been prepared for the following species:

- Latham's Snipe (*Gallinago hardwickii*)
- Marsh Sandpiper (*Tringa stagnatilis*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- Common Greenshank (*Tringa nebularia*)
- Glossy Ibis (*Plegadis falcinellus*)

All of the above species except the Glossy Ibis are regular, common or usual summer migrants to the Hunter Estuary (Herbert, 2007). All species except the Glossy Ibis do not breed in Australia. More information is provided below on important habitats for these species.

### **Latham's Snipe**

The Latham's Snipe spends most of its non-breeding in south-eastern Australia south of the Richmond River in NSW (DEE, 2019c). There have been no estimates of the number of locations in which Latham's Snipe occurs in Australia. Estimates of the number of locations are problematic, given that the species is highly mobile, will readily move between locations as conditions become more or less favorable, has a widespread distribution and, in wet years (when potentially many wetland areas are available), can have a widely dispersed population (DEE, 2019c). However, six important sites (i.e. supporting major populations) have been identified in Victoria, Tasmania and South Australia (DEE, 2019c). No important sites have been identified in NSW; however, the species is considered a significant species for the Hunter Estuary, as they have been regularly recorded at Pambalong Nature Reserve, Hexham Swamp and Hunter Wetlands Centre (Herbert, 2007).

### **Marsh Sandpiper**

Five important sites for the Marsh Sandpiper have been identified and these are all located in China. Three of these sites are important during northern migration and four during southern migration (DEE, 2019f). There are no important sites identified in Australia for the species, although the species is considered a significant species for the Hunter Estuary as they occur throughout the estuary in saline and peripheral freshwater sites (Herbert, 2007).

### **Sharp-tailed Sandpiper**

An estimated 85 000 Sharp-tailed Sandpipers occupy the East Asian-Australasian Flyway (EAAF) (DEE, 2019b). During the non-breeding season approximately 91% of the EAAF population occurs in Australia and New Zealand (DEE, 2019b). There are 39 important sites for this species identified in Australia (Bamford *et al.*, 2008); the Hunter Estuary, including Hexham Swamp, has not been identified as an important site for the species, although the Hunter Estuary is considered a key site for migratory shorebirds in general (DEE, 2019b), with large numbers often recorded in both fresh and saline habitats throughout the Hunter Estuary (Herbert, 2007).

### **Common Greenshank**

The EAAF population of the Common Greenshank is thought to be approximately 110 000, of which 18 000–19 000 spend the non-breeding season in Australia (DEE, 2019e). The Hunter Estuary is identified to be a site of international importance for the Common Greenshank with consistently high counts recorded from summer and winter surveys (Herbert, 2007; DEE, 2019e).

## Glossy Ibis

Glossy Ibis is an occasional visitor to the Hunter Estuary as it will move in response to good rainfalls; however, its core breeding areas are limited to (DEE, 2019d):

- Murray Darling Basin in northern New South Wales (NSW)
- Western Riverina of NSW/Victoria
- Wider south-east South Australia
- Channel Country of Queensland/South Australia (wetlands of the Bulloo, Diamantina and Georgina River systems, occasionally also Cooper Creek)
- Lower Ord/Keep Rivers of Western Australia and the Northern Territory

The Glossy Ibis is not known to breed in the Hunter Estuary and is treated as a bird of passage, with occurrence and numbers varying according to local and regional conditions (Herbert, 2007).

### Migratory Wetland Species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

**Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species**

All of these migratory species have been recorded within or adjacent to the study area, associated with important wetland areas including Pambalong Nature Reserve, Hexham Swamp and the Hunter Wetlands Centre. For many of these migratory species, that rely on suitable habitat to regain energy reserves for long-distance migrations, the nature of their records at these locations suggest the habitat is likely to be important.

However, the proposal is considered to have a minor impact on the habitat for these species. The total amount of vegetation subject to direct impacts (clearing) within the subject site has been reduced to 29.8 ha, comprising 26.5 ha of non-native vegetation and 3.3 ha of native vegetation. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site.

The proposal would, widen existing gaps in vegetation by up to six metres in areas where regrowth vegetation occurs. Habitat connectivity would be retained around the edges of the subject site. These impacts represent an increase in existing gaps and disturbances rather than novel impacts, and the resulting gaps in vegetation are likely to be readily traversed by these highly mobile species.

The proposal also has the potential to indirectly impact on aquatic habitats through alterations to hydrology, including changes to surface flows. These impacts have been considered during the design of the Richmond Vale Rail Trail and design features such as the construction of boardwalks over wetland areas have been proposed to maintain the current natural hydrology and reduce potential impacts.

The potential for hydrocarbon contamination or increased nutrient or sediment inputs would be avoided or minimised through the implementation of appropriate mitigation measures as outlined in Section 7.

## Migratory Wetland Species

### **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species,**

Foxes (*Vulpes vulpes*) were observed within the proposal area during field surveys. Given that existing tracks utilised by foxes already occur within the proposal area, it is unlikely that the proposal would increase the abundance of this species.

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus* sp. aggregate (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15). Of these, *Juncus acutus* (Sharp Rush), Alligator Weed and *Tradescantia fluminensis* (Trad) would have the highest effect on migratory species due to their capacity to change habitat conditions in aquatic and saline conditions.

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible.
- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas.
- Implementing soil erosion and sediment control measures.
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation.
- Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds.

### **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.**

The study area is not likely to support an ecologically significant proportion of the population of the above migratory species, except for Common Greenshank for which the Hunter Estuary is an important site.

For the Common Greenshank, the loss or modification of foraging and resting habitat is a key threat. The reason for this is that the species regularly flies for thousands of kilometres over some of the most densely populated areas of the world where there has been a lot of pressure on natural resources. This makes the species particularly susceptible to cumulative loss of habitat along its migration route (DEE, 2019e).

Other threats include silt/pollution, weed/pest invasion, and disturbance from human recreational activity.

The proposal would clear approximately 3.3 ha of native vegetation, including wetland habitats comprising suitable foraging habitat for the Common Greenshank. This habitat is along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site. The loss of habitat is therefore not considered likely to seriously

## Migratory Wetland Species

disrupt the feeding or resting behaviour of the Common Greenshank, or the remaining four migratory species assessed in this assessment.

The subject site occurs adjacent to wetlands that are recognised to be high value habitats for migratory wetland species both for foraging and breeding habitat. The proposal will mitigate and manage potential risks of siltation and pollution, and weed spread during construction, and maintain restrictions on dog access through the National Park.

The subject site currently comprises an existing track utilised by nearby landowners and local birdwatchers and therefore the migratory species utilising adjacent habitat are likely to be already habituated to disturbance from current human activity in the area. There are also regular visitors to the Hunter Wetland Centre, where the species is also known to forage.

Given the above, it is unlikely the proposal would have an adverse effect on the life cycle of any migratory species such that a viable local population would be placed at risk of extinction.

### Conclusion of Assessment

The proposal is unlikely to result in a significant impact on migratory species given that:

- The 3.3 ha of native vegetation being removed is considered marginal due to its location along the edge of the existing cleared areas previously subjected to disturbance associated with installation of the HWC Chichester rising main and Richmond Vale railway, and is therefore considered to be low value potential habitat in comparison to the broad extents of high quality habitat that exist throughout the Hunter Wetlands National Park and associated Hunter Estuary Ramsar site.
- The subject site contains an existing track that transects the wetland habitat that is currently utilised by nearby landowners and local birdwatchers, suggesting birds in the area may already be habituated to some human disturbance.
- Implementation of mitigation measures would reduce the potential for disturbance to these species and modification to habitat.

## Wetlands of international importance

### Wetlands of International Importance

An action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:

#### **Areas of the wetland being destroyed or substantially modified**

The Hunter Estuary Wetlands Ramsar Site (No. 24) is located at the Hunter Wetlands Centre site (see Figure 4-4). Within the Hunter Wetlands Centre, approximately 0.6 ha of native vegetation along the edges of an existing unsealed track will be removed or trimmed to accommodate the construction of the pathway. Approximately 0.2 ha of this vegetation represents rainforest or open forest types, with the remaining 0.4 ha representing wetland vegetation types (Swamp Forest PCT 1718, Swamp Oak Forest PCT 1727 and Typha Rushland PCT 1737).

The majority of wetland habitats that are present within the Ramsar site will not be directly removed by the proposal. The construction of the proposed pathway will involve implementation of mitigation measures under a CEMP to manage and minimise the risk of impacts from weeds, pollution, sedimentation etc. that could modify the nature of the wetland habitats within the Ramsar site.

#### **A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland**

The construction of the pathway within the Hunter Wetlands Centre (and hence the Ramsar site) will involve laydown of a sealed pathway along an existing track that is maintained as a walking track through the wetland centre. Whilst the existing track is not impermeable, it is relatively compacted to render it suitable as a walking track for the public; the creation of a hard stand walking track is considered unlikely to substantially increase the volume and velocity of surface run-off from the pathway such that it would result in a substantial change in the hydrological regime of the wetland within the Ramsar site.

#### **The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected**

Fauna species dependent upon the wetlands include a large diversity of wetland migratory bird species. Many of these species utilise the wetland for foraging, roosting and breeding habitat. Key threats include habitat loss, silt/pollution, weed/pest invasion, and disturbance from human recreational activity.

The proposal would clear approximately 0.6 ha of native vegetation, including 0.4 ha of wetland habitats. This habitat is along the edge of existing tracks maintained as a walking track for the public, and is therefore considered to be low value potential habitat in comparison to the wetland habitats maintained as part of the Hunter Wetlands Centre. The loss of habitat is therefore not considered likely to seriously disrupt the habitat or lifecycle of native species utilising these habitats.

The proposal will also mitigate and manage potential risks of siltation and pollution, and weed spread during construction, and maintain restrictions on dog access through the National Park.

The subject site currently comprises an existing track utilised by visitors to the centre and therefore the migratory species utilising adjacent habitat are likely to be already habituated to disturbance from current human activity in the area.

The following recommendations are considered necessary to protect migratory shorebird species during the construction phase of the proposal:

- Construction should be undertaken between the end of April and beginning of September when the majority of migratory birds are in the northern hemisphere within areas of potential shorebird habitat (chainages 5200 to 600 and the extension to Hunter Wetlands Centre)



## Wetlands of International Importance

**A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or**

A Sediment and Erosion Control Plan will be incorporated into the Construction Environmental Management Plan (CEMP) for the proposal. Specific sediment and erosion control measures during the construction phase to reduce impacts to water quality within the wetland include the following:

- Installation of erosion and sediment control measures prior to any works
- Regular inspection of erosion and sediment control measures, particularly following rainfall events, to ensure their ongoing functionality
- Stockpile management measures which minimise the potential for erosion and surface water runoff
- Construction and maintenance of silt fences to capture and isolate any surface water runoff
- Immediate removal offsite of excavated materials
- Specific measures will be incorporated into the CEMP to minimise the generation of dust and associated impacts on adjacent natural environment include the following:
  - Setting maximum speed limits for all traffic within the proposal area to limit dust generation
  - Use of a water tanker or similar to spray unpaved access tracks during the construction phase where required
  - Application of dust suppressants or covers on soil stockpiles
  - Stockpile management to limit the potential for dust generation
  - Specific measures will be incorporated into the CEMP to minimise the potential for chemical spills and associated impacts on adjacent natural environments include the following:
    - All chemicals must be kept in clearly marked bunded areas
    - Regularly inspect vehicles and mechanical plant for leakage of fuel or oil
    - No re-fuelling of vehicles, washing of vehicles or maintenance of vehicles and plant to be undertaken within 20 m of creeks

**An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.**

Four priority weeds under the *Biosecurity Act 2015* within the Hunter Region were identified within the study area. These include:

- *Lantana camara* (Lantana)
- *Senecio madagascariensis* (Fireweed)
- *Rubus fruticosus sp. aggregate* (Blackberry)
- *Alternanthera philoxeroides* (Alligator Weed)

A number of high threat weeds identified by OEH (2017a) have also been identified within the study area (Table 5-15).

A weed management sub-plan to prevent the spread of weeds will be included within the EMP, and would include measures to prevent the spread of weeds, including hygiene procedures for equipment used during the construction phase. The weed management plan would also include measures designed to mitigate edge effects that reduce impacts outside the footprint of the proposal (namely within surrounding retained vegetation). The aim of these measures would be to control the possible impacts at their source within existing weed infested areas and soften the edge between the earthworks and the retained native vegetation. Measures that would be adopted would include:

- Avoid stockpiling of materials adjacent to native vegetation wherever possible

### Wetlands of International Importance

- Avoid stockpiling of fill in areas of remnant vegetation but instead in adjacent already cleared areas
- Implementing soil erosion and sediment control measures
- Areas of vegetation to be retained should be demarcated to restrict access by site staff and machinery to remnant vegetation
- Undertake maintenance of silt fences and other mitigation measures to isolate runoff; and immediately rehabilitate disturbed vegetation to limit the potential for colonisation by weeds

#### **Conclusion of Assessment of Significance:**

The proposal is unlikely to result in a significant impact on wetlands of international importance given that:

- The proposal is appropriately located along an existing track to minimise the area of impact on native vegetation.
- The area of impact will be limited to approximately 0.6 ha of vegetation along the edges of the existing track.
- The proposal is unlikely to substantially change the hydrological regime of the Ramsar site.
- Measures are proposed to protect species and habitat associated with the wetlands.
- Measures are proposed to protect water quality within the wetlands.
- Measures are proposed to prevent the spread of invasive species within the wetlands.

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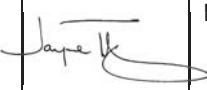

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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