Australian Government

BUILDING OUR FUTURE

NSW GOVERNMENT

M1 Pacific Motorway extension to Raymond Terrace

Environmental impact statement – Chapter 9: Biodiversity

Transport for NSW | July 2021

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9. Biodiversity

This chapter describes the potential biodiversity impacts that may be generated by the construction and operation of the project and presents the approach to the management of these impacts.

The desired performance outcomes for the project relating to biodiversity, as outlined in the SEARs, are to:

- Consider all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity
- Offsets are equivalent to any remaining impacts from construction and operation of the project
- Assure the delivery of offsets and /or supplementary measures required for the project.

Table 9-1 outlines the SEARs that relate to biodiversity, including the Commonwealth assessment requirements under the EPBC Act, and identifies where they are addressed in this EIS. The full assessment of biodiversity impacts is provided in the Biodiversity Assessment Report (BAR) (**Appendix I**).

Table 9-1 SEARs (biodiversity)

Secretary's requirement	Where addressed
1. Environmental Impact Assessment Process	
2. The project will impact matters of national environmental significance (MNES) protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and will be assessed in accordance with the NSW Bilateral Agreement (2015). The Proponent must assess impacts to MNES protected under the EPBC Act. The assessment must be in accordance with the requirements listed in Attachment A.	Impacts of the project on MNES are assessed in **Section 9.4.2** and **Section 9.4.3**. Attachment A requirements of the SEARs are detailed below (within this table).
4. Biodiversity	
1. The Proponent must assess biodiversity impacts in accordance with the Framework for Biodiversity Assessment (FBA) and be carried out by a person accredited in accordance with section 142B(1)(c) of the *Threatened Species Conservation Act 1995*.	The biodiversity impacts of the project are assessed in **Section 9.4.2** and **Section 9.4.3**. Impacts have been assessed in accordance with the FBA, as outlined in **Section 9.1** and **Section 9.2**.
2. The Proponent must assess any impacts on biodiversity values not covered by the FBA, as specified in section 2.3, including but not limited to aquatic biodiversity values covered by the *Fisheries Management Act 1994*, relating to aquatic species, riparian and marine vegetation, instream macrophytes and habitat condition.	Other impacts not covered by the FBA, including impacts to aquatic habitat, are discussed in **Section 9.4.2** and **Section 9.4.3**.
3. The Proponent must survey and assess impacts on EECs, threatened species and/or populations and provide the information specified in section 9.2 of the FBA. Species specific surveys shall be undertaken for those species and in accordance with the survey requirements specified by the OEH.	Information relating to surveys is provided in **Section 9.2.3.** Potential impacts on EECs, threatened species and/or populations are identified in **Section 9.4.2** and **Section 9.4.3**.
4. The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process (KTP) in accordance with the listings in the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).	Key threatening processes listed under legislation are discussed in **Section 9.4.2**.

Secretary's requirement	Where addressed
12. Socio-economic, land use and property	
5. The Proponent must undertake an assessment of biosecurity risks and management measures relating to the potential for spread of pests, disease or weeds, in accordance with the 'general biosecurity duty' under the *Biosecurity Act 2015*.	Existing weeds, pests and pathogens are discussed in **Section 9.3.8**. The potential risks of spread are discussed in **Section 9.4.2, Section 9.4.3** and **Section 14.4.2**.
17. Safety and risk	
2. The Proponent must assess the biosecurity risk of the project to minimise the inadvertent spread of disease and pathogens affecting agricultural activities, native vegetation and threatened fauna.	Impacts associated with the inadvertent spread of disease and pathogens on native vegetation and threatened fauna is discussed in **Section 9.4.2** and **Section 9.4.3**. Impacts to agricultural activities are discussed in **Chapter 22** (safety and risk).
Attachment A of the SEARs: Commonwealth (EPBC Act) General assessment requirements	
The EIS must address the matters outlined in Schedule 4 of the EPBC Act Regulations and the matters outlined below in relation to the controlling provisions. For each of the EPBC Act-listed species and ecological communities impacted by the proposed action, the EIS must provide:	The EIS has addressed the matters outlined in Schedule 4 of the EPBC Act Regulations (refer to **Appendix C**)
1. Survey results, including details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Commonwealth guidelines and policy statements. For ecological communities, this includes any condition thresholds provided in the listing advice or approved conservation advice.	A summary of the surveys is presented in **Section 9.2.3**. Further details of surveys such as timing, scope and methodologies are provided in the BAR (**Appendix I**).
2. A description and quantification of habitat in the study area (including suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advices, conservation advices and recovery plans, threat abatement plans.	A description of habitat within the study area is provided in **Section 9.3.** Further details are provided in the BAR (**Appendix I**).
3. Maps displaying the above information (specific to EPBC matters) overlaid with the proposed action. It is acceptable, where possible, to use the mapping and assessment of Plant Community Types (PCTs) and the species surveys prescribed by the BAM as the basis for identifying EPBC Act-listed species and communities. The EIS must clearly identify which PCTs are considered to align with habitat for the relevant EPBC Act-listed species or community and provide individual maps for each species or community.	The PCTs and threatened ecological communities within the construction footprint have been mapped in **Figure 9-5** and **Figure 9-6** respectively. **Table 9-6** identifies the PCTs that align with the threatened ecological communities. **Section 9.3.5** identifies habitat for threatened species listed under the TSC Act and the EPBC Act. Threated species recorded within and adjacent to the construction footprint are displayed on **Figure 9-7**. Individual maps are provided in the BAR (**Appendix I**).
4. Description of the nature, geographic extent, magnitude, timing and duration of any likely direct, indirect and consequential impacts on any relevant EPBC Act-listed species and communities. It must clearly identify the location and quantify the extent of all impact areas to each relevant EPBC Act-listed species or community.	Impacts to EPBC Act listed species and migratory species are summarised in **Section 9.4.2** and **Section 9.4.3**. Further details are provided in the BAR (**Appendix I**).

Secretary's requirement	Where addressed
5. Information on proposed avoidance and mitigation measures to deal with the impacts of the action, and a description of the predicted effectiveness and outcomes that the avoidance and mitigation measures will achieve.	Design refinements that have avoided or minimised potential impacts of the project are outlined in **Section 9.4.1**. Environmental management measures identified to minimise the biodiversity impacts of the project are presented in **Section 9.5**.
6. Quantification of the offset liability for each species and community significantly impacted, and information on the proposed offset strategy, including discussion of the conservation benefit for each species and community, how offsets will be secured, and the timing of protection. It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like-for-like'. Like-for-like includes protection of native vegetation that is the same ecological community or habitat being impacted (preferably in the same region where the impact occurs), or funding to provide a direct benefit to the matter being impacted e.g. threat abatement, breeding and propagation programs or other relevant conservation measures.	Quantification of offset liability is provided in **Section 9.6**. A Biodiversity Offset Strategy (BOS) has been prepared for the project (Appendix I of the BAR (**Appendix I**)).

9.1 Policy and planning setting

The biodiversity assessment for the project was facilitated under Clause 28 of the Biodiversity Conservation (Savings and Transitional) Regulation 2017, which permits the proponent to submit the application in accordance with the former planning provisions. This approach was approved by DPIE (formerly Department of Planning and Environment) on 13 November 2017. As such, the former provisions of the TSC Act remain in force for this assessment, rather than the *Biodiversity Conservation Act 2016* (BC Act). This includes the listing of threatened species and ecological communities as per the TSC Act, instead of the BC Act.

Biodiversity impacts have been assessed through implementation of the FBA (OEH 2014a) and with reference to the NSW Biodiversity offsets policy for major projects (OEH 2014b). For aquatic biodiversity impacts, the FBA refers to the requirements guided by the Fisheries NSW Policy and guidelines for fish habitat conservation and management (DPI 2013a).

The biodiversity assessment has been prepared by a person accredited in accordance with s142B(1)(c) of the TSC Act (accreditation number 179).

As described in **Section 2.2.2**, the project is a controlled action (under section 75 of the EPBC Act) due to its potential for significant impacts on listed threatened species and communities (section 18 and 18A of the EPBC Act). As such, the project requires assessment and approval under the EPBC Act.

The biodiversity assessment was prepared in accordance with the following relevant legislation, policy and guidelines:

- Legislation:
  - Biodiversity Conservation (Savings and Transitional) Regulation 2017
  - *Threatened Species Conservation Act 1995* (TSC Act)
  - *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
  - *Biodiversity Conservation Act 2016* (BC Act)
  - Bilateral agreement made under section 45 of the EPBC Act relating to environmental assessment between Commonwealth of Australia and the State of New South Wales
  - *Fisheries Management Act 1994* (FM Act)
  - State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP)
  - National Parks and Wildlife Regulation 2019.
- Guidelines:
  - Guideline for Biodiversity Offsets (Roads and Maritime Services 2016e)
  - Policy and guidelines for fish habitat conservation and management (DPI 2013a)
  - Aquatic Ecology in Environmental Impact Assessment – EIA guideline (Marcus Lincoln Smith 2003)
  - Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft 2004 (Department of Environment and Conservation 2004)
  - NSW Guide to Surveying Threatened Plants (OEH 2016a). This guideline has since been superseded by "Surveying threatened plants and their habitats – NSW survey guide for the Biodiversity Assessment Method" (DPIE 2020a). While flora surveys were completed before the updated guideline was published, the guidelines are considered to be generally consistent
  - Risk Assessment Guidelines for Groundwater Dependent Ecosystems (Kuginis et al. 2012)
  - Why do fish need to cross the road? Fish passage requirements for waterway crossings (Fairfull & Witheridge 2003)
  - NSW Biodiversity Offsets Policy for Major Projects (OEH 2014b)
  - Framework for Biodiversity Assessment (OEH 2014a)
  - Developments adjacent to NPWS: Guidelines for consent and planning authorities (NPWS 2020a). This guideline has superseded the "Guidelines for developments adjoining land and water managed by DECCW" (DECCW 2010b).

Further detail on the above legislation, policies and guidelines, and how they apply to the project, is provided in the BAR (**Appendix I**).

9.2 Assessment methodology

9.2.1 Study area

In accordance with the FBA, the study area for the biodiversity assessment is the area directly affected by the development and any additional areas likely to be affected, either directly or indirectly. For this assessment the study area is the construction footprint, as described in **Section 5.4.1**, and shown on **Figure 9-1**.

A wider study area was used to assess landscape values and native vegetation cover percentages. This wider study area comprised of a 550 metre buffer around the construction footprint, known as a 'landscape buffer' (**Figure 9-1**).

9.2.2 Desktop assessment

Background research

In July 2020, a default list of threatened flora and fauna species with the potential to occur within the study area (known as 'candidate species') was first identified using the assessment filtering tool in the BioBanking Credit Calculator (BBCC). A review was then conducted to identify possible additional candidate species using the following databases and literature sources:

- NSW BioNet Vegetation Classification database (DPIE 2020b)
- BioNet Atlas of NSW Wildlife
- BioNet Threatened Biodiversity Data Collection
- The federal Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE) (Australian Bureau of Meteorology 2020a)
- NSW Coastal Management State Environmental Planning Policy – interactive map viewer (DPIE 2020c)
- Soil Landscapes of the Newcastle 1:100,000 Sheet Map (Matthei 1995)
- Available regional vegetation mapping and previous biodiversity studies
- NSW Department of Primary Industries (DPI) Fisheries Spatial Data Portal
- The federal Department of Agriculture, Water and the Environment (formerly the Department of Environment) Protected Matters Search Tool (PMST)
- Department of Planning, Industry and Environment Area of Outstanding Biodiversity Value register
- Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) (Port Stephens Council and Australian Koala Foundation 2002)
- Hunter Wetlands National Park: Plan of Management (NPWS 2020b).

Additionally, the following spatial databases (using a 10 kilometre radius around the construction footprint) were also consulted:

- Lower Hunter Koala Study (Eco Logical Australia 2013) mapping of key habitat areas for the koala in the lower Hunter
- Grey-headed Flying-fox management strategy for the Lower Hunter (GeoLink 2013)
- Swift Parrots and Regent Honeyeaters in the Lower Hunter Region of New South Wales: An assessment of status identification of high priority habitats and recommendations for conservation (Birdlife Australia 2013).

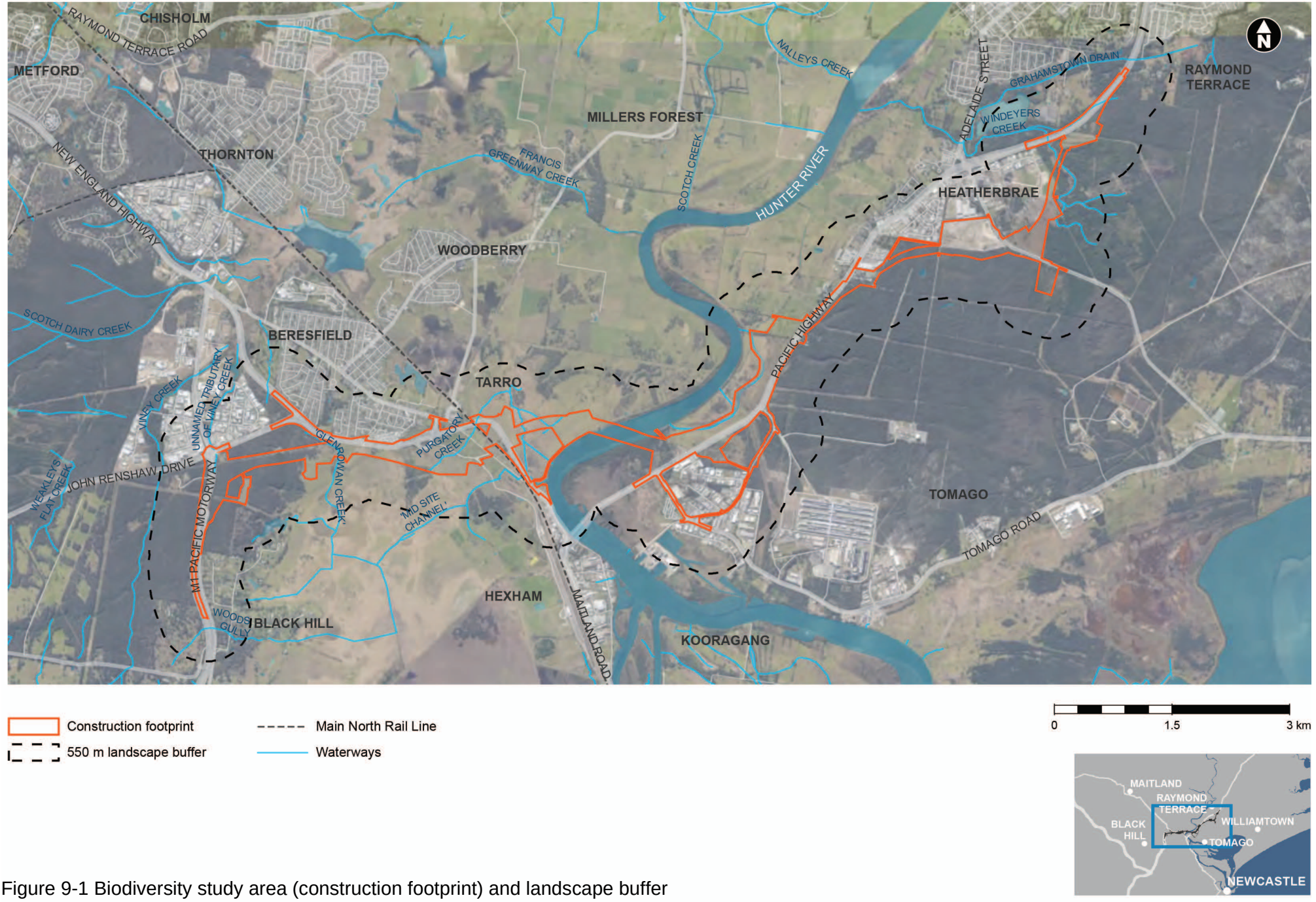

Figure 9-1 Biodiversity study area (construction footprint) and landscape buffer

Candidate species

Ecosystem credit species

The BBCC assessment tool identified 38 ecosystem credit species for consideration within the construction footprint. In assessing the likely presence of these species, the FBA allows an assessor to identify whether any of the habitat components for the predicted threatened species are present or not within the construction footprint.

The likelihood of occurrence for each species was then considered based on the presence of habitat components. The assessment identified 25 of the 38 ecosystem credit species initially identified by the BBCC with a likelihood to occur within the construction footprint. These species were targeted in field surveys discussed below.

Species credit species

The BBCC assessment tool identified, as a first filtering step, 24 species credit species to be assessed for potential presence, considering geographic and habitat constraints described for each species. From this, seven species were removed on the basis that specific habitat constraints were not present in the study area, and/or the species range occurred outside the study area. The remaining 17 species were considered in a second filtering step, by assessing the habitat present in the study area with the preferred habitat requirements of each species.

The BBCC identified an additional 19 species to be assessed in the second filtering step, due to known records of each species in a 10 kilometre radius of the study area, as determined by database searches and/or were identified in the SEARs.

The 36 identified species represent potential candidate species credits from the BBCC. A number of additional species credit species were not identified in the BBCC, although were identified from the background review of regional records and / or were identified in the SEARs (in correspondence with government agencies). Those species identified as having a moderate to high likelihood of occurring in the construction footprint were also considered candidate species and were targeted in field surveys.

9.2.3 Field surveys

Vegetation mapping

Field surveys were carried out within the construction footprint between 2014 and 2020 across multiple years, seasons and conditions, to identify and map vegetation communities and optimise candidate species (threatened species considered to have potential habitat present) surveys. Site value (i.e. vegetation condition) was assessed using data collected from 56 plots within the construction footprint, as shown on **Figure 9-5**. Surveys were carried out at an additional 10 plots in areas of non-native vegetation and vegetation outside of the construction footprint.

Targeted surveys

Targeted surveys were carried out between December 2014 and November 2018 for threatened flora and fauna species considered to have moderate to high likelihood of occurring within the construction footprint.

Targeted threatened flora

Targeted flora surveys for 20 candidate species were carried out and involved traversing parallel transects through potential habitat for target species within and around the construction footprint, in accordance with the relevant guidelines. Targeted threatened flora species are listed in **Table 9-2** and survey locations for threatened flora are provided in the BAR (**Appendix I**).

Table 9-2 Targeted threatened flora species

Scientific name	Common name	Conservation status	
		TSC Act	EPBC Act
Non-cryptic plant species			
Acacia bynoeana	Bynoe's Wattle	V	V
Asperula asthenes	Trailing Woodruff	V	V
Callistemon linearifolius	Netted Bottle Brush	V	-
Commersonia prostrata	Dwarf Kerrawang	E	E
Cynanchum elegans	White-flowered Wax Plant	E	E
Eucalyptus camfieldii	Camfield's Stringybark	V	V
Eucalyptus parramattensis subsp. decadens	Drooping Red Gum	V	V
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V
Maundia triglochinoides	-	V	-
Persicaria elatior	Tall Knotweed	V	-
Rhodamnia rubescens	Scrub Turpentine	CE	CE
Rhodomyrtus psidioides	Native Guava	CE	CE
Rutidosis heterogama	Heath Wrinklewort	V	V
Cryptic plant species			
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V
Diuris arenaria	Sand Doubletail	V	-
Diuris pedunculata	Small Snake Orchid	E	E
Diuris praecox	Rough Doubletail	V	V
Corybas dowlingii	Red Helmet Orchid	V	-
Pterostylis chaetophora	-	V	-
Rhizanthella slateri	Eastern Underground Orchid	V	E

Note: V = Vulnerable, E = Endangered, CE = Critically Endangered.

Targeted threatened fauna

Based on the desktop review, targeted fauna surveys for 24 candidate species were carried out using the following survey methods:

- Arboreal (tree-based) Elliot traps
- Terrestrial (ground-based) Elliot traps
- Pitfall trapping
- Camera trapping
- Nest boxes
- Harp traps
- Bat call recording
- Time and area-based bird surveys
- Walked and vehicle spotlighting transects
- Area-based frog searches/spotlighting/call playback
- Koala Rapid Assessment Method (KRAM).

Targeted threatened fauna species are listed in **Table 9-3** and survey locations are shown in **Figure 9-2**.

Table 9-3 Targeted threatened fauna species

Scientific name	Common name	Conservation Status	
		TSC Act	EPBC Act
Amphibians			
Litoria aurea	Green and Golden Bell Frog	E	V
Litoria brevipalmata	Green-thighed Frog	V	-
Crinia tinnula	Wallum Froglet	V	-
Uperoleia mahonyi	Mahoney's Toadlet	E (BC Act)	-
Birds			
Anthochaera phrygia	Regent Honeyeater	CE	CE
Pandion haliaetus	Eastern Osprey	V	-
Haliaeetus leucogaster	White-bellied Sea-Eagle	V (BC Act)	M
Ixobrychus flavicollis	Black Bittern	V	-
Botaurus poiciloptilus	Australasian Bittern	E	E
Ephippiorhynchus asiaticus	Black-necked Stork	E	-
Irediparra gallinacea	Comb-crested Jacana	V	-
Xenus cinereus	Terek Sandpiper	V	M
Mammals			
Phascolarctos cinereus	Koala	V	V
Petaurus norfolcensis	Squirrel Glider	V	-
Phascogale tapoatafa	Brush-tailed Phascogale	V	-
Cercartetus nanus	Eastern Pygmy Possum	V	-

Scientific name	Common name	Conservation Status	
		TSC Act	EPBC Act
Planigale maculata	Common Planigale	V	-
Pseudomys novaehollandiae	New Holland Mouse	-	V
Chalinolobus dwyeri	Large-eared Pied Bat	V	V
Miniopterus australis	Little Bent-winged Bat	V	-
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-
Myotis macropus	Southern Myotis	V	-
Pteropus poliocephalus	Grey-headed flying fox	V	V
Reptiles			
Hoplocephalus bitorquatus	Pale-headed Snake	V	-

Note: M = Migratory, V = Vulnerable, E = Endangered, CE = Critically Endangered.

All surveys were carried out under the appropriate licences, including scientific licences as required under Clause 22 of the National Parks and Wildlife Regulation 2002 (now superseded by the National Parks and Wildlife Regulation 2019), Section 132C (now repealed) of the *National Parks and Wildlife Act 1974* (License Number: SL100044) and Animal Care and Ethics approval and animal research authority 15/681 from DPI. A change to scientific licence as a result of superseded legislation is granted under Part 2 of the BC Act.

Koala

Surveys for the koala were carried out in 2016 and 2018. The key activities carried out were:

- Stratification of habitats by PCT with all forest habitats targeted
- Spotlighting including area based and transect surveys (walked and vehicle surveys)
- Call playback at the start of each spotlighting transect with the species call played for five minutes from a loud speaker
- Tracks, scats and scratches searches
- Identification of koala food tree species and densities.

Koala scat searches were conducted at 61 sites stratified across the construction footprint using the KRAM to target koalas and assess the quality of koala habitat. Surveys were carried out in 2016 and then each site was revisited again in 2018 (resulting in searches of 122 sites). Surveys involved sampling a radial plot randomly placed at the site and searching for scats, starting at a central tree and continuing until 20 trees were searched. Details of each tree species within the plot were recorded. Further information is provided in the BAR (**Appendix I**).

Aquatic surveys

The aquatic habitat assessment is based on aquatic assessments at monitoring sites, desktop review of available literature, threatened species distribution mapping (DPI 2016) and species sightings recorded in public databases. The location of aquatic monitoring sites is shown in **Figure 9-8**.

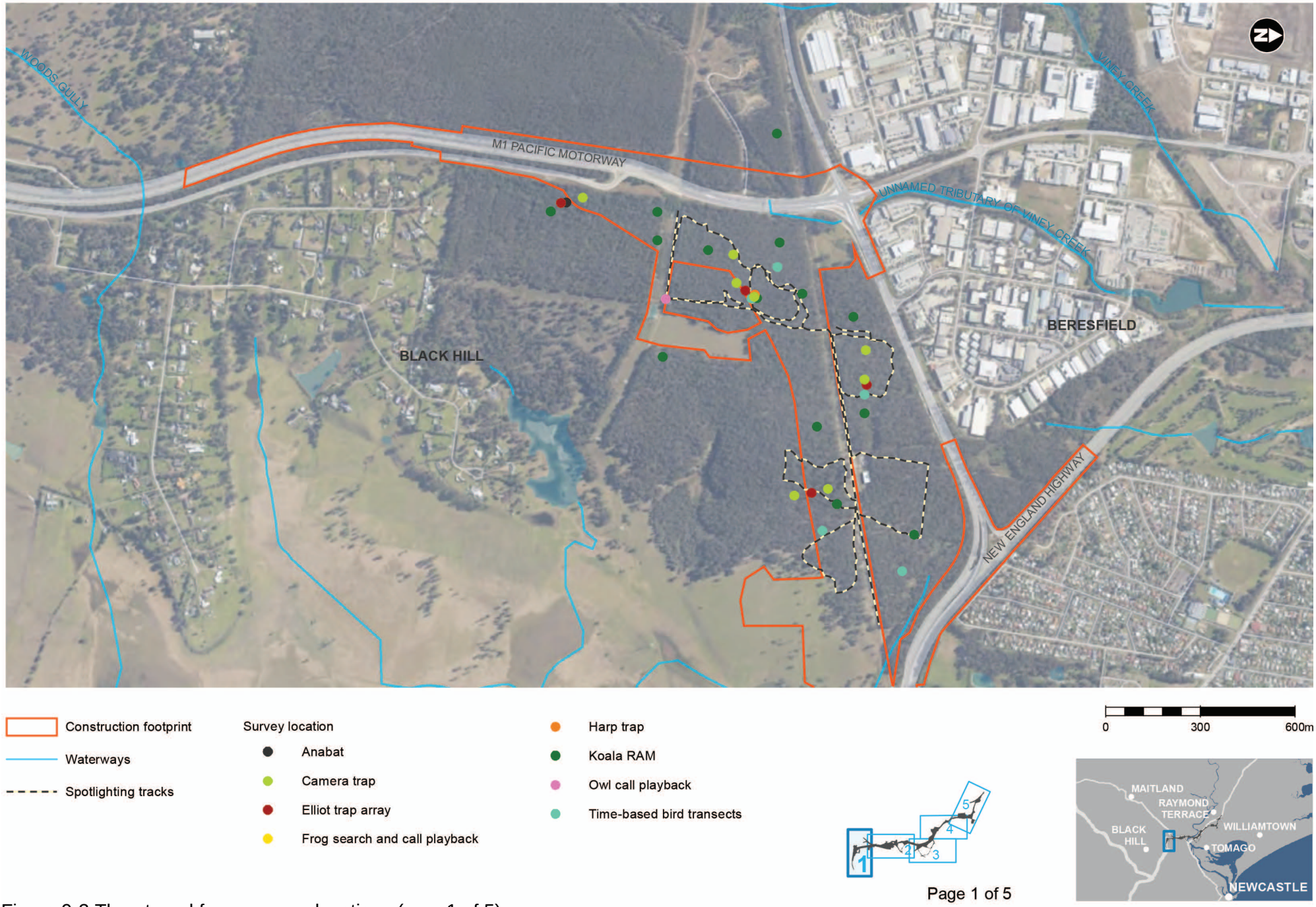

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Figure 9-2 Threatened fauna survey locations (map 1 of 5)

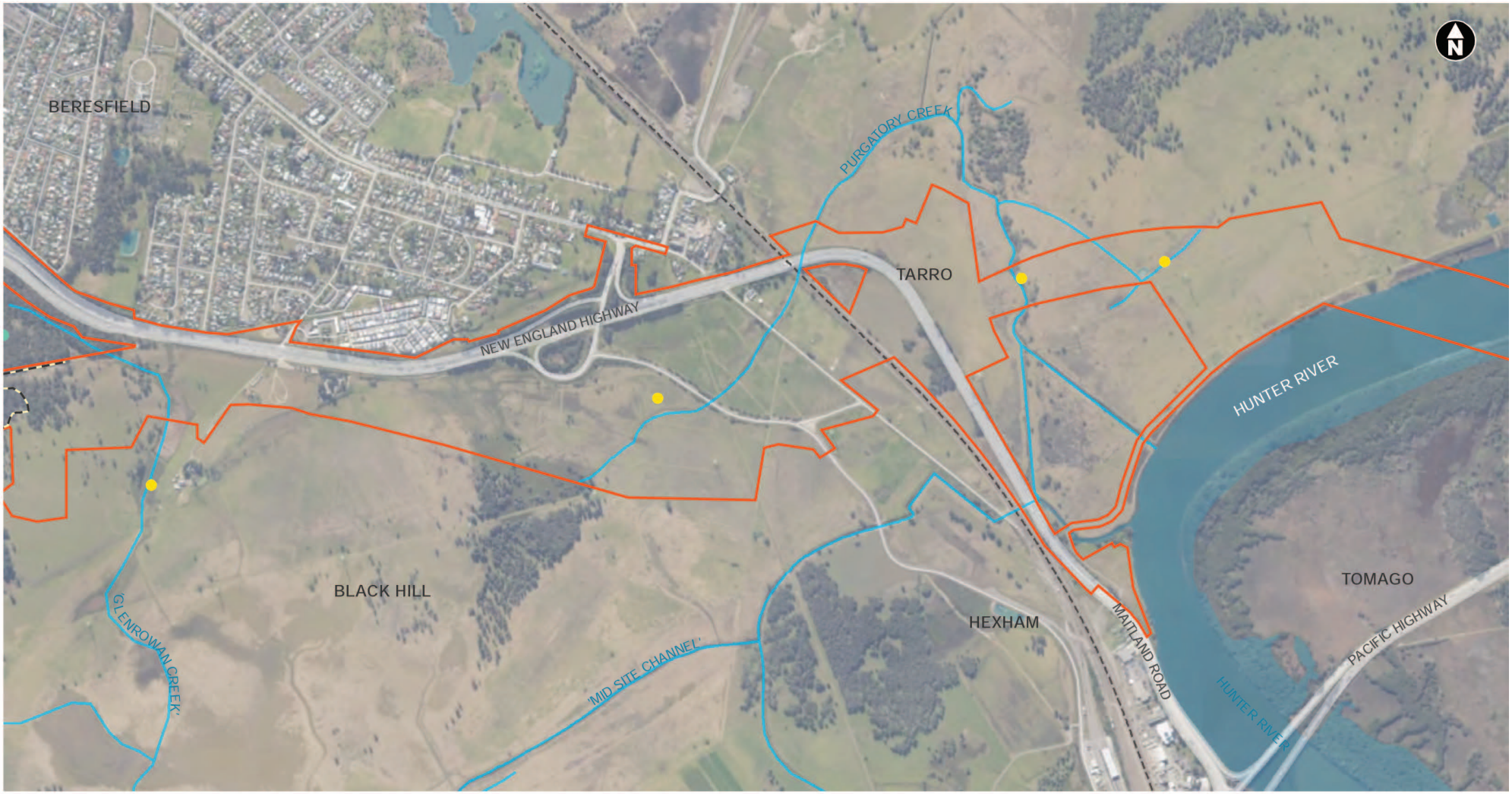

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Figure 9-2 Threatened fauna survey locations (map 2 of 5)

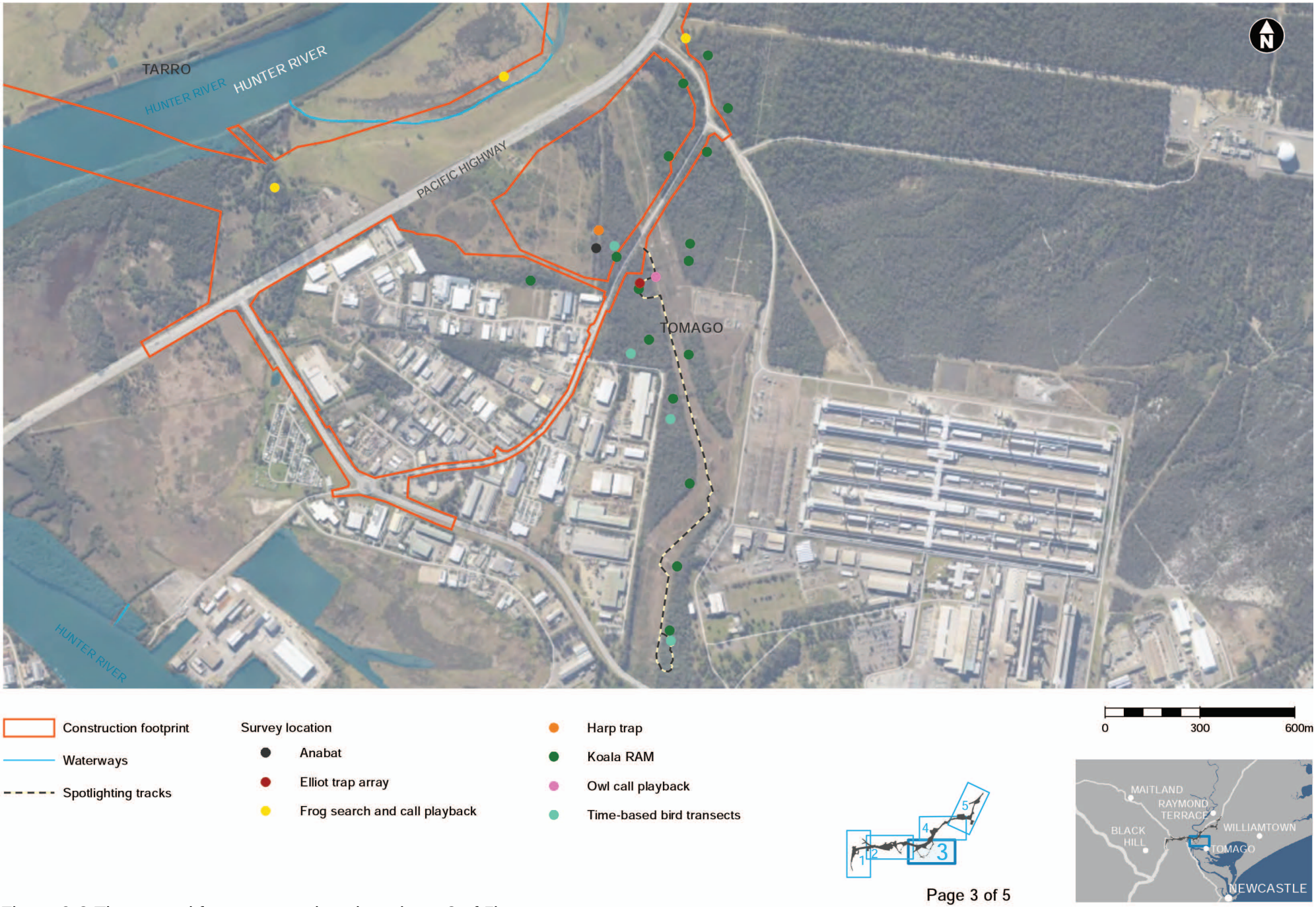

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Figure 9-2 Threatened fauna survey locations (map 3 of 5)

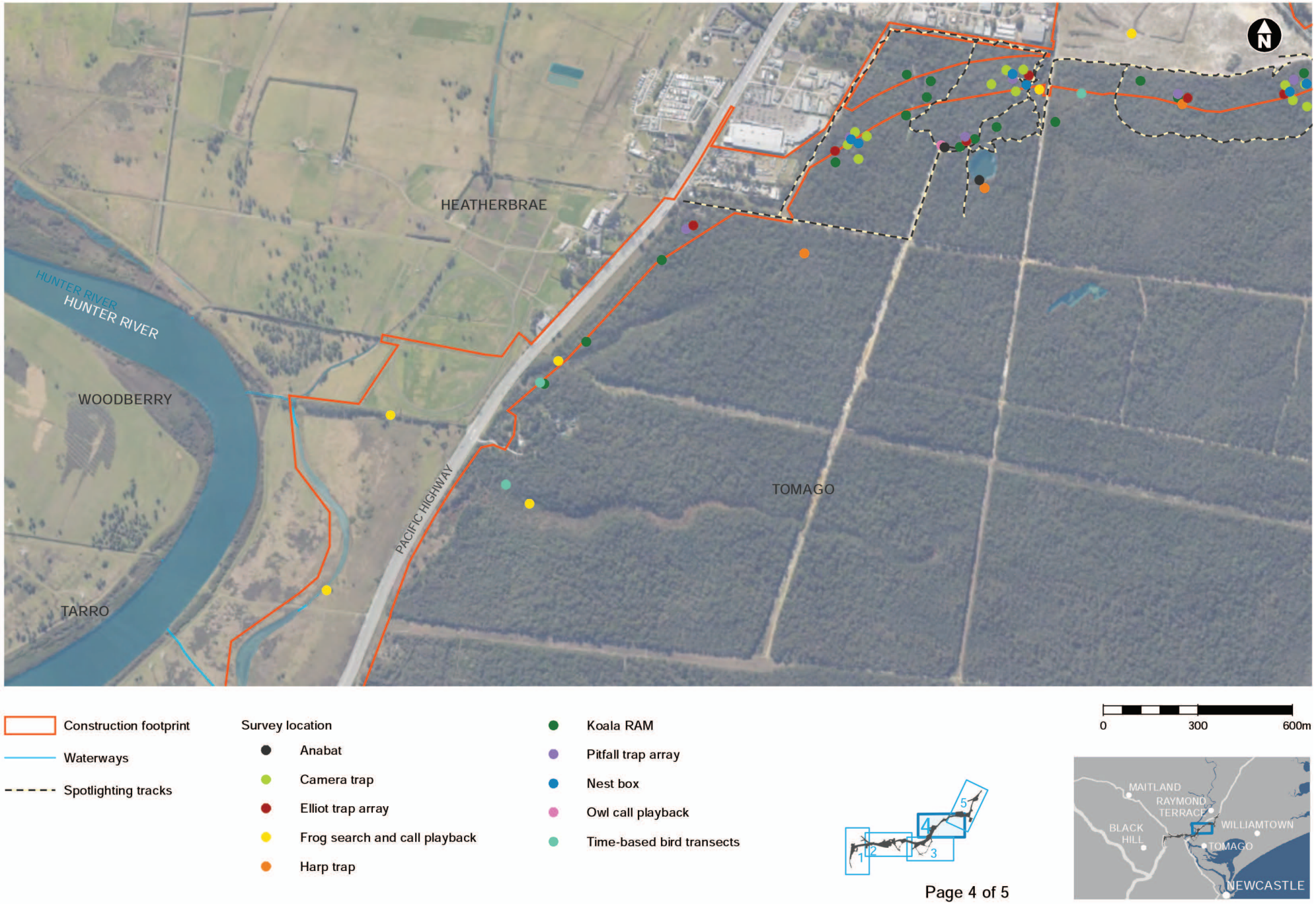

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Figure 9-2 Threatened fauna survey locations (map 4 of 5)

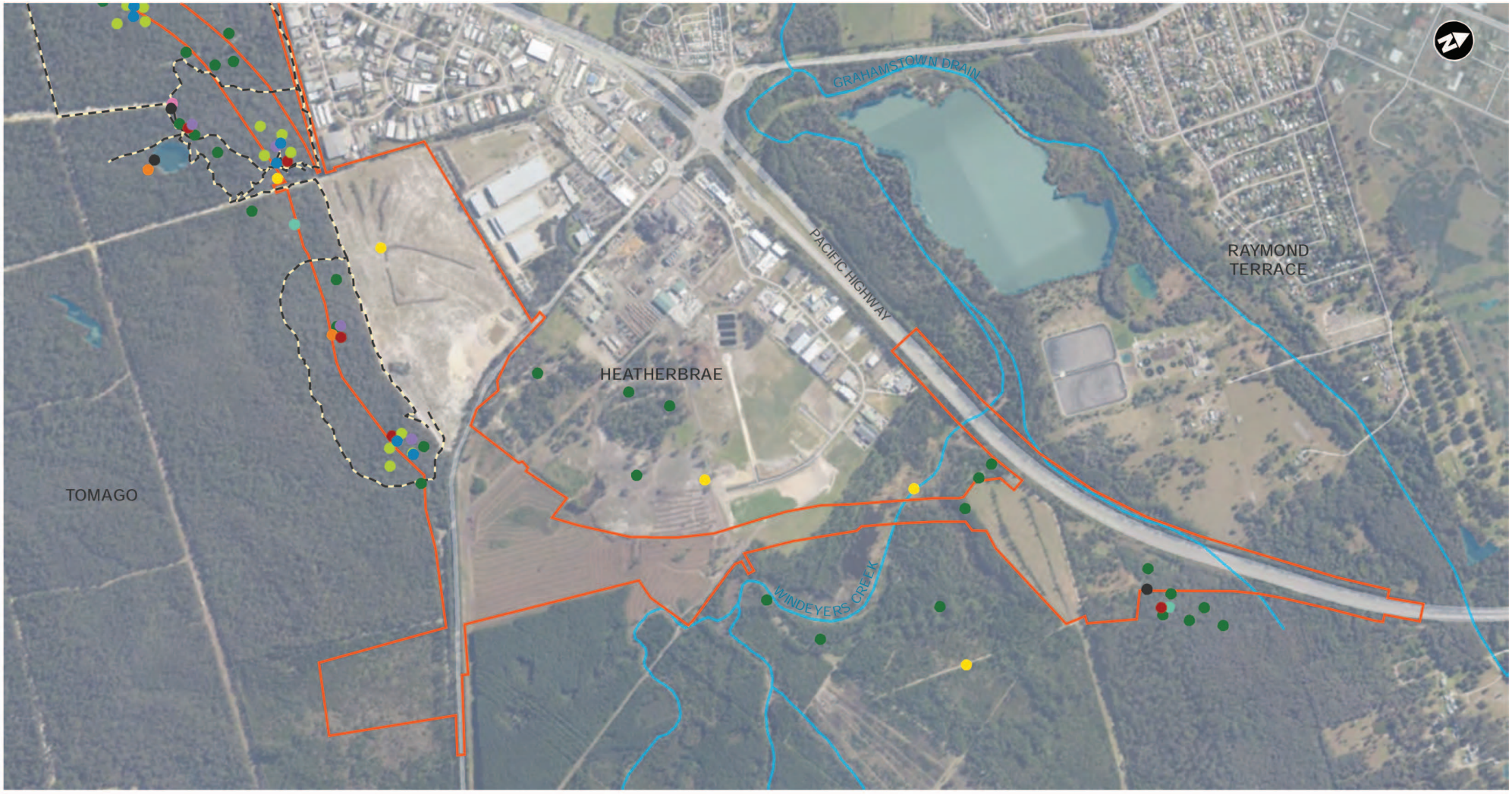

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Figure 9-2 Threatened fauna survey locations (map 5 of 5)

9.2.4 Key fish habitat

Habitat type and the waterway class were used to assess the functionality and determine the requirement to maintain long-term fish passage.

The Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013a) outlines the habitat types and sensitivity classes used for assessing potential impacts of certain activities and developments on key fish habitat types. These habitat types and waterway classifications are discussed in further detail in the BAR (**Appendix I**).

9.2.5 Biodiversity offsets

Under the FBA, residual impacts that cannot be avoided, minimised or mitigated, must be offset. The process for identifying the required offsets involved an accredited assessor using the BBCC with inputs from the field vegetation integrity assessment and area of confirmed habitat or number of individuals for threatened species impacted. Offsetting requirements under the FBA are discussed in **Section 9.6**.

9.3 Existing environment

9.3.1 Landscape features and values

The landscape features were determined in accordance with the requirements of the FBA. **Table 9-4** summarises the relevant biodiversity landscape features identified. Important wetlands, waterways and the existing BioBanking site are shown in **Figure 9-3**. Native vegetation extent and fauna corridors are shown in **Figure 9-4**.

Table 9-4 Biodiversity landscape features and values

Landscape feature/value	Description
Landscape features	
Interim Biogeographic Rationalisation for Australia bioregions and subregions	• Sydney Basin Bioregion (Hunter subregion) from Black Hill to Tomago • NSW North Coast Bioregion from Tomago to Heatherbrae.
NSW landscape Regions (Mitchell landscapes)	• Newcastle Coastal Ramp • Lower Hunter Channels and Floodplains • Sydney – Newcastle Barriers and Beaches.
Rivers and streams	The construction footprint is located within the Hunter River catchment and would traverse the Hunter River and its floodplain. The Hunter River catchment covers an area of about 22,000km^2 and is a major river in NSW. The confluence of the Williams River and the Hunter River is at Raymond Terrace about 1km upstream of the construction footprint. In addition to the Hunter River, the project would cross several waterways including: • A tributary of Viney Creek • 'Glenrowan Creek' (Note: this is an unnamed local tributary of Mid Site Creek and is referred to as Glenrowan Creek for ease of interpretation only) • Purgatory Creek • Hunter River • Windeyers Creek.

Landscape feature/value	Description
Wetlands and aquatic habitat	Aquatic habitats within the landscape buffer area include mangroves and saltmarsh, freshwater wetlands, ephemeral streams and drainage channels that are located on the floodplains and flow toward the Hunter River. Three waterways have been identified as key fish habitat (KFH) within the construction footprint (discussed further in **Section 9.3.6**): • Purgatory Creek (downstream of floodgates at junction with Hunter River) (Type 1 KFH) • Hunter River (Type 1 KFH) • Unnamed wetland listed under Coastal Management SEPP (Type 1 KFH).
	Three wetlands listed under the Coastal Management SEPP are located within the construction footprint: • South of the existing New England Highway at Tarro • On the western banks of the Hunter River • The eastern bank of the Hunter River, north of the Pacific Highway. Other Coastal Management SEPP coastal wetlands within 500m of the construction footprint are shown in **Figure 9-3**. Although not classified under the Coastal Management SEPP or a protected wetland, a wetland (referred to as the Hunter River wetland, site M12RT8) is located adjacent to the Hunter Region Botanic Gardens on the north-eastern side of the Hunter River. This wetland is considered likely to be supported by groundwater discharge and is likely to be a groundwater dependent ecosystem. Hexham Swamp Nature Reserve forms part of the floodplain environment on the southern side of the Hunter River. The Hexham Swamp Nature Reserve, and the surrounding wetland area, is classified as Coastal Wetland under the Coastal Management SEPP. The boundary of the Hexham Swamp Nature Reserve is located about two kilometres south of the construction footprint.
	The Hunter Estuary Wetlands Ramsar site is located within 10km of the construction footprint, and is comprised of: • Kooragang Nature Reserve (as part of the Hunter Wetlands National Park). The Reserve is located about 1.9km to the south-east of the construction footprint at its nearest point at Tomago Road. The reserve is located about 5.1km downstream of the proposed crossing of the Hunter River • Hunter Wetlands Centre Australia in Shortland located about 3.8km south of the construction footprint.
State, regional, local biodiversity links and connectivity value	No plan detailing regionally significant biodiversity links approved by the EES Group Chief Executive exists for the landscape buffer area and there are no state significant or regionally significant biodiversity links intersected by the construction footprint. However, the following corridors have been identified within the landscape buffer area: • The construction footprint is wholly within the Watagan to Stockton Green Corridor as identified in the Lower Hunter Regional Strategy (NSW Department of Planning 2006) • The northern portion of the construction footprint is within the regional corridor referred to as Richardson Road (Scotts 2003), which provides a link from the Hexham Swamp Nature Reserve north and east across the Hunter River to Grahamstown Dam • The Newcastle and Karuah-Hunter coastal climate change corridors (i.e. Newcastle and Karuah-Hunter) join at the Hunter River (DECC 2007a) and identify a north-south regional link traversing to the west of Newcastle within the construction footprint • The riparian buffer of the Hunter River (as a 6th order stream or greater) located in the construction footprint supports Mangrove and Swamp Oak forests as well as Coastal Saltmarsh.
Existing BioBanking sites	The construction footprint impacts on about 0.6ha of a site with an existing BioBanking Agreement, located around the Hunter Region Botanic Gardens and east of the existing Pacific Highway. The entire BioBanking site is around 106ha in size.

Landscape feature/value	Description
Landscape values	
Native vegetation extent	The landscape buffer comprises a mix of remnant native vegetation, planted (exotic) vegetation and modified and cleared land used for agriculture. Existing native vegetation cover in the landscape buffer assessment area is estimated at 1,277ha (43.79 per cent).
Patch size	The average patch size score for the vegetation in the construction footprint is 11.7ha (the average of the patch scores for the three NSW (Mitchell) Landscapes).
Area to perimeter ratio	Linear projects are required to assess the change in area to perimeter ratio of vegetation patch size areas that are impacted by the project in accordance with the FBA. The BAR identified a proportional change in area to perimeter ratio of 14 per cent. The patch area to perimeter ratio increases after the development, caused by a reduction in the area of the patches, but an increase in perimeter as a result of fragmentation in some areas.

Hunter Valley Flood Mitigation Scheme

Hunter Valley Flood Mitigation Scheme provides flood protection to people, property and infrastructure across the Hunter floodplain. The scheme is managed by DPIE with support from Hunter Local Land Services and is subject to periodic maintenance and reviews. The scheme includes levees, spillways, control banks, floodgates on drainage channels and waterways directly connected to the Hunter River. The floodgates in the vicinity of the project are shown on **Figure 9-8**. The floodgates have significantly altered tidal processes including tidal flushing on the floodplain, movement of salt and freshwater between the Hunter River and its tributaries and has removed the ability for species migration upstream in the local waterways.

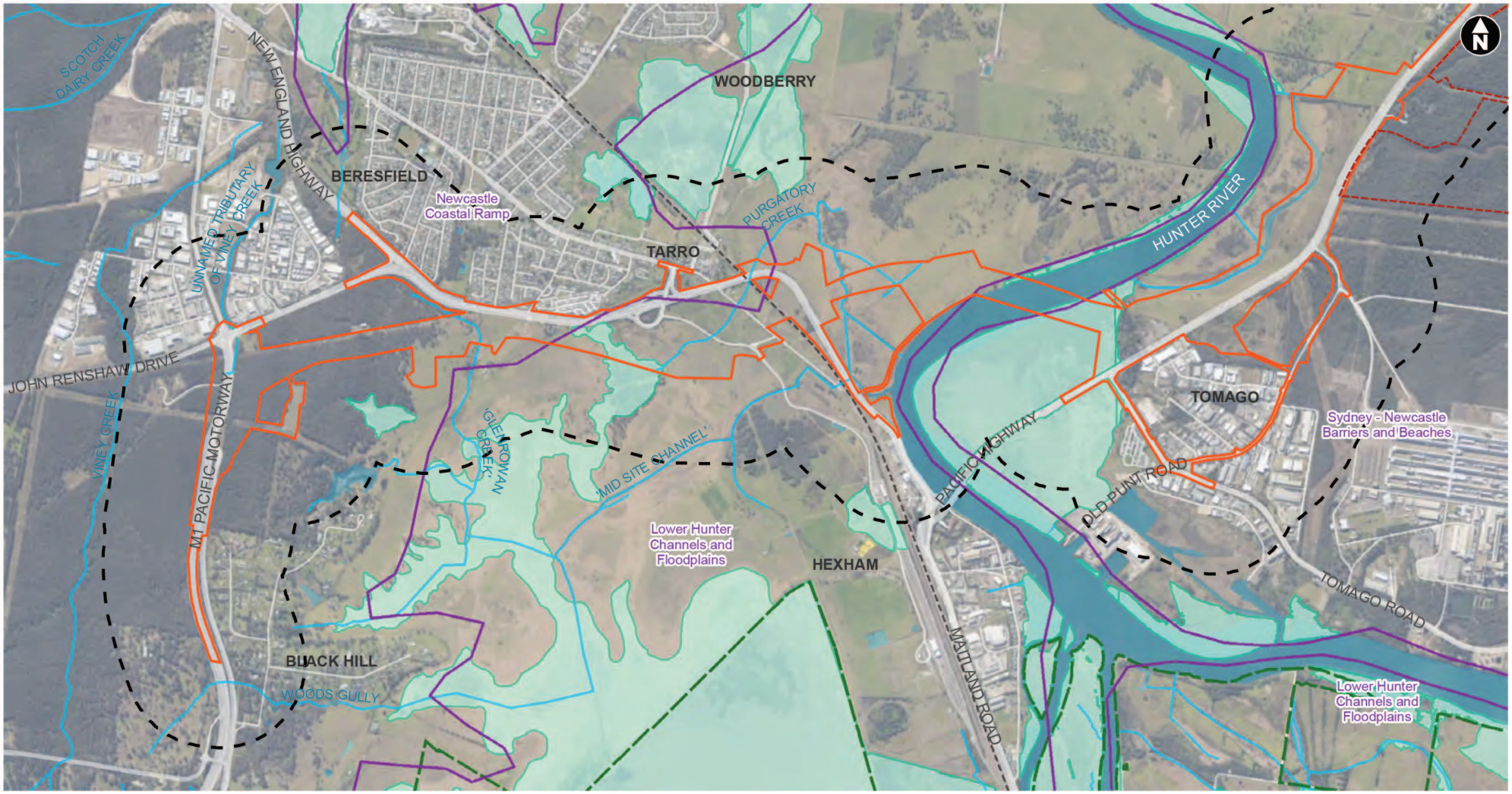

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Figure 9-3 National parks and coastal wetlands (map 1 of 2)

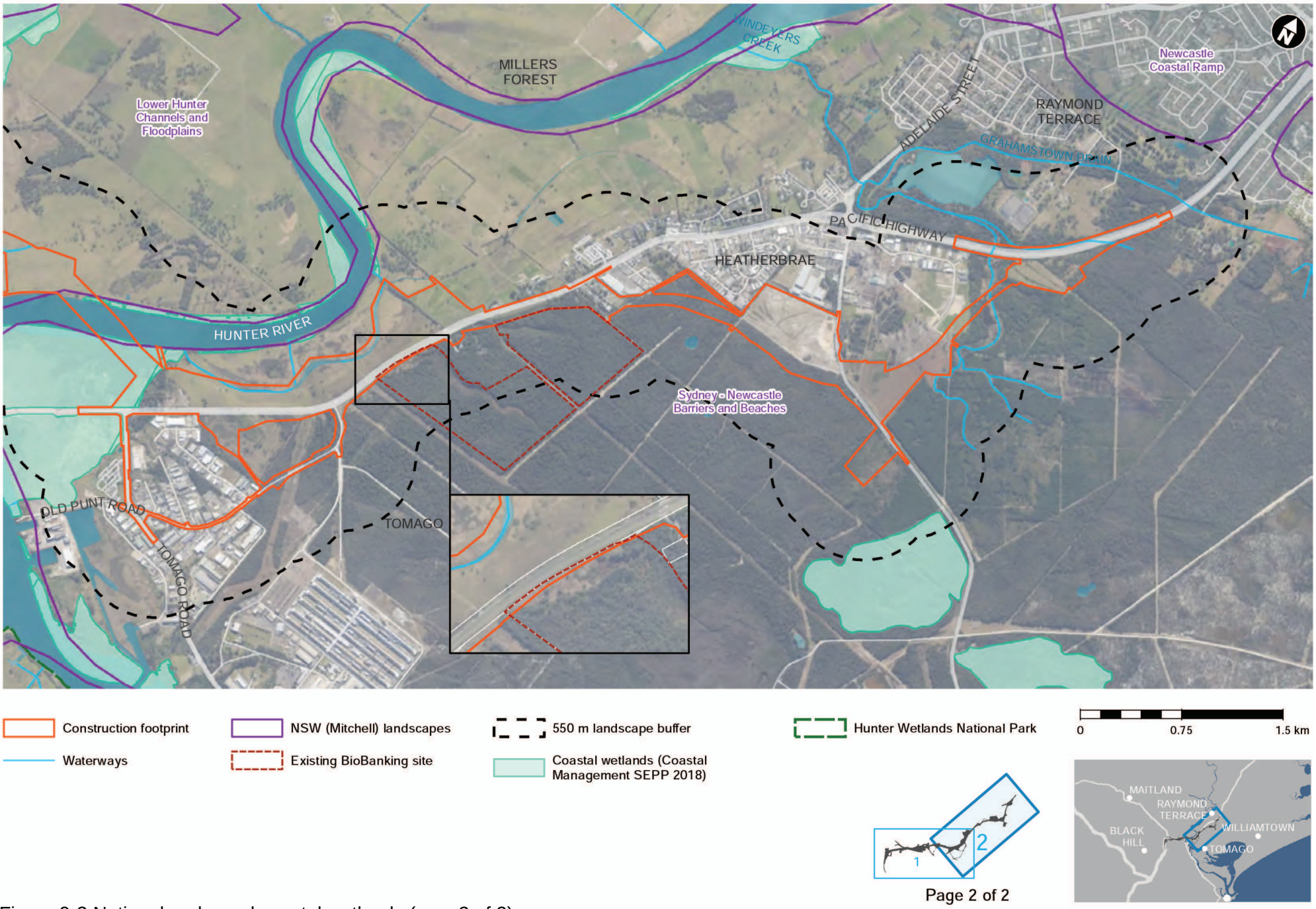

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Figure 9-3 National parks and coastal wetlands (map 2 of 2)

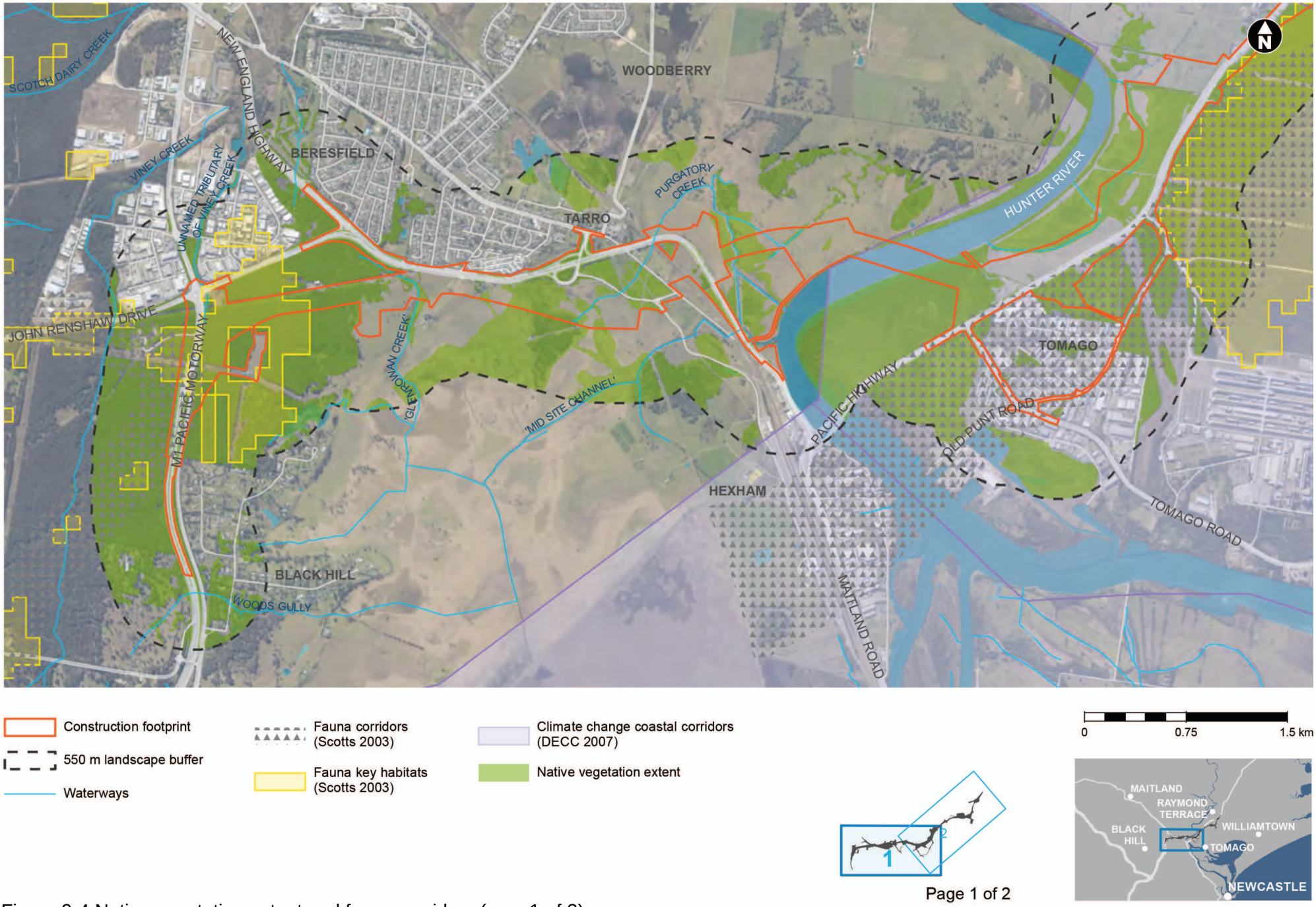

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Figure 9-4 Native vegetation extent and fauna corridors (map 1 of 2)

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Figure 9-4 Native vegetation extent and fauna corridors (map 2 of 2)

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9.3.2 Native vegetation

Following desktop review and detailed field surveys, 14 PCTs were identified within the construction footprint, that were then assigned into 21 vegetation zones according to their condition, consistent with the NSW BioNet Vegetation Classification Database.

Table 9-5 provides a summary of the PCTs and vegetation zones identified within the construction footprint (shown on **Figure 9-5**). The corresponding Biometric Vegetation Type code (BVT) is also provided for consistency with the BioBanking Credit Calculator (BBCC). The area of non-native vegetation within the construction footprint is also presented in the table below. Full details on the floristic and structural condition of each vegetation zone are provided in the BAR (**Appendix I**).

Table 9-5 PCTs identified within the construction footprint

PCT No.	Plant community type (PCT) (BVT)	Vegetation zone	Area within construction footprint (ha)
1590	Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest of the Lower Hunter (HU804)	1. Good	25.16
		2. Moderate	8.35
		3. Regenerating	8.37
1588	Grey Ironbark – Broad-leaved Mahogany – Forest Red Gum shrubby open forest on Coastal (HU802)	4. Moderate	6.78
		5. Regenerating	0.82
1646	Smooth-barked Apple – Blackbutt – Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (HU860)	6. Good	20.76
		7. Poor	7.83
1649	Smooth-barked Apple – Red Mahogany – Swamp Mahogany – *Melaleuca sieberi* heathy swamp woodland of coastal lowlands (HU863)	8. Good	1.36
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter (HU812)	9. Poor	0.45
1716	Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast (HU930)	10. Good	1.82
1717	Broad-leaved Paperbark – Swamp Mahogany – Swamp Oak – Saw Sedge swamp forest of the Central Coast and Lower North Coast (HU931)	11. Good	3.85
		12. Poor	6.64
1724	Broad-leaved Paperbark – Swamp Oak – Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (HU938)	13. Good	1.61
1727	Swamp Oak – Sea Rush – *Baumea juncea* swamp forest on coastal lowlands of the Central Coast and Lower North Coast (HU941)	14. Moderate	8.76
1736	Water Couch – Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (HU950)	15. Good	33.23
		16. Moderate	25.81
1742	Jointed Twig-rush sedgeland (HU956)	17. Good	1.45
1071	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (HU673)	18. Good	7.71

PCT No.	Plant community type (PCT) (BVT)	Vegetation zone	Area within construction footprint (ha)
1746	Saltmarsh Estuarine Complex (HU960)	19. Good	1.26
1747	Grey Mangrove low closed forest (HU961)	20. Good	2.04
		21. Moderate	0.23
Subtotal			**174.29**
N/A	Planted native vegetation	N/A	13.04
N/A	Pine plantation	N/A	25.87
N/A	Exotic vegetation	N/A	1.86
Total			**215.06**

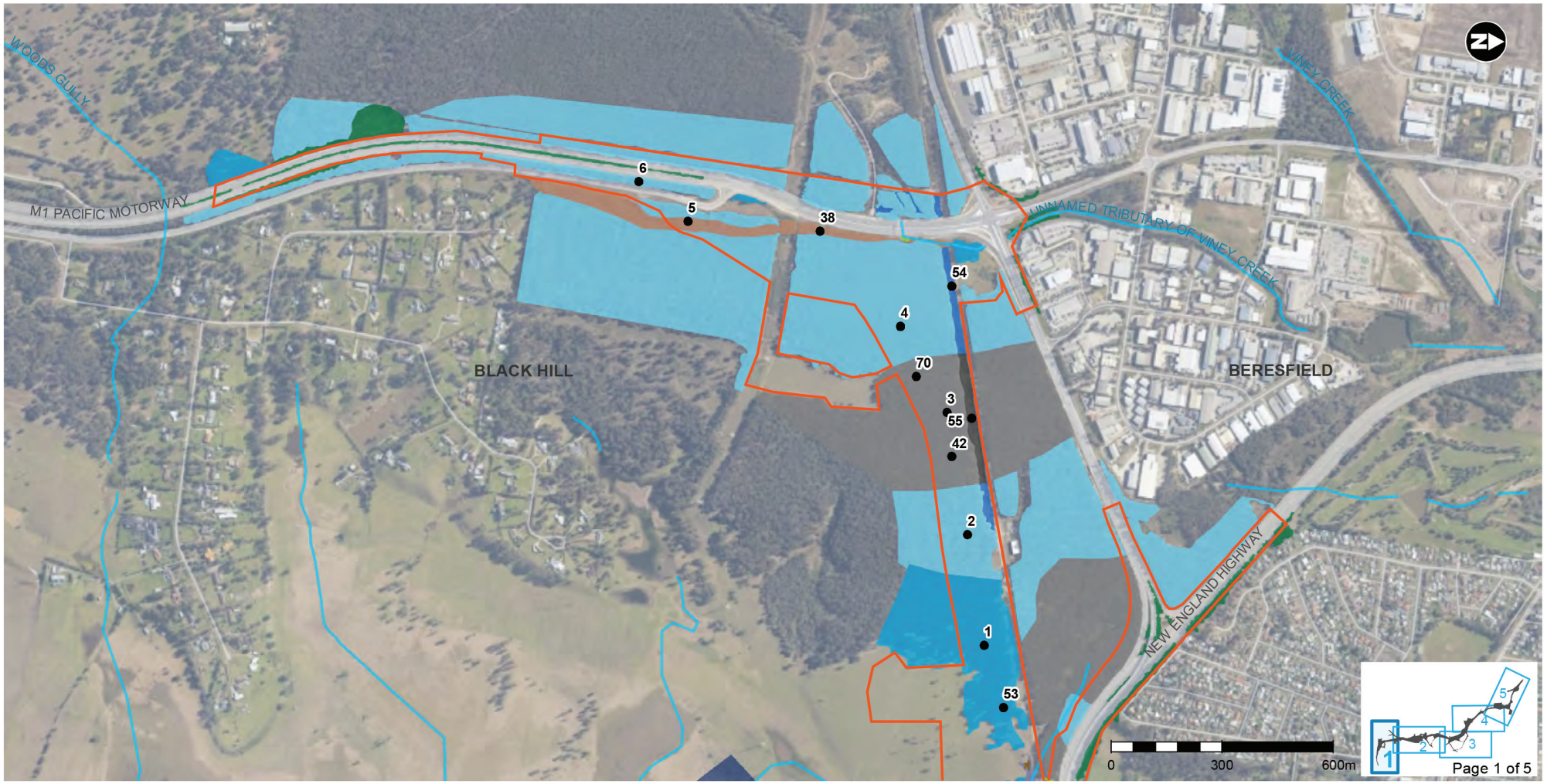

Figure 9-5 Plant Community Types, condition and vegetation survey locations (map 1 of 5)

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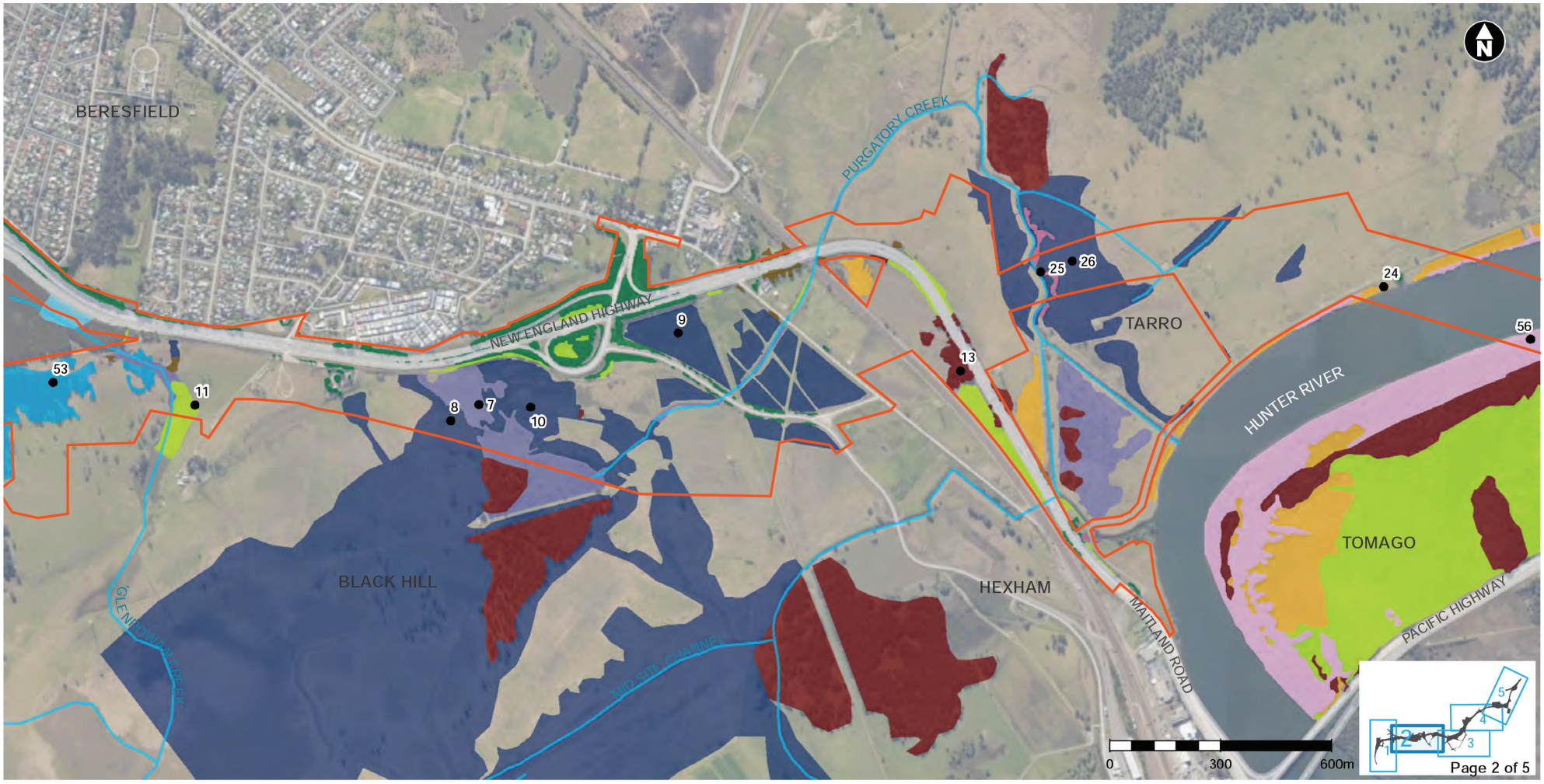


Figure 9-5 Plant Community Types, condition and vegetation survey locations (map 2 of 5)

Date: 9/12/2020 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Biodiversity_Assessment\IA230000_CD_BAR_006_VegPCTs_JAC_A4L_15000_V03.mxd

Construction footprint
Waterways
Plots
Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast (1717). Good - zone 11
Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1724). Good - zone 13
Forest Red Gum grassy open forest on floodplains of the lower Hunter (1598). Good
Forest Red Gum grassy open forest on floodplains of the lower Hunter (1598). Moderate - zone 9
Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast (1588). Moderate - zone 4
Grey Mangrove low closed forest (1747). Good - zone 20
Grey Mangrove low closed forest (1747). Moderate - zone 21
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion (1071). Good - zone 18
Planted native vegetation
Saltmarsh Estuarine Complex (1746). Good - zone 19
Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646). Good - zone 6
Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (1590). Good - zone 1
Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (1590). Moderate - zone 2
Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest (1590). Regenerating - zone 3
Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1727). Moderate - zone 14
Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (1736). Good - zone 15
Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (1736). Moderate - zone 16

Note: Areas within the construction footprint that are not mapped have been cleared and at the time of survey did not constitute native vegetation

Figure 9-5 Plant Community Types, condition and vegetation survey locations (map 3 of 5)

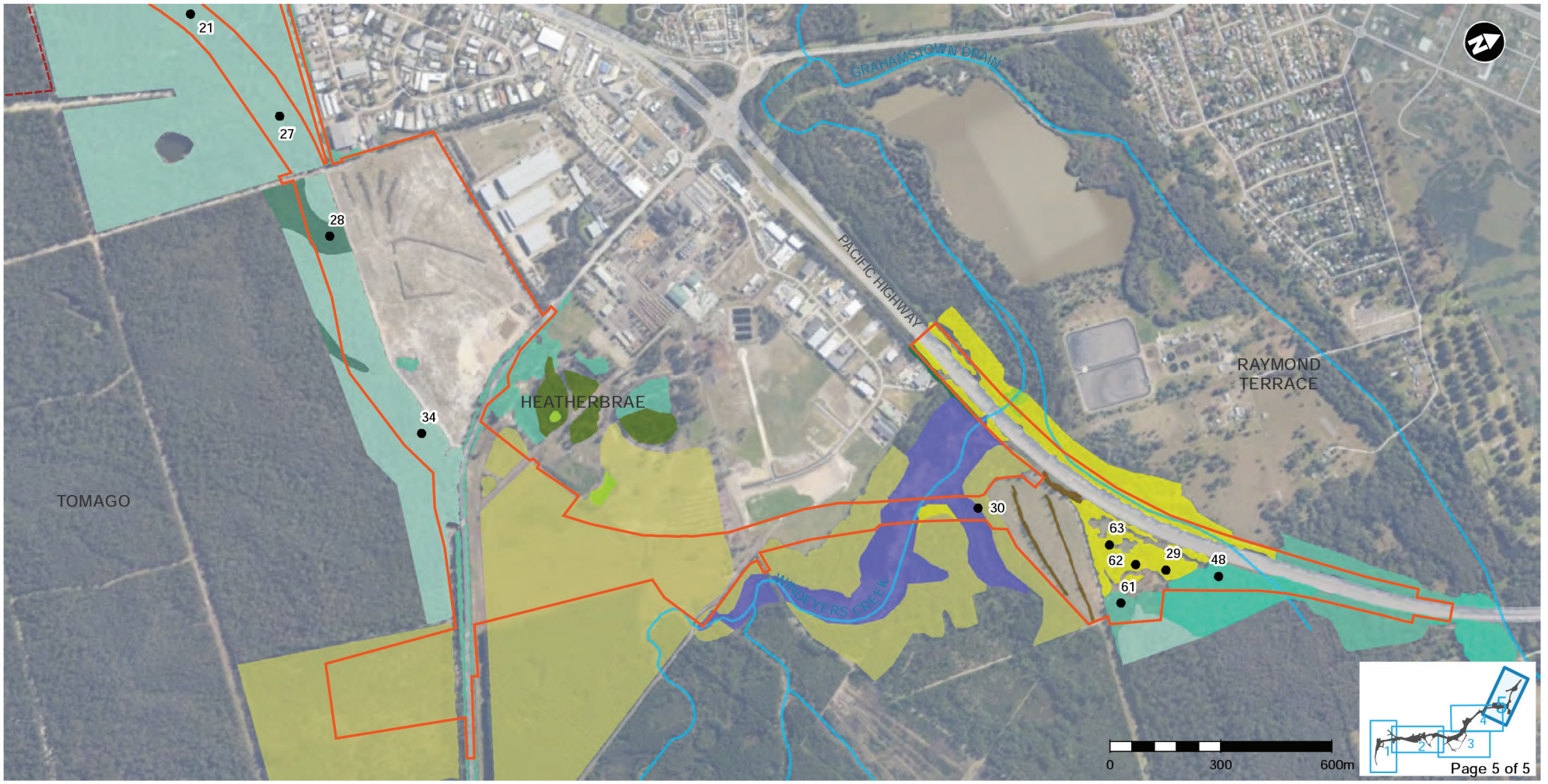
Date: 9/12/2020 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Biodiversity_Assessment\IA230000_CD_BAR_006_VegPCTs_JAC_A4L_15000_V03.mxd

Construction footprint
Existing BioBanking Site
Waterways
Plots
Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast (1717). Good - zone 11
Non-native woody vegetation
Forest Red Gum grassy open forest on floodplains of the lower Hunter (1598). Moderate - zone 9
Jointed Twig-rush sedgeland (1742). Good - zone 17
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion (1071). Good - zone 18
Planted native vegetation
Saltmarsh Estuarine Complex (1746). Good - zone 19
Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646). Good - zone 6
Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646). Poor - zone 7
Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowlands (1649). Good - zone 8
Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1727). Moderate - zone 14
Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (1736). Good - zone 15
Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (1736). Moderate - zone 16

Note: Areas within the construction footprint that are not mapped have been cleared and at the time of survey did not constitute native vegetation.

Figure 9-5 Plant Community Types, condition and vegetation survey locations (map 4 of 5)

Date: 9/12/2020 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Biodiversity_Assessment\IA230000_CD_BAR_006_VegPCTs_JAC_A4L_15000_V03.mxd



Construction footprint
Existing BioBanking Site
Waterways
Plots
Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast (1717). Good - zone 11
Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast (1717). Poor - zone 12
Non-native woody vegetation
Forest Red Gum grassy open forest on floodplains of the lower Hunter (1598). Disturbed
Jointed Twig-rush sedgeland (1742). Good - zone 17
Phragmites australis and Typha orientalis coastal freshwater wetlands of the Sydney Basin Bioregion (1071). Good - zone 18
Pine plantation
Planted native vegetation
Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646). Good - zone 6
Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646). Poor - zone 7
Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowlands (1649). Good - zone 8

Note: Areas within the construction footprint that are not mapped have been cleared and at the time of survey did not constitute native vegetation.

Figure 9-5 Plant Community Types, condition and vegetation survey locations (map 5 of 5)

Date: 9/12/2020 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Biodiversity_Assessment\IA230000_CD_BAR_006_VegPCTs_JAC_A4L_15000_V03.mxd

9.3.3 Threatened ecological communities

Eleven of the 14 PCTs identified within the construction footprint correspond with six Threatened Ecological Communities (TECs) listed under the TSC Act. **Table 9-6** summarises the corresponding PCTs for each TEC listed under the TSC Act and provides the area within the construction footprint.

In addition, 0.55 hectares of PCT 1746 (Saltmarsh Estuarine Complex) is also consistent with the listed Subtropical and Temperate Coastal Saltmarsh community, listed as vulnerable under the EPBC Act. This is described further in **Table 9-11**.

The location and distribution of TECs is shown in **Figure 9-6**. A description of each TEC is provided in the BAR (**Appendix I**).

Table 9-6 TECs present within the construction footprint

TEC	TSC Act Status	Corresponding PCT	Area within construction footprint (ha)
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregion	Endangered	1746	1.26
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	1742, 1071, 1736	68.18
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Endangered	1598	0.45
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	Endangered	1590	41.88
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	1727	8.76
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	1649, 1716, 1717, 1724	15.28
Total			**136**

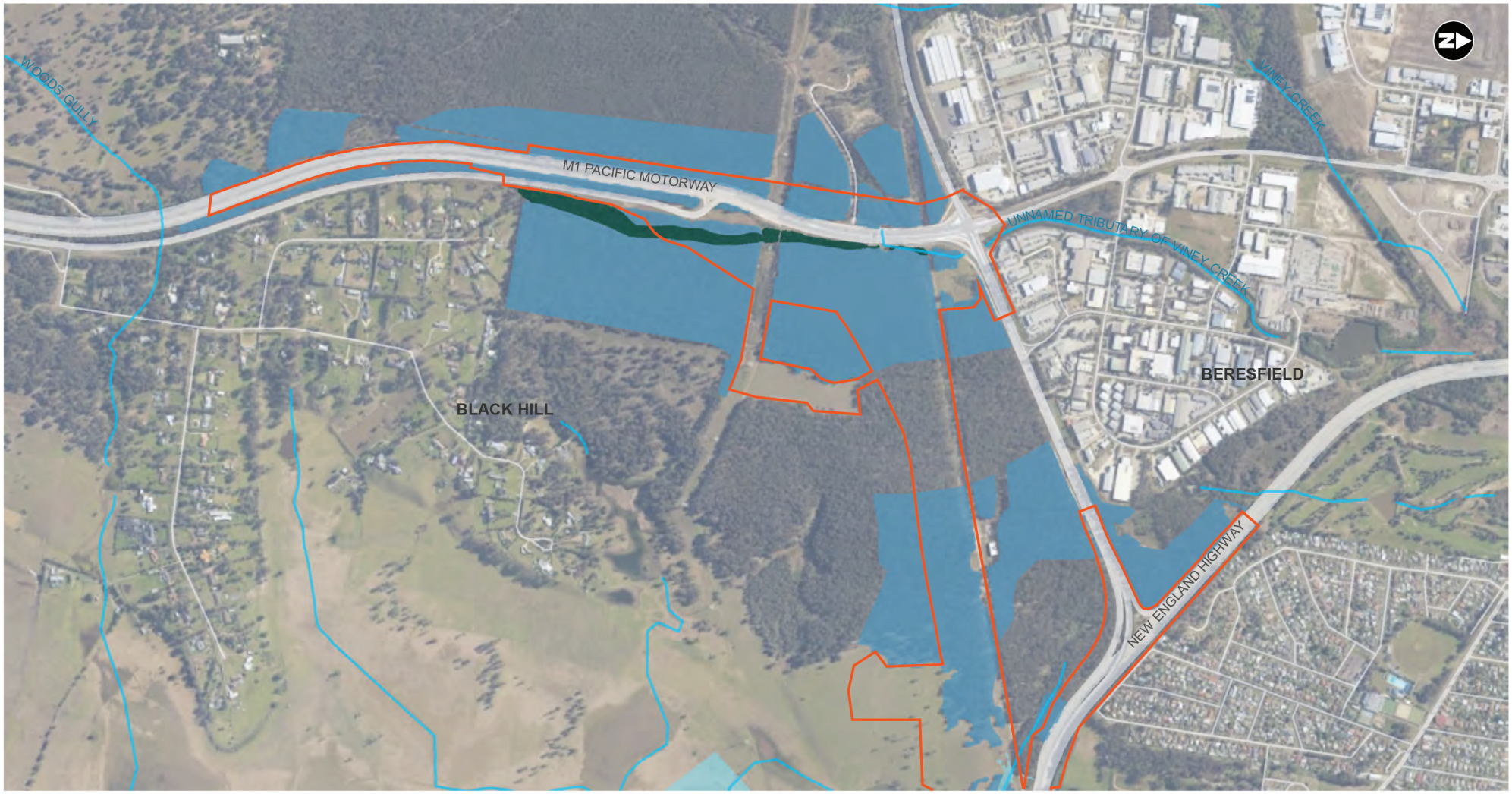


Figure 9-6 Threatened ecological communities identified within the construction footprint (map 1 of 5)

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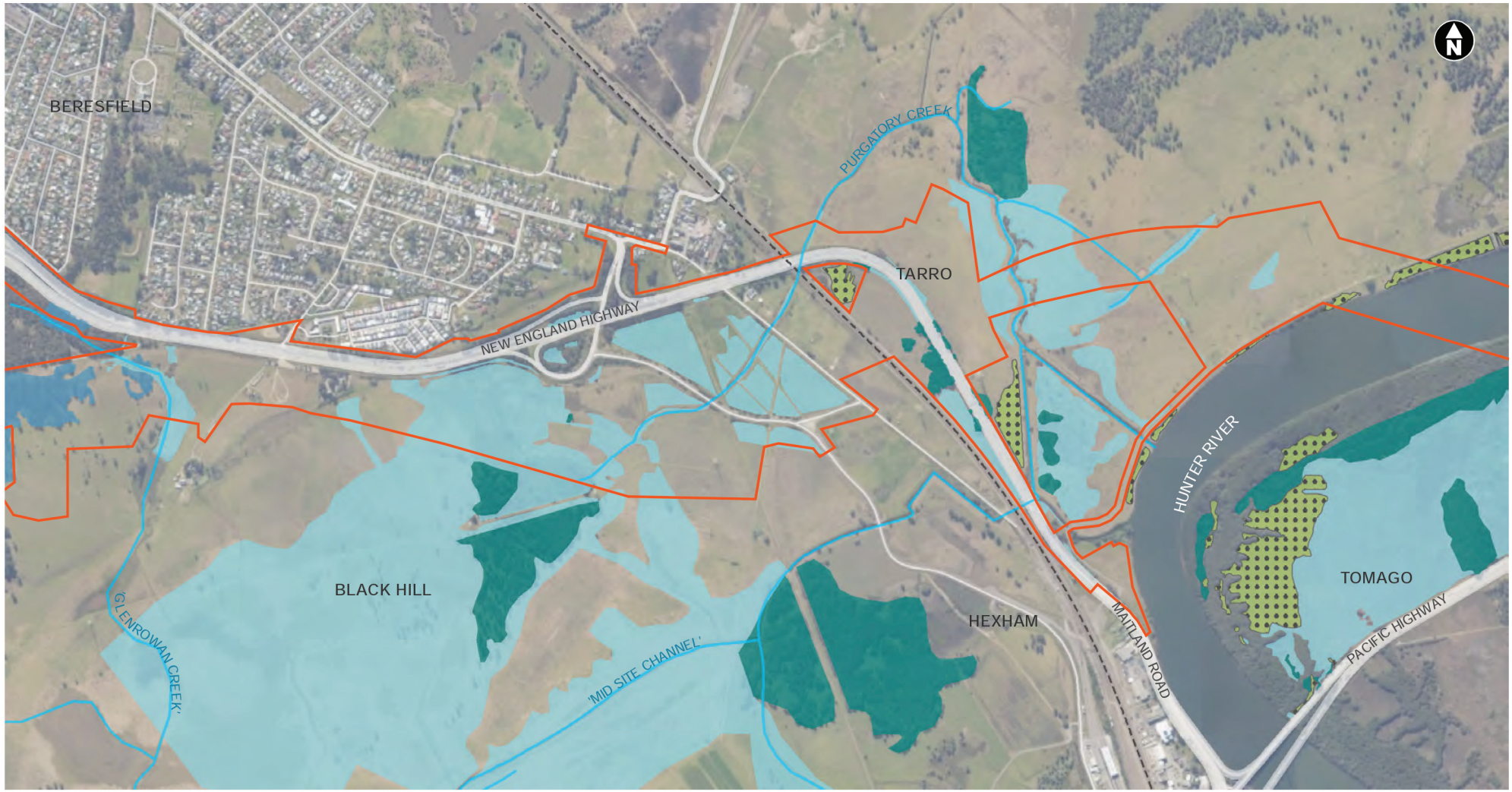

Figure 9-6 Threatened ecological communities identified within the construction footprint (map 2 of 5)

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Figure 9-6 Threatened ecological communities identified within the construction footprint (map 3 of 5)

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Figure 9-6 Threatened ecological communities identified within the construction footprint (map 4 of 5)

Date: 9/12/2020 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Biodiversity_Assessment\IA230000_CD_BAR_007_VegTECs_JAC_A4L_15000_V03.mxd

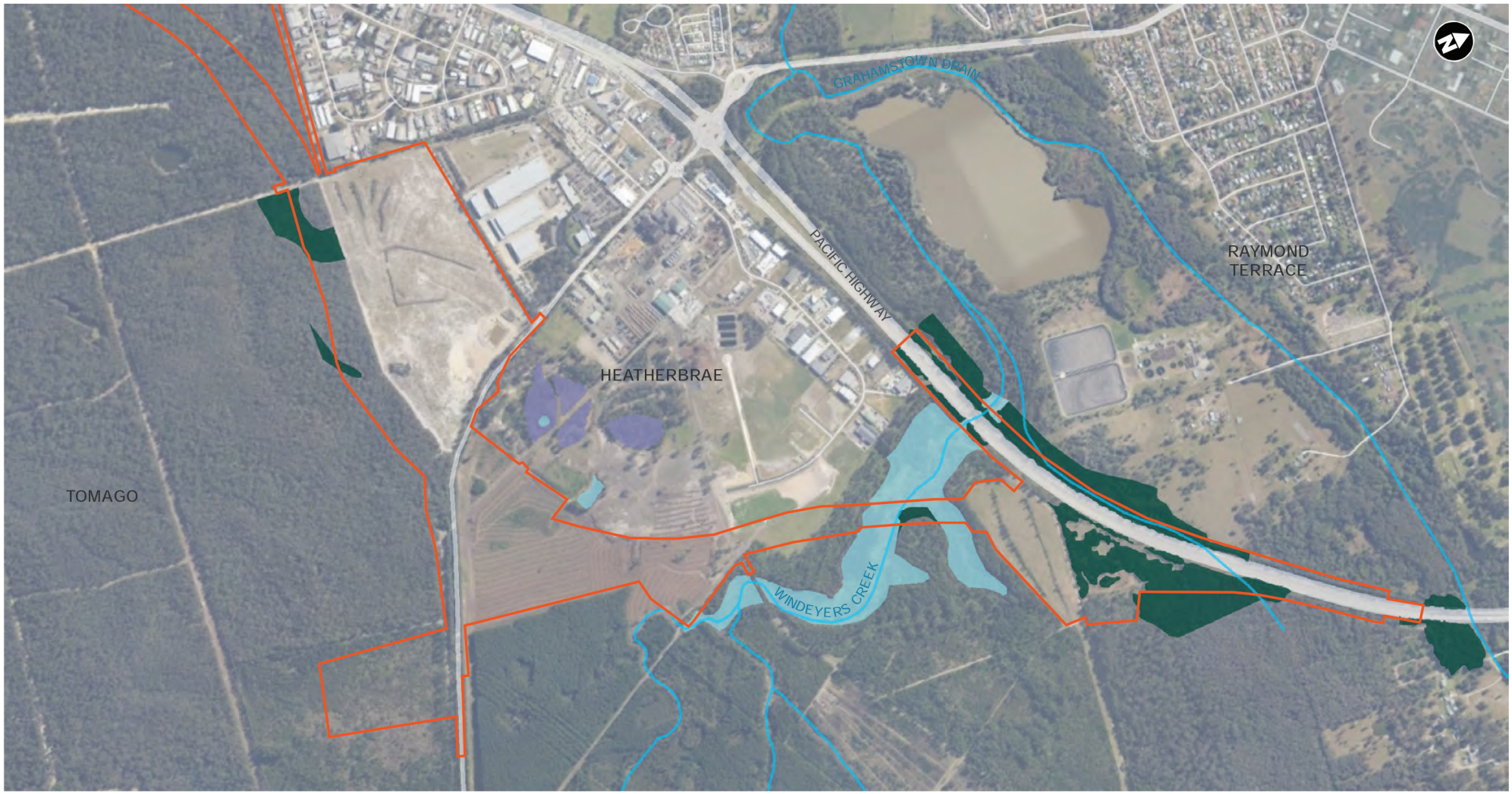

Figure 9-6 Threatened ecological communities identified within the construction footprint (map 5 of 5)

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9.3.4 Groundwater dependent ecosystems

Based on the PCTs identified in the construction footprint during field surveys and a review of Bell and Driscoll (2006), Kuginis et al. (2012) and the GDE Atlas, it is likely that some of the PCTs present in the construction footprint would have a degree of groundwater dependence (refer to **Table 9-7**), and include:

- Known aquatic GDEs:
  - Floodplain wetlands (Hexham Swamp Nature Reserve and surrounding wetlands, Hunter Wetlands National Park)
  - Hunter River.
- Potential terrestrial GDEs:
  - Coastal Floodplain Wetlands on the floodplain of the Hunter River (Tarro, Hexham and Tomago)
  - Mangrove Swamps on margins of the Hunter River
  - Coastal Dune Dry Sclerophyll Forests on the Tomago Sandbeds (Tomago and Heatherbrae)
  - Freshwater wetlands adjacent to the floodplain such as sedgeland plant communities.

The PCTs identified in **Table 9-7** are not obligate GDEs (i.e. they are not entirely dependent on groundwater) and are likely to be opportunistic GDEs that may depend on the subsurface presence of groundwater during excessive dry periods. The PCTs that are likely to have the most dependence on groundwater are those located in low-lying areas in the Hunter River floodplain and Tomago Sandbeds. Based on the distribution of each PCT, a possible corresponding groundwater system has also been assigned. Groundwater systems are described in further detail in **Chapter 10** (hydrology and flooding).

Table 9-7 Potential terrestrial groundwater dependent ecosystems present within the construction footprint

PCT ID	Plant community type	Possible corresponding groundwater system	Area within construction footprint (ha)
1071	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Hunter Alluvium system	7.71
1590	Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest	Tomago Sandbeds (excluding Black Hill occurrence)	41.88
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	Tomago Sandbeds	0.45
1646	Smooth-barked Apple – Blackbutt – Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Tomago Sandbeds	28.59
1649	Smooth-barked Apple – Red Mahogany – Swamp Mahogany – *Melaleuca sieberi* heathy swamp woodland of coastal lowlands	Tomago Sandbeds	1.36
1716	Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast	Hunter Alluvium system (in part)	1.82
1717	Broad-leaved Paperbark – Swamp Mahogany – Swamp Oak – Saw Sedge swamp forest of the Central Coast and Lower North Coast	Tomago Sandbeds	10.49
1724	Broad-leaved Paperbark – Swamp Oak – Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	Tomago Sandbeds	1.61

PCT ID	Plant community type	Possible corresponding groundwater system	Area within construction footprint (ha)
1727	Swamp Oak – Sea Rush – *Baumea juncea* swamp forest on coastal lowlands of the Central Coast and Lower North Coast	Hunter Alluvium system (in part)	8.76
1736	Water Couch – Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	Hunter Alluvium system (in part)	59.04
1742	Jointed Twig-rush sedgeland	Tomago Sandbeds	1.45
1746	Saltmarsh Estuarine Complex	Hunter Alluvium system	1.26
1747	Grey Mangrove low closed forest	Hunter Alluvium system	2.27
Total			**166.70**

9.3.5 Threatened species

Threatened flora species

Four of the targeted threatened flora species (refer to **Table 9-2**) were recorded within the construction footprint during the field surveys and are presented in **Table 9-8**.

Table 9-8 Recorded threatened flora within the construction footprint

Flora species	Conservation Status		Presence in the construction footprint
	TSC Act	EPBC Act	
Drooping Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)	V	V	34 plants
Sand Doubletail (*Diuris arenaria)*	V	-	161 plants
Netted Bottlebrush (*Callistemon linearifolius)*	V	-	157 plants
Tall knotweed (*Persicaria elatior)*	V	V	3 plants

Two additional threatened flora species were also recorded near the construction footprint:

- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) – listed as vulnerable under the TSC Act and EPBC Act)
- *Maundia triglochinoides* – listed as vulnerable under the TSC Act.

The recorded location of the above threatened flora species are shown on **Figure 9-7**.

Threatened terrestrial fauna species

Ten threatened fauna species (refer to **Table 9-3**) were recorded during the field surveys, and three additional credit species have been assumed to be present on the basis that there are associated PCTs present, stable habitat and reliable and recent records of these species in the locality.

Two species, the White-bellied Sea-Eagle (*Haliaeetus leucogaster*) and Mahony's Toadlet (*Uperoleia mahonyi*) were listed under the BC Act in 2016 and 2018 respectively. These species have not been added

to the BioBanking calculator assessed for this project, however impacts have been included and assessed in order the meet the SEARs. Mahony's Toadlet (*Uperoleia mahonyi*) was assumed to be present.

In addition, four species listed as migratory under the EPBC Act were recorded during the targeted bird surveys and opportunistically in the construction footprint during surveys, listed in **Table 9-9**. The recorded locations of threatened fauna species are shown on **Figure 9-7**. Migratory species that were observed are not presented in the figure as the assessment focused on whether important habitat for migratory species was present or not, rather than the location of individuals. Further, migratory species were typically observed in degraded grazing paddocks and flying over the site, not on the ground surface.

Table 9-9 Listed threatened and migratory fauna species confirmed by surveys or assumed present within the construction footprint

Fauna species	Conservation Status		Presence in the construction footprint
	TSC Act	EPBC Act	
Wallum Froglet (*Crinia tinnula*)	V	-	Recorded
Squirrel Glider (*Petaurus norfolcensis*)	V	-	Recorded
Grey-crowned Babbler (*Pomatostomus temporalis temporalis*)	V	-	Recorded
Varied Sittella (*Daphoenositta chrysoptera*)	V	-	Recorded
Little Bent-winged Bat (*Miniopterus australis*)	V	-	Recorded
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Recorded
Masked Owl (*Tyto novaehollandiae*)	V	-	Recorded
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	V (BC Act)	M	Recorded
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V	-	Recorded
Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)	V	-	Recorded
Koala (*Phascolarctos cinereus*)	V	V	Assumed present
Australasian Bittern (*Botaurus poiciloptilus*)	E	E	Assumed present
Black Bittern (*Ixobrychus flavicollis*)	V	-	Assumed present
Mahony's Toadlet (*Uperoleia mahonyi*)	E (BC Act)	-	Assumed present
Latham's Snipe (*Gallinago hardwickii*)	-	M	Recorded
Satin flycatcher (*Myiagra cyanoleuca*)	-	M	Recorded
Rufous Fantail (*Rhipidura rufifrons*)	-	M	Recorded

Note: M = Migratory V = Vulnerable, E = Endangered

Koala

The northern portion of the construction footprint occurs within the Port Stephens Council LGA within an area mapped as known koala habitat by CKPoM (Port Stephens Council and Australian Koala Foundation 2002). The construction footprint has also been identified in the Lower Hunter Koala Study as containing moderate and high value koala habitats and a very small area of very high value koala habitat (Eco Logical Australia 2013). The majority of recorded koala sightings in the locality are relatively old, however, there have been infrequent koala sightings recorded outside the northern extent of the construction footprint every year since 2011. The most recent records are from 2018 with one recorded sighting located about two kilometres north of the construction footprint. The consistent but relatively low number of sightings each year between Tomago, Raymond Terrace/Ferodale and Williamtown demonstrate the presence of a low density population accessing habitat close the construction footprint on the eastern side.

The more recent targeted survey and assessment work for the project, carried out over several years, identified no evidence of koalas within the construction footprint. There were no observations of koalas during targeted and opportunistic surveys and no evidence of koala activity identified within the potential habitat areas within the construction footprint.

Some primary and secondary koala feed trees are present within the construction footprint. North of the Hunter River three primary feed tree species are present, Swamp Mahogany (*Eucalyptus robusta*), Forest Red Gum (*E. tereticornis*) and Drooping Red Gum (E. parramattensis subsp. decadens). These trees were recorded from 21 of the 61 plots (34.4 per cent). Two secondary koala feed tree species are also present in this area, Grey Gum (*E. punctata*) and Red Mahogany (*E. resinifera*). These species were present in six plots (9.8 per cent). The remaining 34 plots (55.7 per cent) did not contain koala feed tree species. While koala habitat is mapped in parts of the construction footprint from desktop data, the field survey data for the project assessment indicates an absence of the species in these specific areas along the construction footprint.

While koala feed tree species also occur at the south western end of the project around Black Hill (i.e. the primary feed tree *Eucalyptus tereticornis* and secondary feed trees *E. agglomerata* and *E. eugenioides*) there are no historic records at Black Hill east of the M1 Pacific Motorway and the scat surveys suggest no evidence of koala presence in this portion of the construction footprint.

Threatened aquatic fauna species

Database review of threatened fish species habitat and distribution identified three species with potential to occur in the construction footprint:

- Purple Spotted Gudgeon (*Mogurnda adspersa*) – listed as endangered under FM Act
- Black Rock Cod (*Epinephelus daemelii*) – listed as vulnerable under the FM Act and EPBC Act
- Green Sawfish (*Pristis zijsron*) – listed as vulnerable under EPBC Act, though presumed extinct in NSW.

Due to the highly disturbed and largely saline conditions of the Hunter River and tributaries, it is considered unlikely that the Purple Spotted Gudgeon or the Black Rock Cod inhabit waterways within the construction footprint. The Green Sawfish is presumed extinct in NSW (last observed in 1972 in the Clarence River). Therefore, no protected or threatened fish species are expected to occur within the construction footprint.

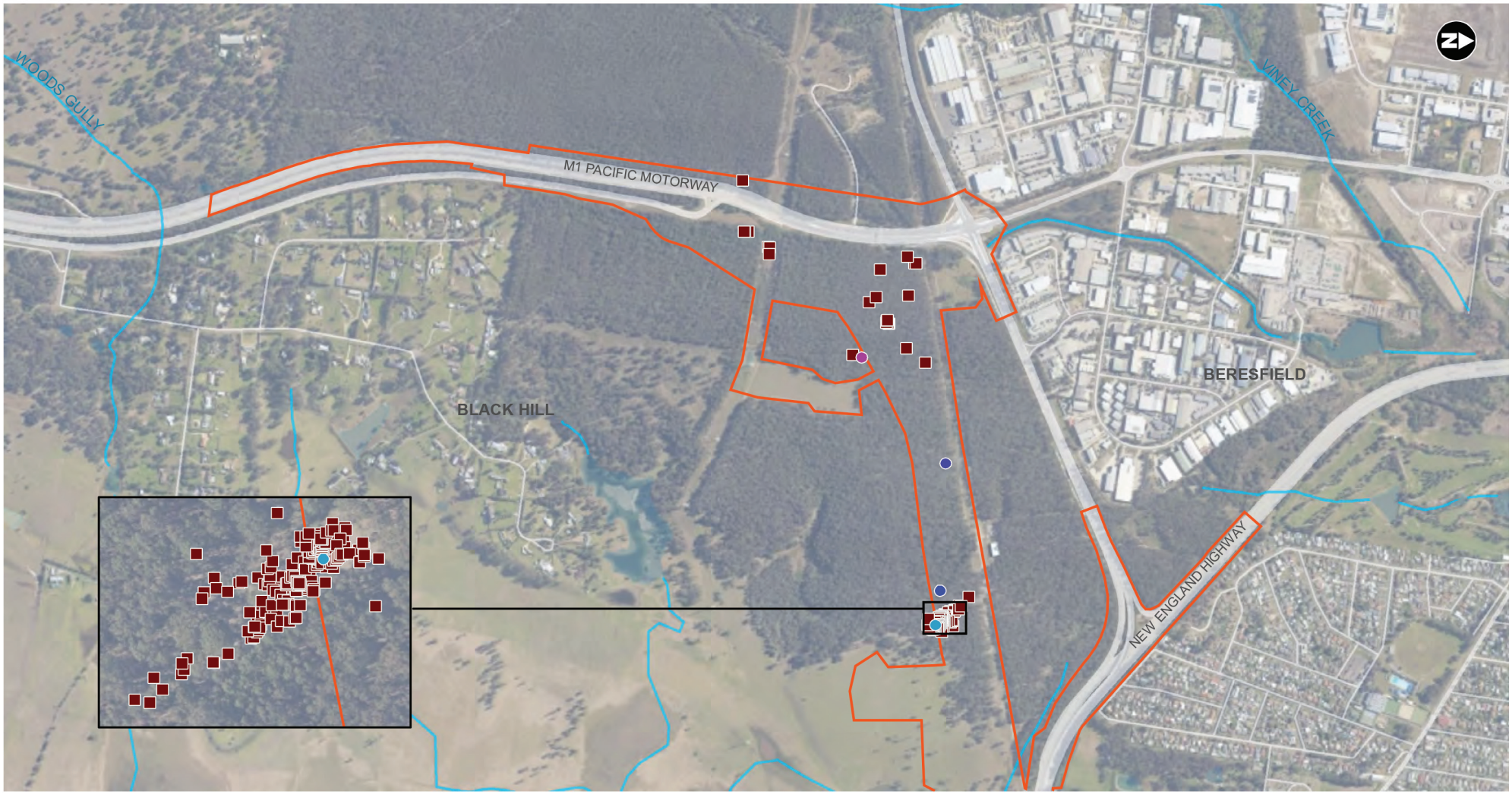

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Figure 9-7 Recorded threatened species (map 1 of 5)

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Figure 9-7 Recorded threatened species (map 2 of 5)

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Figure 9-7 Recorded threatened species (map 3 of 5)

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Figure 9-7 Recorded threatened species (map 4 of 5)

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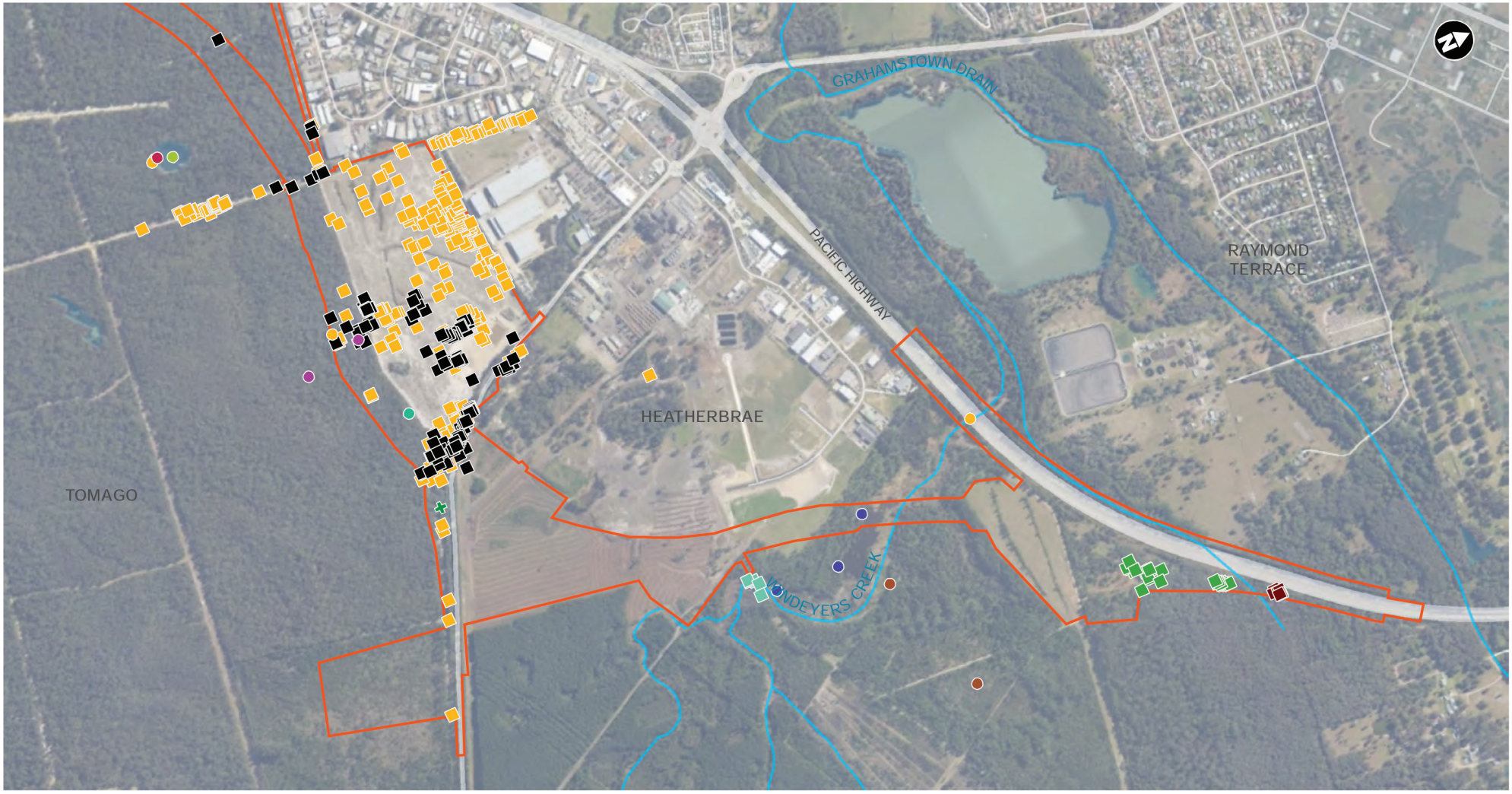

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Figure 9-7 Recorded threatened species (map 5 of 5)

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9.3.6 Aquatic habitat

The Hunter River is a ninth order major river which originates in the Liverpool Range and flows generally in a south-easterly direction, reaching the Tasman Sea at Newcastle. In general, the benthic habitats of the Hunter River estuary are considered disturbed from the surrounding land use and history, though still provide important habitat. No threatened invertebrates have been recorded in the area.

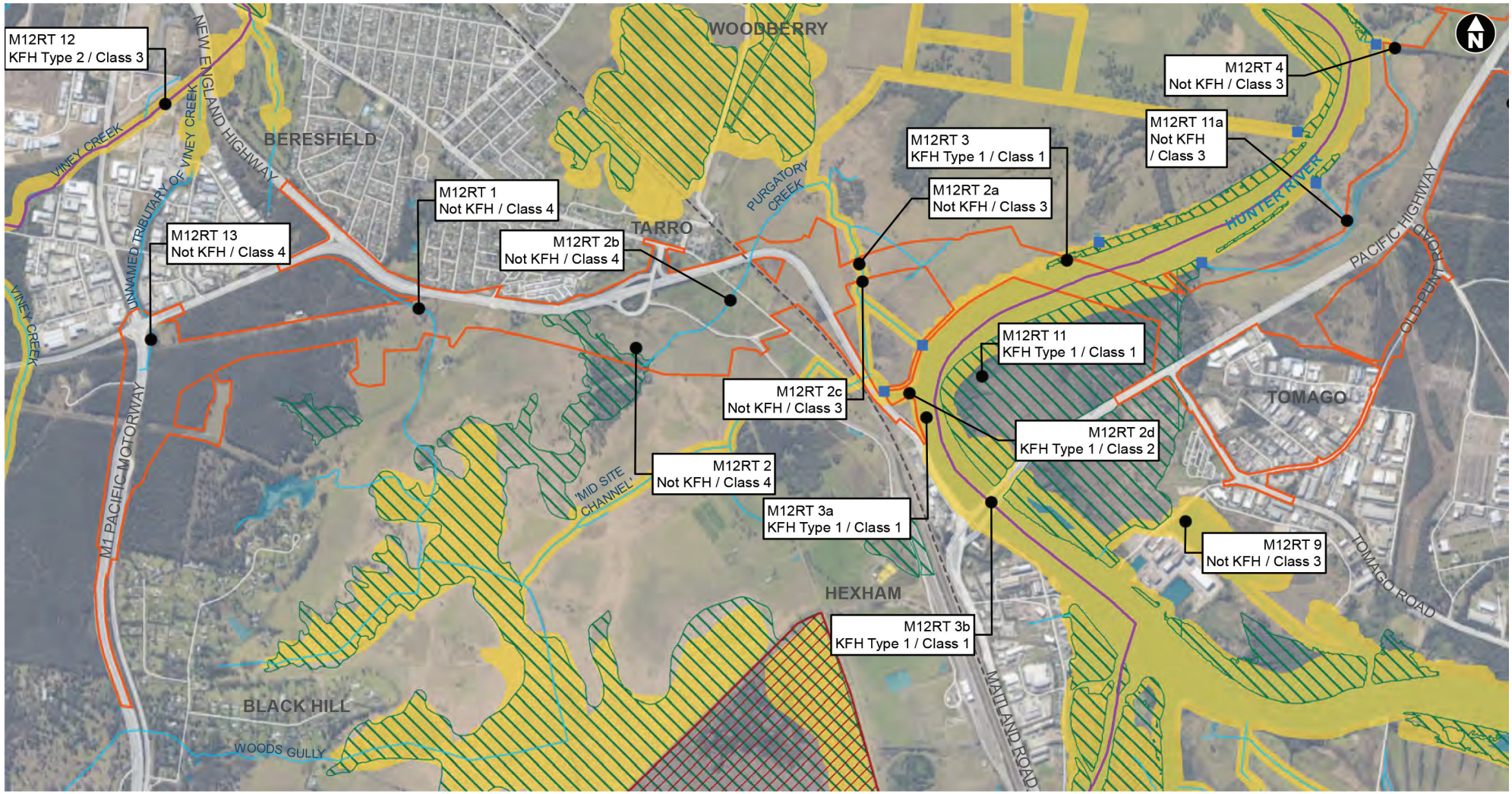
Seagrass beds are not known to occur in the lower Hunter River estuary and therefore the fish assemblages are different to those of other nearby NSW estuaries which are dominated by seagrasses (DPI 2000).

Table 9-10 lists the waterways within the construction footprint identified as KFH in accordance with the definitions in the Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013a) and that have been mapped by DPI Water (DPI 2007).

Table 9-10 Waterways identified as KFH within the construction footprint

Waterway name	KFH type (DPI 2013a)	Waterway classification (Fairfull and Witheridge 2003)
Purgatory Creek downstream of floodgates at junction with Hunter River	Type 1 – Highly sensitive Key Fish Habitat	Class 2 – Moderate fish habitat
Hunter River estuary – at proposed Hunter River crossing	Type 1 – Highly sensitive Key Fish Habitat	Class 1 – Major fish habitat
Unnamed wetland listed under the Coastal Management SEPP	Type 1 – Highly sensitive Key Fish Habitat	Class 1 – Major fish habitat

The location of KFH is provided in **Figure 9-8**.



Construction footprint

Main North Rail Line

Coastal wetlands (Coastal Management SEPP 2018)

Key Fish Habitat DPI 2007

Hexham Swamp Nature Reserve

Southern Purple Spotted Gudgeon (current predicted distribution DPI 2015)

Monitoring site

Floodgates

0 0.5 1 km

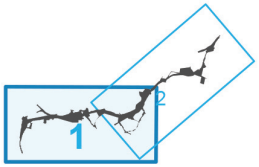


Figure 9-8 Aquatic habitat and key fish habitat assessment sites (map 1 of 2)

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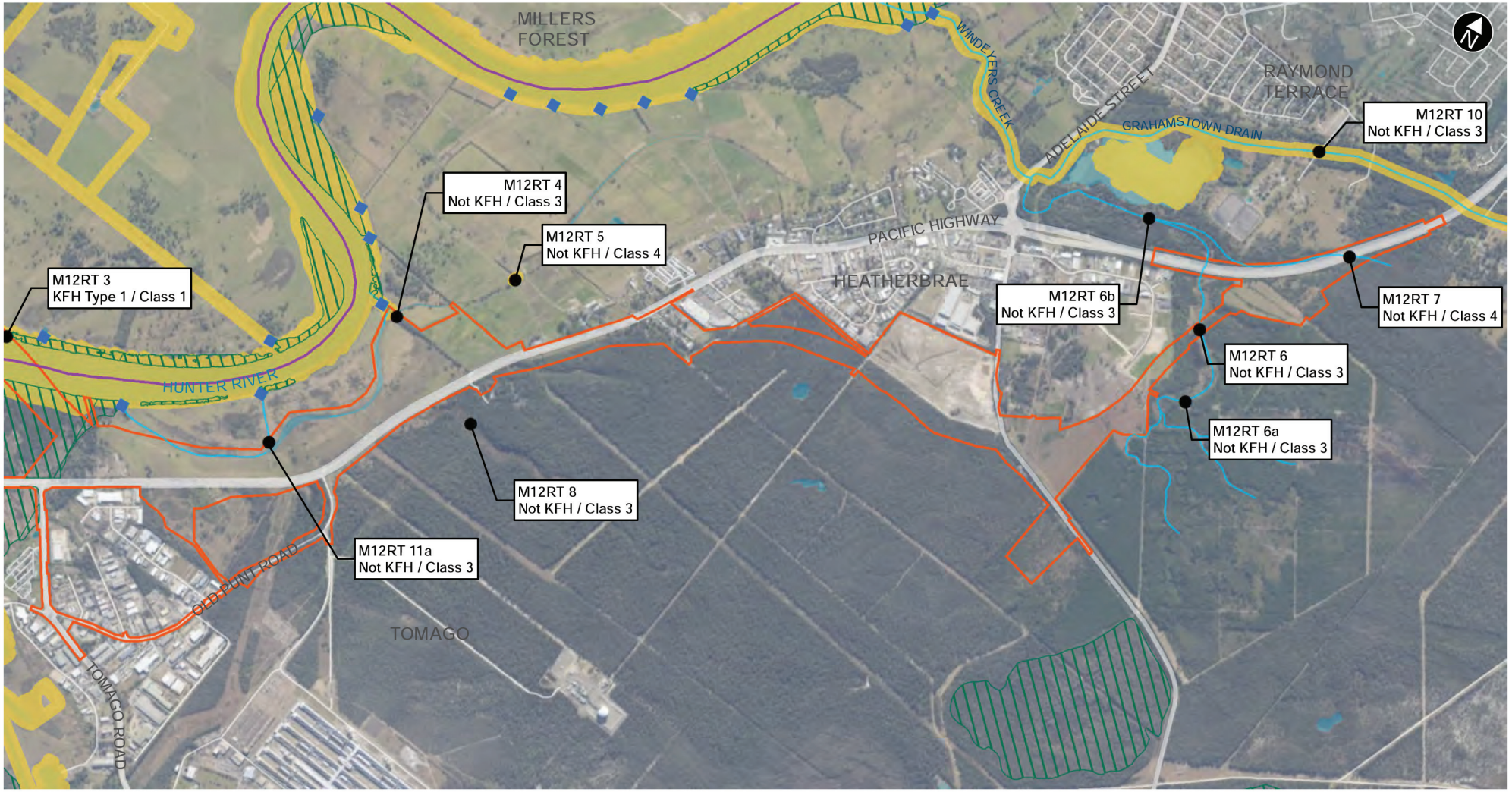

Construction footprint

Coastal wetlands (Coastal Management SEPP 2018)

Key Fish Habitat DPI 2007

Southern Purple Spotted Gudgeon (current predicted distribution DPI 2015)

Monitoring site

Floodgates

0 0.5 1 km

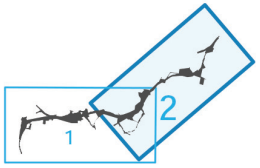

Figure 9-8 Aquatic habitat and key fish habitat assessment sites (map 2 of 2)

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9.3.7 Matters of national environmental significance

Desktop review and field survey results indicated the presence of Matters of National Environmental Significance (MNES) within the construction footprint including threatened species and communities listed under the EPBC Act as described in **Table 9-11**.

Table 9-11 MNES applicable to the project

MNES factor	Applicability to the project
Wetlands of international importance (Ramsar wetlands)	As described in **Table 9-4**, the Hunter Estuary Wetlands Ramsar site is located within 10km of the construction footprint, and is comprised of: • Kooragang Nature Reserve about 1.9km to the south-east of the construction footprint and about 5.1km downstream of the proposed crossing of the Hunter River • Hunter Wetlands Centre Australia in Shortland located about 3.8km south of the construction footprint. Hunter Wetlands National Park and Kooragang Nature Reserve contains mangroves, saltmarsh, paperbark and Swamp Oak swamp forest, brackish swamps, mudflats and sandy beaches. The Ramsar site receives surface water flows that pass through the project. The Hunter Wetlands Centre Australia is in a hydraulically separate subcatchment from the project. Given the distance from the construction footprint and the nature of the subcatchment, the Hunter Wetlands Centre Australia is not considered to be subject to potential impacts as a result of the project.
Listed ecological communities	Five nationally listed TECs listed under the EPBC Act were identified from the desktop assessment. Detailed field surveys confirmed that vegetation types consistent with two TECs were potentially present within the construction footprint based on the occurrence of corresponding PCTs: • Subtropical and Temperate Coastal Saltmarsh – listed as Vulnerable • Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community – listed as Endangered. Based on condition thresholds about 0.55 hectares of the saltmarsh community (PCT 1746) in the construction footprint is consistent with Subtropical and Temperate Coastal Saltmarsh TEC. None of the occurrences of PCT 1727 within the construction footprint are of sufficient size or condition to meet the eligibility for the listed Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community.
Listed threatened flora species	Eleven threatened flora species listed under the EPBC Act were considered to have a moderate to high likelihood of occurring in the construction footprint. The targeted field surveys confirmed two nationally listed threatened flora species in the construction footprint: • *Eucalyptus parramattensis* subsp. *decadens* (listed as vulnerable) • *Persicaria elatior* (listed as vulnerable).
Listed threatened fauna species	Nine nationally listed fauna species listed under the EPBC Act were identified as having a moderate to high likelihood of occurring within the construction footprint: • Regent honeyeater (*Anthochaera Phrygia*) • Australasian Bittern (*Botaurus poiciloptilus)* • Swift parrot (*Lathamus discolor)* • Australasian painted snipe (*Rostratula australis)* • Spotted tail quoll (*Dasyurus maculatus)* • Koala (*Phascolarctos cinereus)* • New Holland mouse (*Pseudomys novaehollandiae)* • Grey-headed Flying-fox (*Pteropus poliocephalus*) • Green and golden bell frog (*Litoria aurea).* The Grey-headed Flying-fox (*Pteropus poliocephalus*) (listed as vulnerable) was the only one of these species to be observed within the construction footprint (refer to **Table 9-9**).

MNES factor	Applicability to the project
Listed migratory species	The desktop assessment identified 16 listed migratory species listed under the EPBC Act with a moderate to high likelihood of occurring within the construction footprint: • 10 migratory wetland species • 6 migratory forest species. Of these species, White-bellied Sea-Eagle, Latham's Snipe, Satin Flycatcher and Rufous Fantail were observed within the construction footprint (refer to **Table 9-9**).

9.3.8 Weeds, pests and pathogens

A total of 32 high-threat exotic weed species (associated with the Biodiversity Assessment Methodology (BAM)), were identified in the construction footprint during surveys. Five of these species are listed as Weeds of National Significance and include *Alternanthera philoxeroides* (Alligator weed), *Asparagus aethiopicus* (Asparagus weed), *Lantana camera* (Lantana), *Rubus fruticosus agg.* (Blackberry) and *Senecio madagascariensis* (Fireweed). The classification and legal requirements associated with weed species identified in the construction footprint is provided in **Table 9-18**.

The construction footprint is currently habitat for a range of pest species including rabbits, cats, foxes, and Plague Minnow.

Pathogens were not observed in the construction footprint.

9.4 Assessment of potential impacts

9.4.1 Avoidance and minimisation of impacts

As described in **Chapter 4**, the project development has been an iterative process. The environmental focus of the route selection for the project was to align the construction footprint with existing development and infrastructure and thereby avoid biodiversity impacts where possible. This has resulted in a construction footprint that has minimal impact to vegetation connectivity at a landscape scale since the route follows the edge of existing vegetation, particularly north of Tomago Road. For this reason, potential impacts to large areas of koala habitat between Tomago and Raymond Terrace have been avoided and the project is not expected to impact on the movements of koala.

The following key refinements were made to the project design to avoid potential impacts on biodiversity:

- Aligning the western section of the operational footprint with existing development to limit the interface with the wetlands
- Locating the northern section of the operational footprint to reflect the existing development corridor so as to limit impacts to habitat and limit habitat fragmentation (inclusive of koala habitat)
- Design of a viaduct crossing the Hunter River and floodplain, in contrast to a built formation option that has resulted in avoiding a lengthy direct impact to floodplain wetlands and associated biodiversity and maintained connectivity for fauna associated with floodplain habitats
- Moving the previously proposed viaduct crossing the Hunter River further upstream, which has resulted in avoiding impacts to the Coastal Management SEPP coastal wetland on the western bank of the Hunter River and reducing the extent of impacts on Saltmarsh TEC and Freshwater Wetland TEC
- Moving the main alignment closer to the New England Highway has reduced the area of land to be fragmented which may provide suitable habitat for some migratory and wetland species
- Reduced impacts to the Coastal Wetland directly south of the Tarro interchange

- Reconsideration of the scope and functionality of project elements, such as the removal of a previously considered link road at Tomago, which has avoided impacts to remnant vegetation, potential habitat for threatened species, connectivity impacts and a population of 150 Grevillea parviflora subsp. parviflora individuals
- The locations of ancillary facilities have been positioned, where possible, to avoid impacts to biodiversity by placing them within previously cleared and disturbed land such that there would be minimal vegetation disturbance required.

Where it was not possible to avoid all impacts by the preferred corridor location, the project was designed to minimise impacts as far as possible, including:

- Raymond Terrace: Removal of the northbound exit ramp. This design change allowed the project to minimise impacts on native vegetation in this area
- Locating the northern abutment of the Hunter River bridge across former industrial site that is a known contamination site, resulting in minimising vegetation loss and removing the contamination source to limit future ongoing contamination risk
- Inclusion and design of fauna fencing and fauna crossing opportunities designed to minimise impacts to localised movements of fauna.

9.4.2 Assessment of potential construction impacts

Removal of native vegetation

Vegetation clearance and habitat loss are likely to be the largest detrimental impacts for terrestrial biodiversity that may arise from the project. The impact may be direct in the form of vegetation and habitat removal, or indirect in the form of fragmentation of habitat and edge effects to retained areas of vegetation.

This assessment has assumed that there would be complete vegetation clearance within the construction footprint. This precautionary approach has been applied to the assessment of the impacts of the concept design to ensure all potential 'worst case' impacts are assessed. If approved, the project would undergo a detailed design phase, during which impacts will be further reviewed and minimised as far as practicable.

The project would result in the removal of about 174.3 hectares of native vegetation from 14 different PCTs within the construction footprint (refer to **Figure 9-5**), representing 13.6 per cent of the native vegetation within the landscape buffer.

The impacts identified in **Table 9-12** include the impact on 0.6 hectares (0.5 per cent) of the existing 106 hectare BioBanking site. Transport will acquire this impacted land and offset the impacts to the existing BioBanking site.

The native vegetation to be removed includes 136 hectares of TEC listed under the TSC Act and 0.55 hectares of TEC listed under the EPBC Act. For all TECs listed under the TSC Act, with the exception of Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions, vegetation clearance is listed as a key threatening process (KTP), however, the proportional impact of the project is relatively low.

Management measures designed to reduce the impact of vegetation removal are provided in **Section 9.5**. Impacts on TECs listed under EPBC Act are discussed below.

Table 9-12 Impacts to PCTs and TECs listed under the TSC Act and EPBC Act

Vegetation zone	Plant Community Type	Threatened Ecological Community		Impact (ha)
		TSC Act	EPBC Act	
1. 1590 – Good	Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest (1590) (HU804)	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions (Endangered)	-	25.16
2. 1590 – Moderate				8.35
3.1590 – Regenerating				8.37
4.1588 – Moderate	Grey Ironbark – Broad-leaved Mahogany – Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast (1588) (HU802)	-	-	6.78
5.1588 – Regenerating				0.82
6. 1646 – Good	Smooth-barked Apple – Blackbutt – Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646) (HU860)	-	-	20.76
7.1646 – Poor				7.83
8.1649 – Good	Smooth-barked Apple – Red Mahogany – Swamp Mahogany – *Melaleuca sieberi* heathy swamp woodland of coastal lowlands (1649) (HU863)	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	1.36
9.1598 – Poor	Forest Red Gum grassy open forest on floodplains of the lower Hunter (1598) (HU812)	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (Endangered)	-	0.45
10.1716 – Good	Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast (1716) (HU930)	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	1.82
11.1717 – Good	Broad-leaved Paperbark – Swamp Mahogany – Swamp Oak – Saw Sedge swamp forest of the Central Coast and Lower North Coast (1717) (HU931)	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)		3.85
12.1717 – Poor				6.64
13.1724 – Good	Broad-leaved Paperbark – Swamp Oak – Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1724) (HU938)	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	-	1.61

Vegetation zone	Plant Community Type	Threatened Ecological Community		Impact (ha)
		TSC Act	EPBC Act	
14.1727 – Moderate	Swamp Oak – Sea Rush – *Baumea juncea* swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1727) (HU941)	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered)	Does not meet size or condition criteria for a listed community under EPBC Act	8.76
15.1736 – Good	Water Couch – Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (1736) (HU950)	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	-	33.23
16.1736 – Moderate				25.81
17.1742 – Good	Jointed Twig-rush sedgeland (1742) (HU956)	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	-	1.45
18.1071 – Good	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (1071) (HU673)	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (Endangered – in part 7.67ha)	-	7.71
19.1746 – Good	Saltmarsh Estuarine Complex (1746) (HU960)	Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregion (Endangered)	Subtropical and Temperate Coastal Saltmarsh (vulnerable – in part 0.55ha meets condition criteria)	1.26
20.1747 – Good	Grey Mangrove low closed forest (1747) (HU961)	-	-	2.04
21.1747 – Moderate				0.23
Total area of clearing		**136ha**	**0.55ha**	**174.29**

Threatened flora

The project would directly impact four threatened flora species, as summarised in **Table 9-13**.

Table 9-13 Impacts to threatened flora

Threatened flora species	TSC Act	EPBC Act	Individuals impacted	Significance to local population
Eucalyptus parramattensis subsp. *decadens*	V	V	34 plants	Given the condition and location of the habitat where these trees are located on the edge of the Pacific Highway, the loss of 34 trees from the broader Tomago Sandbeds population is unlikely to lead to the decline of the local population and is not considered to be a significant impact.

Threatened flora species	TSC Act	EPBC Act	Individuals impacted	Significance to local population
Diuris arenaria	V	-	161 plants	A small number of plants will remain outside the construction footprint however the cumulative loss from this project and an adjacent approved development represents a significant loss of plants from this local population.
Callistemon linearifolius	V	-	157 plants	The loss of plants from the southern end of the construction footprint (considering only known individuals) is likely a large portion of the known population around the footprint east of the M1 Pacific Motorway. The remaining plants at the southern end of the population would be subject to indirect impacts through edge effects, with many located on the edge of the new road, suggesting the long-term viability of the remainder of this local population would also be impacted. Other populations and suitable habitat occur to the west of the project.
Persicaria elatior	V	V	3 plants	The direct impact on these three individuals represents a small number of plants that form a small isolated population. The habitat where these plants were identified is considered to be poor quality habitat for the species, due to impacts from ongoing cattle grazing and weed invasion. The three individuals likely represents a small isolated population that have dispersed from nearby large areas of swamp forest and wetlands to the east. Given this, the habitat that would be impacted by the project is not considered likely to be habitat critical to the survival of the species.

Threatened fauna species habitat and habitat features

The project would result in loss of about 174.3 hectares of habitat for threatened fauna species. The loss of habitat is a KTP listed under the TSC Act and is described as land clearance under the EPBC Act. Habitat loss would be made up of:

- Dry sclerophyll forests with a shrub and grass understorey: 49.49 hectares (about 28.4 per cent)
- Dry sclerophyll forests with a shrubby understorey: 28.59 hectares (about 16.4 per cent)
- Freshwater wetland habitat: 68.2 hectares (about 39.1 per cent)
- Forested wetlands: 24.49 hectares (about 14.1 per cent)
- Saline wetlands: 3.53 hectares (about two per cent).

The project would also remove about 13.04 hectares of planted native vegetation, which provide a foraging resource for a range of mobile nectivorous bird and bat species.

The removal of this native vegetation would result in the loss of fauna habitat features known to support locally occurring threatened fauna species. This includes potential breeding and sheltering habitats in the form of hollow-bearing trees, riparian vegetation, dead and dying wood and wetland vegetation, as well as foraging habitat and resources such as foliage, nectar and sap exudates. Additionally, a number of threatened fauna species require winter flowering food resources, which are present within the construction footprint, to supply food when there are resource shortages, or to coincide with migratory movements.

A summary of the potential impacts on threatened fauna species is provided in **Table 9-14**.

Table 9-14 Summary of threatened fauna species impacts

Threatened species	Credit type	TSC Act	EPBC Act	Habitat or individuals in construction footprint (direct impact)	Potential habitat in the landscape buffer area
Wallum Froglet (*Crinia tinnula*)	Species	V	-	3.21ha of confirmed habitat based on a 40m buffer around the waterways where this species was identified.	About 73ha
Squirrel Glider (*Petaurus norfolcensis*)	Ecosystem	V	-	93.36ha of potential habitat, populations recorded at Black Hill and Heatherbrae.	About 396ha, very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry.
Grey-crowned Babbler (*Pomatostomus temporalis temporalis*)	Ecosystem	V	-	70.47ha of potential habitat based on associated PCTs, prefer dry sclerophyll forest with grassy/shrubby understorey.	Extent of population and occurrence not known, although up to 511ha of potential habitat present.
Varied Sittella (*Daphoenositta chrysoptera*)	Ecosystem	V	-	100.96ha of potential habitat based on associated PCTs, prefer dry sclerophyll forest with grassy/shrubby understorey. Consistently recorded at Black Hill at western end of the construction footprint	Up to 511ha of potential habitat within landscape buffer.
Little Bent-winged Bat (*Miniopterus australis*)	Ecosystem and Species	V	-	82.78ha of potential foraging habitat impacted. No roosting habitat identified in the construction footprint. Roosting habitat identified at Windeyers Creek bridge, which is outside the construction footprint and would not be impacted.	This species may forage over all forested and open habitats including cleared and modified lands, urban and industrial areas. Over 1000ha of forest habitat present plus very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry.
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Ecosystem	V	V	85.05ha of potential foraging habitat based on associated PCTs and habitat modelling data for the locality.	Over 1000ha of potential foraging habitat present. Very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry.
Masked Owl (*Tyto novaehollandiae*)	Ecosystem	V	-	70.47ha of potential habitat. The species was confirmed at Black Hill and Heatherbrae and is likely to comprise separate individuals and home range area. No nesting trees identified, although suitable large tree hollows are present in the landscape at Heatherbrae and there is potential to remove trees used for nesting.	About 396ha of potential habitat present, very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry

Threatened species	Credit type	TSC Act	EPBC Act	Habitat or individuals in construction footprint (direct impact)	Potential habitat in the landscape buffer area
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	Ecosystem	V	-	82.78ha of potential habitat based on associated PCTs. This includes all forested habitats of the construction footprint.	This species occupies a diversity of forest habitat with tree hollows for roosting, may forage over all forested and open habitats. Over 1000ha of forest habitat present plus very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry.
Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)	Ecosystem	V	-	82.78ha of potential habitat based on associated PCTs. This includes all forested habitats of the construction footprint.	This species occupies a diversity of forest habitat with tree hollows for roosting, may forage over all forested and open habitats. Over 1000ha of forest habitat available plus very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry.
Koala (*Phascolarctos cinereus*)	Species	V	V	Impacts to about 51.12ha from Tomago to Heatherbrae, predominantly impacts on edge habitats and fragmented habitat, no impacts to koala movements anticipated. Up to 5.3ha of potential habitat would be isolated at Heatherbrae, however this is on the edge of the existing industrial area, and no evidence of koala use was recorded.	Large areas of potential habitat across the Tomago Sandbeds through to Williamtown and north to Grahamstown Dam. About 670ha mapped within the landscape buffer.
Australian Bittern (*Botaurus poiciloptilus*)	Species	V	-	43.64ha of potential habitat based on associated PCTs. Historical record from Windeyers Creek.	Known from Hunter Wetlands National Park and Hexham Swamp Nature Reserve. Up to 160ha of potential habitat occurs.
Black Bittern (*Ixobrychus flavicollis*)	Species	V	-	61.95ha of potential habitat based on associated PCTs could occur in freshwater and saline wetlands.	Known from Hunter Wetlands National Park. Up to 233ha of potential habitat mapped within the landscape buffer. High quality habitat occurs to the east in the Hunter Region Botanic Gardens and to the south at Black Hill. These areas are outside of the construction footprint and would not be impacted.

Threatened species	Credit type	TSC Act	EPBC Act	Habitat or individuals in construction footprint (direct impact)	Potential habitat in the landscape buffer area
Mahony's Toadlet (*Uperoleia mahonyi*)	Newly listed species – Not listed under the TSC Act or included in the BBCC	E (BC Act)	-	3.21ha of confirmed habitat based on a 40m buffer around the waterways where this species was identified. The extent of the population in the construction footprint is unknown, but is considered to be a minor proportion of the broader local population.	About 73ha. Similar type habitats are widespread and very large, particularly in Hunter Water Corporation owned lands in Heatherbrae and to the east of Raymond Terrace within the Tomago Sandbeds region.
White-bellied Sea- Eagle (*Haliaeetus leucogaster*)	Newly listed species – Not listed under the TSC Act or included in the in BBCC	V (BC Act)	M	174.3ha of potential foraging habitat, largely associated with vegetation surrounding the Hunter River and small tributaries. No nest sites identified in the construction footprint during surveys.	May forage over all forested and open habitats including cleared and modified lands. Over 1000ha of forest habitat present plus very large areas of contiguous habitat for this species extend east to Tomago, Williamtown and Tilligerry.

Note: M = Migratory, V = Vulnerable, E = Endangered

Koala

The project has been designed to minimise the loss of mature forest by selecting an alignment as close as possible to the existing Pacific Highway from Tomago to Heatherbrae, along the edge of the known koala habitat within Port Stephens Council LGA. While no evidence of koalas was recorded during targeted field surveys, construction of the project would remove about 51.12 hectares of potential koala habitat. This area of impact has been calculated based on the area of PCTs associated with koala habitat within the Tomago to Heatherbrae section of the project. As there is no known koala population within the Black Hill area west of the M1 Pacific Motorway and PCTs within this area have not formed part of the koala habitat impact area.

The 51.12 hectares impacted is predominantly comprised of edge habitats and fragmented habitat with no impacts to koala movements anticipated. Up to 5.3 hectares of potential habitat would be isolated at Heatherbrae, however this is on the edge of the existing industrial area, and no evidence of koala use was recorded during field survey.

As part of the assessment process under the EPBC Act, the Koala habitat assessment tool (DoE 2013a) was used to identify the extent and importance of the impact to koala habitat. The assessment tool uses a scoring system based on known occurrence, presence of feed trees, habitat connectivity, existing threats and recovery value. Even though survey results identified no recent koala activity within the construction footprint, based on the habitat present and previous records in the local area, the construction footprint was identified as having habitat critical to the survival of the koala in accordance with the assessment tool guidelines.

As the project was considered likely to adversely affect habitat critical to the survival of the koala, an assessment of significance was required under the EPBC Act referral guidelines (DoE 2014). The key outcomes from the assessment of significance are:

- No evidence of koala activity was confirmed within the construction footprint during surveys
- The small area of habitat to be lost along the edge of the existing Pacific Highway between Tomago and Heatherbrae is unlikely to result in a long-term decrease in the size of the Port Stephens koala population
- The small loss of habitat area (in comparison to the large areas of very high and high quality habitat to the east and north of the construction footprint) is considered unlikely to reduce the area of occupancy for the koala
- While the project would isolate two small patches of habitat considered to be of low value, the project is not expected to fragment habitat for an important koala population and would not sever an important link between areas of core koala habitat
- The project is unlikely to impact habitat critical to the survival of the species
- The project has the potential to disrupt the breeding cycle of a small number of animals, however, this impact would be minor relative to the extent of the Port Stephens koala population
- Management measures such as fencing would prevent koalas from accessing the road. Connectivity measures were not considered necessary as the project would not isolate an important area of habitat or sever an important link.
- The project would not be directly responsible for introducing disease known to affect koala populations such as Chlamydia
- The project would not interfere with any of the objectives identified in the National Recovery Plan for the Koala
- The project would have minimal impact to koala habitat in terms of absolute habitat loss and impacts to the movement of koalas, due to the location of the proposed action being at the outer extent of koala habitat.

Given the position of the project, the findings from the background review, spatial review and field surveys, and the outcomes of the Assessment of Significance, the proposed action is not expected to significantly impact on the koala.

Removal of migratory species habitat

The project would result in impacts associated with the removal of habitat for wetland and terrestrial migratory species listed under the EPBC Act, including:

- 16.4 hectares of habitat for Latham's snipe (wetland species)
- 70.47 hectares of habitat for Rufous Fantail and Satin Flycatcher (terrestrial species).

The project would remove around 174.3 hectares of potential hunting, perching, and nesting habitat used by White-bellied Sea-Eagle during construction. However, this is not expected to impact on the ability of the species to forage and hunt along riverine / estuarine habitats within the construction footprint.

The Rufous Fantail and Satin Flycatcher were recorded at Black Hill near the proposed M1 Pacific Motorway interchange within the adjacent Spotted-Gum – Ironbark Forest with a paperbark understorey. Rufous Fantail was also recorded in the sandy Blackbutt dominated forest at the northern end of the project. Suitable habitat for these species is widespread across the construction footprint and wider area. The impact to these species would be minimal and affect non-breeding habitat.

Since habitat for migratory species within the construction footprint is not classed as 'important habitat' as defined under the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (DoE 2013b), is it unlikely that the project would have a significant impact on these species.

Landscape features and values

Impacts on landscape features and values that are considered to be complicated or severe, that were subject to further consideration in accordance with the requirements of the FBA, include the following, which are discussed below:

- Impacts on vegetation in the riparian buffer zone bordering rivers and streams 4th order or greater
- Impacts on important wetlands and their buffers
- Impacts on biodiversity links
- Impacts in the buffer zone along estuaries.

Impacts on riparian buffer of important rivers, streams and estuaries

The project would directly impact on vegetation in the riparian buffer zone where it is proposed to cross the Hunter River. Specifically, the project would result in the removal of vegetation at:

- The western bank (immediate western edge):
  - Mangrove forest (PCT 1747) about 0.18 hectares
  - Saltmarsh complex (PCT1746) about 0.48 hectares.
- The eastern bank (floodplain between Hunter River and existing highway):
  - Mangrove forest (PCT 1747) about 1.86 hectares
  - Swamp Oak forest (PCT 1727) about 6.28 hectares
  - Swamp Mahogany – Flax-leaved Paperbark swamp forest (PCT 1717) about 0.36 hectares
  - *Phragmites australis* and *Typha orientalis* freshwater wetlands (PCT 1071) about 3.39 hectares.

Impacts on important wetlands

Important wetlands in the construction footprint include wetlands listed under the Coastal Management SEPP. The project has the potential to impact on important wetlands in the construction footprint by:

- Partial clearance of areas classified as coastal wetland
- Removal of vegetation within wetlands

- Changes to hydrological regimes (i.e. flooding) resulting in:
  - Changes in species assemblages
  - Reduction in water quality
  - Weed invasion.
- Establishment and spread of new and existing exotic flora species.

Hexham Swamp Nature Reserve is located about two kilometres from the construction footprint, therefore construction activities would not directly impact or discharge directly into the reserve. Indirect water quality impacts from the project are also not expected because surface water flow from the construction footprint would not reach Hexham Swamp Nature Reserve, except during a 20% or greater annual exceedance probability (AEP) flood event when the northern and southern floodplain at Hexham become hydrologically connected due to culvert flow (refer to **Chapter 11** (hydrology and flooding) for further details). During these events, any water quality impacts which are associated with the project would be negligible due to flooding from the greater catchment which would provide dilution to any runoff from the project. Therefore any observable changes to water quality in Hexham Swamp Nature Reserve, during and following a flood event, would be representative of the broader catchment pollutant loads and not directly attributable to the project.

The project would directly impact around 16.4 hectares of Coastal Management SEPP coastal wetlands, concentrated around three areas:

- Riparian vegetation on the eastern bank of the Hunter River (about 11.9 hectares): includes Mangrove forest (PCT 1747), Swamp Oak forest (PCT 1727), Swamp Mahogany – Flax-leaved Paperbark swamp forest (PCT 1717) and *Phragmites australis* and *Typha orientalis* wetlands (PCT 1071)
- A thin strip of riparian vegetation on the western bank of the Hunter River (about 0.66 hectares), which includes Mangroves (PCT 1747) and Saltmarsh (PCT 1746)
- An area of wetland (about 4.95 hectares), which consists of vegetation identified as Water Couch – Tall Spike Rush freshwater wetland (PCT 1736). The area of PCT 1736 in this area covers a larger area than mapped coastal wetlands.

Mapped important wetlands associated with the Hunter River floodplain in this location have a long history of impacts from development. These impacts are associated with clearing and modification for past agricultural land use. This included flood mitigation and this has resulted in altered surface hydrology, reduced cover of macrophytes and corresponding reduced wetland health.

The potential for downstream impacts to occur outside of the construction footprint, such as sedimentation resulting in a reduction in water quality or a change in the hydrological regime resulting in changes in species assemblages or water quality, is considered to be low in both the short-term and long-term. These short-term impacts can be mitigated using effective management measures. Management measures proposed to mitigate impacts on wetlands are described in **Section 9.5**.

Biodiversity links and connectivity

The project would not impact on any State biodiversity links.

The regional landscape corridors identified in **Table 9-4** are only important for large and mobile fauna species and the project structures and operation would not impact on the movements of these species. On a local scale, a connectivity strategy was developed to provide effective mitigation in areas of the construction footprint that may become fragmented and therefore impact on the movements of fauna species. Further information regarding proposed connectivity features is provided in **Section 9.5.1**.

Impacts on Matters of National Environmental Significance

As discussed in **Section 2.2.2**, the project was determined to be a controlled action based on its potential to impact on MNES. As part of the referral, assessments of significance under the MNES Significant impact guidelines 1.1 (DoE 2013b) were completed for the TECs and species identified through desktop assessment and field surveys.

Based on assessment of the referral, DoAWE determined that significant impacts would be unlikely for Earp's Gum (*Eucalyptus parramattensis* subsp. *decadens*), Small-flowered Grevillea (*Grevillea parviflora* subsp. *parviflora*), Tall Knotweed (*Persicaria elatior*), Australasian Bittern (*Botaurus poiciloptilus*), Australian Painted Snipe (*Rostratula australis*), Spotted-tailed Quoll (*Dasyurus maculatus*), New Holland Mouse (*Pseudomys novaehollandiae*) and Green and Golden Bell Frog (*Litoria aurea*).

Since the referral, the biodiversity assessment has identified one new impacted species (*Persicaria elatior*) and increased impacts on five threatened species (*Eucalyptus parramattensis* subsp. *decadens*, Australasian Bittern, Australian Painted Snipe, Spotted-tailed Quoll and New Holland Mouse).

Assessments of Significance have concluded that a significant impact to any of the species and TECs listed within the original referral or identified as having an increased and changed impact is considered unlikely. A detailed assessment against the EPBC Act significant assessment criteria is provided in the BAR (**Appendix I**).

Six nationally listed TECs under the EPBC Act were identified from the PMST and desktop assessment for consideration in the construction footprint:

1. Subtropical and Temperate Coastal Saltmarsh (vulnerable)
2. Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (endangered)
3. Central Hunter Valley eucalypt forest and woodland ecological community (critically endangered)
4. Lowland Rainforest of Subtropical Australia (critically endangered)
5. Posidonia australis seagrass meadows of the Manning-Hawkesbury ecoregion (endangered)
6. River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria.

Assessment confirmed the presence of only Subtropical and Temperate Coastal Saltmarsh and Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland.

Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (endangered under the EPBC Act) was discussed in the referral as having potential to occur, however as described in **Table 9-11** none of the occurrences of Coastal Swamp Oak (PCT 1727) within the construction footprint are considered of sufficient size, condition and connectivity to meet the condition thresholds and eligibility for the listed community.

Of the 1.26 hectares of the PCT Saltmarsh Estuarine Complex (PCT 1746) present within the construction footprint, about 0.55 hectares is consistent with the listed Subtropical and Temperate Coastal Saltmarsh community listed as vulnerable under the EPBC Act. As this community is listed as vulnerable, and not endangered, under the EPBC, an Assessment of Significance is not required as it is not a MNES for the purposes of Part 3 of the EPBC Act (requirements for environmental approval).

The project would result in a loss of habitat for some migratory species listed under the EPBC Act that frequent the Hunter region, including:

- 16.4 hectares of habitat for Latham’s snipe
- 70.47 hectares for Rufous Fantail and Satin Flycatcher.

The project would remove around 174.3 hectares of potential hunting, perching, and nesting habitat used by White-bellied Sea-Eagle during construction. However, this is not expected to impact on the ability of the species to forage and hunt along riverine / estuarine habitats within the construction footprint.

The Assessment of Significance concluded that the loss of habitat would be unlikely to result in a significant impact on these threatened migratory species.

The impact of the project on MNES has been assessed in further detail in the BAR (**Appendix I**).

Aquatic impacts and changes to hydrology

Construction activities associated with the project have the potential to impact aquatic ecosystems and result in changes to existing hydrology. Aquatic impacts could occur due to changes in water quality, habitat loss, temporary instream barriers and potential impacts to KFH. Impacts to these environmental values and KFH have been considered in this section.

The potential aquatic impacts associated with construction activities is discussed in the sections below.

Bridge crossings over waterways and near wetlands

The project involves three bridge crossings over waterways or wetlands including:

- A 2.6 kilometre viaduct (B05) over the Hunter River floodplains, Hunter River and areas classified as Coastal Wetland (Coastal Management SEPP) on either side of Hunter River
- A single bridge (B11) over Windeyers Creek
- Twin bridges (B02) over Glenrowan Creek and in proximity to a Coastal Wetland (Coastal Management SEPP), located south of the existing New England Highway.

Potential impacts associated with bridge construction over waterways and adjacent to wetlands are described in **Table 9-15**.

Table 9-15 Potential impacts associated with proposed bridge construction

Proposed bridge crossing	Construction activities	Potential impact
Viaduct over the Hunter River (B05)	Aquatic risks are primarily associated with the bridge construction activities, such as: • Vegetation clearing in the riparian zones of the Hunter River which would directly remove a section of dense mangrove vegetation located on the eastern bank of the river inside the construction footprint. There are no mangroves on the western bank of the river at the bridge site, however small areas of saltmarsh would be directly impacted • Piling for installation of instream and floodplain bridge foundations and substructures (including piles, abutments and piers) • Dredging of a limited area of the riverbed to allow shallow water access for barges during construction • Installation of temporary instream structures which may include rock platforms with sheet piled retaining walls (or similar) that would be built out from the banks at each side of the river, two wharf structures which would be built out from the banks at each side of the river, floating barge platforms (that would be anchored and docked at the wharf structures or mid channel) and silt curtains around piling and dredging locations • Movement and use of heavy vehicles and machinery over water and on the banks of the river • Construction of in situ steel reinforced concrete piers and bridge structure above water. This may also include the installation of offsite prefabricated pier and bridge components • Extraction of surplus spoil and construction waste and transfer from waterway to land for management. Wastewater may also be transferred to land for management • Removal of temporary construction structures and material from the ricer channel and riparian areas.	• The loss of aquatic habitat features such as mangrove forest and associated woody debris and other riparian vegetation • A reduction in local water quality associated with mobilisation of riparian sediments or existing contaminates • Exposure of acid sulfate soils (ASS) to the air after extracted from the waterway (either on barges or on land) • Impacts to local river bank morphology due to destabilisation/erosion as a result of clearing of existing riparian vegetation or removal of imported riparian armouring materials • Introduction of invasive aquatic species to the local environment from the construction vessels and equipment • A reduction in local water quality associated with the uncontrolled release of concrete dust, concrete slurries or waste water associated with work overwater. • A reduction in local water quality values associated unplanned release of hydrocarbons (i.e. fuel for plant equipment and vessels on barges) as a result of accidental spills or leaks • A reduction in local water quality associated with the unplanned loss of solid waste and construction materials (e.g. litter and equipment) within the river and surrounding wetland habitats. Following the implementation of appropriate management measures and erosion and sediment controls, the risk of impacts to aquatic biodiversity within the Hunter River are considered to be low and any residual impacts that are expected would be localised and minor. In the location where the proposed viaduct crosses the Hunter River, and dredging would occur, this area does not support gravel beds, snags or other fish spawning areas. There are also no significant areas of instream vegetation in the deep section of channel. Specific management measures related to dredging activities are planned to avoid or minimise potential direct and indirect impacts to estuarine fauna and mangrove areas within the Hunter River.

Proposed bridge crossing	Construction activities	Potential impact
Glenrowan Creek (B02) and Windeyers Creek (B11) bridge crossings	Construction activities which have potential to cause temporary impacts to these waterways include: • Vegetation clearing in the riparian zone of creeks • Preparation of instream bridge work areas including, piling and crane pads, as well as construction of site access roads • Temporary instream access tracks to allow haulage of material across waterways. Temporary access tracks may remain in place for up to two years • Associated civil works for the bridges, including cut and fill earthworks, as well as movement and use of heavy vehicles and machinery within and on the banks of the waterway • Dewatering of pile locations (if water is present) and temporary sediment basins.	• Mortality or a reduction in range of aquatic fauna due to habitat loss • Impacts to aquatic flora due to reduced light penetration from increased suspended sediments from instream civil works • Physiological impact on aquatic fauna (e.g. ingestion of contaminants from suspended sediments) • Reduction in local water quality due to increased suspended sediment and unplanned release of contaminants • A reduction in local water quality associated with the uncontrolled release of concrete dust, concrete slurries or waste water associated with work overwater • A reduction in local water quality values associated with unplanned release of hydrocarbons (i.e. fuel for plant equipment and vessels on barges) as a result of accidental spills or leaks • A reduction in local water quality associated with the unplanned loss of solid waste and construction materials (e.g. litter and equipment) within the river and surrounding wetland habitats • A reduction in local water quality associated with the discharge of water downstream. Construction of the project has aimed to minimise disturbance to the creeks and wetland environments by implementing appropriate management measures and erosion and sediment controls. Any residual impacts that may occur are likely to be highly localised and temporary. As such, it is expected that there would be minimal impacts to aquatic biodiversity as a result of bridge crossings at Glenrowan Creek or Windeyers Creek. Accidental spills would be managed in accordance with the Construction Soils and Water Management Plan (CSWMP) prepared for the project (refer to **Chapter 11** (surface water and groundwater quality)).

Potential impacts to aquatic ecosystems

Construction of the project has potential to impact aquatic ecosystems. In general, impacts to waterways may include:

- Barriers to fish passage
- Displacement or removal of existing large wood debris or snags
- Clearing of mangroves and riparian vegetation
- Interaction with equipment and machinery
- Changes to water quality resulting from, but not limited to:
  - Mobilisation of sediment-laden or contaminated water associated with construction activities
  - Water discharges from temporary sediment basins
  - Untreated ASS drainage
  - Tannin-laden runoff from stockpiled vegetation.
- Removal of instream macrophytes and habitat features
- Unplanned introduction and establishment of aquatic pest species and/or weeds.

Although several waterways in the area are ephemeral or modified drainage channels and disconnected from the Hunter River estuary as part of the flood mitigation scheme, the central portion of the construction footprint is a floodplain that contains patches of terrestrial and wetland features. These areas are mapped as Coastal Wetland under the Coastal Management SEPP (2018) and are potential habitat for dragonfly species and aquatic macroinvertebrates. Infrequent flushing of these areas results in very long residence times for contaminants, therefore, changes to water quality, aquatic habitat and natural flow regimes due to the project could result in the degradation of the wetlands and may reduce the available habitat for these aquatic species.

The above risks to aquatic ecosystems are discussed in the context of the project in **Table 9-16**.

Potential impacts to key fish habitat

As described in **Section 9.3.6**, the project crosses mapped KFH (as identified by DPI and based on field observations) (refer to **Figure 9-8**).

The most sensitive fish habitats (Type 1) within the construction footprint are associated within the Hunter River estuary, including the Hunter River itself, the Coastal Wetland (Coastal Management SEPP) on the eastern side of the Hunter River, and Purgatory Creek (downstream of the floodgate) as these environments consist of mangrove forests or have mangrove and saltmarsh vegetation along the banks and in the intertidal zone.

All other waterways within the construction footprint have been identified as Minimal (Type 3) or Unlikely (Type 4) fish habitat as they are generally disconnected from the Hunter River due to the managed environment (i.e. the Hunter River Flood Mitigation Scheme) and therefore currently do not exhibit aquatic habitat features that would support KFH.

The potential construction impacts to KFH are the same as those identified for the general aquatic environment as addressed in **Table 9-16**. Where potential impacts are specifically relevant to KFH this has been noted in **Table 9-16**.

Table 9-16 Potential impacts to aquatic ecosystems during construction of the project

Type of impact	Associated construction activities	Potential impact
Barriers to fish passage	Installation of instream bridge structures	The construction of the proposed viaduct (B05) over the Hunter River is unlikely to result in barriers to fish passage due to the following: • The floating silt curtains would be limited to installations around individual piling locations and dredging sites and installed in a manner that facilitates fish movement through the river channel • The barges are floating platforms, anchored to the riverbed via cables, therefore no physical barriers to fish passage are anticipated • The rock platforms and wharf structures would result in some obstruction of the waterway; however, they are anticipated to be built from / connected to the riverbank (to a distance of about 20m) and therefore would not significantly obstruct fish movement within the waterway.
Barriers to fish passage	Temporary waterway crossings	There will be no impact to fish passage in the short or medium term as flow conditions at temporary crossings will be maintained.
Removal of large woody debris or snags	In-stream works	The removal of large woody debris or snags is listed under Schedule 6 of the FM Act as a KTP. Woody debris plays an important role in freshwater and marine ecosystems by providing essential habitat for aquatic organisms and stabilising stream beds and banks. Visual assessment during field investigations revealed that large woody debris was not a significant component of the aquatic habitat along waterways traversed by the project. However, there is potential for large woody debris to be submerged and therefore not recorded, or to become deposited prior to construction. As such, large woody debris may be present within the Hunter River, Purgatory Creek, the tributary of Viney Creek, Glenrowan Creek, and Windeyers Creek. To minimise any impacts to aquatic environments due to removal of instream large woody debris, any large woody debris that is identified within the construction footprint prior to construction would be preserved and re-established at the site following construction or relocated downstream in consultation with a qualified ecologist.

Type of impact	Associated construction activities	Potential impact
Clearing of mangrove and riparian vegetation	Vegetation clearing for project components	The project would require clearance of some patches of mangrove vegetation on the eastern side of the Hunter River within the area classified as unnamed Coastal Wetland (Coastal Management SEPP), as well as an area of native riparian vegetation around Windeyers Creek. The eastern side of the Hunter River and unnamed Coastal Wetland are both KFH. Riparian vegetation on the banks of waterways and mangroves that are established in the intertidal zone, banks and floodplain areas of estuaries are structurally important for stabilising stream beds and riverbanks and can be utilised as shelter or refuge habitat for aquatic species or provide nursery habitat. The extent of mangroves in the lower Hunter River estuary is widespread and in the areas adjacent to the project, there are substantial patches of mature Grey Mangrove low closed forest present. Clearance of a portion of the mangroves on the eastern side of Hunter River is required to facilitate the installation of the temporary wharf structure, as well as other temporary assets which will be used to construct the viaduct over Hunter River (B05) and bridge abutments in the area. Additionally, there may be a limited clearance of mangroves associated with the remediation of the former mineral sands processing facility from the eastern bank of the Hunter River. Clearance of portions of the riparian zone around Windeyers Creek is required to facilitate the road and bridge footprint and provide access during construction. To minimise impacts to aquatic environments due to clearance of riparian vegetation and mangroves, temporary riparian and instream construction equipment would be removed, and disturbed areas would be stablilised and rehabilitated progressively or prior to demobilisation. Where practicable, site rehabilitation would include re-planting appropriate vegetation types in the disturbed areas. As such, removal of riparian vegetation and mangroves within the construction footprint is expected to be localised and is considered unlikely to result in a long term impact on the associated aquatic habitat.
Interaction with equipment and machinery	In-stream works	There is potential for fish and other aquatic species to be harmed through interaction with equipment and machinery that would be utilised for instream works. For the proposed viaduct (B05), aquatic species could be harmed as a result of direct interaction with equipment in close proximity to piling locations. However, through minimising the impact area and the use of typical exclusion controls as well as by employing standard mitigation measures for underwater piling these potential impacts are considered minor. For other waterways where temporary and permanent crossing structures would be installed, aquatic species may be harmed (where water is present) if they are in proximity of the instream construction areas. However, this would be avoided as fauna salvage would be carried out prior to water being pumped out of the waterway as per pre-clearing survey requirements.

Type of impact	Associated construction activities	Potential impact
Changes to water quality	• Instream works • Construction activities that mobilise sediment-laden or contaminated water into waterways	Mobilisation of sediments and contaminated water have the potential to reduce water quality within waterways and KFH and consequently directly or indirectly harm native species that are unable to tolerate changes to water quality and favour aquatic pest species, such as the Plague Minnow, which predate on native species. Predation by the Plague Minnow is listed as a KTP under the TSC Act. With the implementation of erosion and water quality control measures during construction the risk of changes to water quality would be minimised therefore aquatic flora and fauna, including KFH, are not expected to be significantly impacted. Contaminated material may enter waterways through disturbance of contaminated sites and/or acid sulfate soils (ASS), spills of fuels and oils, discharge of saline water and leaching of tannins. Any contamination of a waterway would impact the overall ecological health and biological functioning of the waterway and result in a decrease in the likelihood of meeting the relevant NSW Water Quality Objectives. The CSWMP prepared for the project would outline procedures for the management of high-risk activities such as stockpiling, excavation and treatment of ASS, disturbance of soft soils and saline soils, dewatering, discharging water from temporary sediment basins, emergency spill response and unexpected contaminated finds, including asbestos. The plan would also further detail water quality monitoring during construction for both surface water and groundwater quality at nominated monitoring sites. Following the implementation of recommended management measures (refer to **Chapter 11** (surface water and groundwater quality) and **Chapter 16** (soils and contamination)), the project is expected to have only minor to negligible impacts on existing water quality during the construction phase.
Changes to water quality	Discharge from temporary sediment basins	Treated construction runoff is proposed to be discharged (controlled discharge) from temporary sediment basins and other minor locations. Waterways, including those which have been deemed KFH, would receive controlled discharges. Adverse impacts to these aquatic ecosystems are not expected from controlled discharges because temporary sediment basins would capture and treat runoff prior to being released downstream, (refer to **Chapter 11** (surface water and groundwater quality)). The treated discharges would have similar water quality to the existing surface water quality of these receiving environments. The existing water quality of non KFH waterways is indicated to be highly variable, generally poor and currently not meeting the relevant NSW Water Quality Objectives (refer to **Chapter 11** (surface water and groundwater quality)), therefore the limited biodiversity present in the waterways are likely to be habituated to poor water quality conditions. As such, the water quality that would be discharged from temporary sediment basins is expected to be similar to or better than existing water quality of the receiving environment and therefore aquatic ecosystems are likely to remain unchanged. In the event of extreme rainfall events (greater than 38.9mm) however, temporary sediment basins are anticipated to overflow and untreated runoff would be discharged to downstream waterways. These overflows are considered to be partially controlled as the temporary sediment basins would still be able to contain and treat the volume of runoff they have been sized for. This risk is considered low (based on historic rainfall data for the region) as the frequency of these events is likely to be minimal (about seven occurrences per year). As such, it is expected that any changes to water quality caused by releases during partially controlled discharges are likely to be temporary and would settle or become diluted within the surrounding environment in a relatively short

Type of impact	Associated construction activities	Potential impact
		timeframe. Aquatic biodiversity within these waterways is therefore expected to be able to tolerate the changes in the short term (further detail is provided in the Surface Water and Groundwater Quality Working Paper (**Appendix K**). As such, it is expected that any changes to water quality caused by releases during partially controlled discharges are likely to be temporary and would settle or become diluted by the surrounding environment within a relatively short timeframe. Aquatic biodiversity within these waterways are therefore expected to be able to tolerate the changes in the short term. Further information on discharge of temporary sediment basins is provided in **Chapter 11** (surface water and groundwater quality).
Removal of habitat	Purgatory creek adjustment	As described in **Section 5.3.10**, Purgatory Creek would need to be permanently realigned over a distance of 320m to accommodate the Tarro interchange. The creek is proposed to be realigned 90m to the south of its current location and would have a similar capacity to the existing creek channel. Potential impacts to aquatic biodiversity in Purgatory Creek as a result of this activity may include removal of instream aquatic macrophytes and other habitat features such as large woody debris (if present) and potential disruption of aquatic species which may utilise these features. These temporary impacts to the localised habitat are not expected to have a significant impact on aquatic biodiversity because the location is a substantial distance from downstream sections of the waterway that have been identified as KFH, and aquatic fauna that may be present would typically be mobile due to the ephemeral character of the waterway therefore would be able to relocate to similar upstream/downstream habitat during the temporary instream works. Further, large woody debris, if present, would be preserved and relocated downstream at an appropriate location. Following the creek adjustment, the project landscaping of the impacted area is anticipated to generally replicate the existing vegetated form.
Removal of habitat	Tributary of Viney Creek adjustment	As described in **Section 5.3.10**, about 150m of an artificial drainage channel that flows to Viney Creek is proposed to be permanently realigned up to 70m to the east. The section of tributary was modified during the construction of the existing motorway and presents as an ephemeral, partially rock armoured drainage line that flows through culverts under the motorway and later under John Renshaw Drive before flowing through an industrial area with a water level that is controlled by several constructed weirs. Temporary damming and bypassing of the existing drainage channel may be required during construction if water is present. The waterway is ephemeral, has minimal channel definition and is likely to be the product of a stormwater drainage path established by the initial construction of the M1 Pacific Motorway rather than a natural creek at this location. Water quality (when water is present) would reflect the modified catchment and aquatic species are highly unlikely to inhabit the waterway. Further, it is largely isolated from downstream environments due to the presence of several culverts and weirs, therefore upstream migration by aquatic fauna to this area is considered unlikely.

Type of impact	Associated construction activities	Potential impact
		As the drainage channel is highly disturbed and isolated from downstream waterways due to instream barriers, the permanent loss of the existing localised ephemeral features is unlikely to have a significant impact on the downstream aquatic environment of Viney Creek. Furthermore, following the installation of the new drainage channel, the project landscaping of the impacted area is anticipated to generally replicate the existing vegetated form. While risk to aquatic ecology in the tributary of Viney Creek and Viney Creek downstream is considered unlikely to be significant, the project has aimed to protect the downstream receiving environment (i.e. Viney Creek) by minimising disturbance to the waterway by implementing appropriate management measures (as outlined in **Section 9.5**).
Unplanned introduction and establishment of marine pest species in Hunter River	Instream works including barge movements	Instream works and discharges to aquatic environments may create the potential for the introduction and/or spread of aquatic biosecurity hazards. Due to the disconnection between the minor local creeks and wetlands and the Hunter River (and therefore likely sources of vectors of aquatic pests) the notable aquatic biosecurity risk is related to the Hunter River itself. The Hunter River is a shallow-water, nutrient rich, estuarine habitat which may be conducive to the establishment of invasive species. Further, the Hunter River estuary has a heightened risk to biosecurity as it hosts an active prawn fishery which extends from the river mouth to about 30km upstream to Raymond Terrace, and an established oyster farm which is located about 13km downstream of the project. Project activities that present the highest risk to aquatic biosecurity within the Hunter River include the movement and use of the instream floating barge platforms and other vessels required for instream works due to the potential for biofouling organisms on the external surfaces of vessels and/or within the vessel's ballast water, to be introduced into the Hunter River by the vessels. Marine pest species include non-native bivalve molluscs, seaweed and sea snails and slugs. Potential marine pests include seaweeds (*Caulerpa taxifolia* and *Undaria pinnatifida*), crustaceans (*Carcinus maenas*), polychaetes (*Sabella spallanzanii*), gastropods (*Maoricolpus roseus*), bivalve molluscs (*Musculista senhousia* and *Perna viridis*) and fish (*Tridentiger trigonocephalus*, *Oreochromis mossambicus* and *Acanthogobius flavimanus*). Other instream activities including piling, installation and use of temporary crossing structures, as well as in situ concrete pouring and installation of precast concrete structures also present a minor risk to aquatic biosecurity should equipment and/or materials be contaminated. Overall, potential direct and indirect impacts to aquatic ecosystems from introduction of pest species are considered minor and manageable with the application of recommended management measures (outlined in **Section 9.5**).

Changes to hydrology

As described in **Chapter 10** (hydrology and flooding), construction of the project has the potential to change surface water hydrology as it would involve creek adjustments at Purgatory Creek and a tributary of Viney Creek, bridge/viaduct construction over waterways and a wetland and the upgrade of existing and new highway cross drainage. Potential changes during construction include moderate increases to the rate, volume and velocity of stormwater discharged, changes to the existing flow regime at or immediately downstream of stormwater discharge locations, as well as changes to drainage. These changes may result in indirect impacts to aquatic biodiversity and aquatic ecosystems due to:

- Increased streamflow discharge and velocities may lead to reduced bank stability (e.g. scouring, undercutting, slumping), which could cause riverbank and streambed erosion and downstream sedimentation that may lead to infilling aquatic habitat features or smothering of aquatic vegetation
- Increased water turbidity due to suspended material may lead to clogging fish gills or smothering aquatic vegetation. Increased turbidity could also reduce light penetration through the water column which may impact growth of sensitive aquatic vegetation
- Increased flow velocities, reduced water levels or physical obstructions may result in obstruction to fish passage.

Minor changes to the hydrological regime of ephemeral waterways that are not KFH during construction of the project are unlikely to result in long term impacts to aquatic biodiversity and impacts to aquatic habitat within waterways would be highly localised and temporary. Importantly, construction activities are not expected to significantly alter flow in the Hunter River therefore long term impacts to aquatic species and aquatic habitat within the waterway are not anticipated. Despite the low likelihood of impacts, the project proposes to employ environmental management measures that aim to protect the existing aquatic values of all waterways within the construction footprint by minimising or avoiding hydrological changes. This would be achieved by implementing appropriate erosion and sediment controls, site-specific drainage design for the construction footprint, as well as temporary erosion and scour protection and flow dissipation where required.

With respect to the creek adjustments of Purgatory Creek and the tributary of Viney Creek, temporary damming and bypassing of the existing drainage channels may be required during construction if water is present, however temporary erosion and scour protection, as well as flow dissipation will be implemented where required.

In addition, temporary waterway crossings have been designed to be in accordance with the NSW Fisheries guidelines ‘Why do fish need to cross the road? Fish passage requirements for waterway crossings’ (Fairfull & Witheridge 2003) in order to ensure conditions for fish passage are maintained where required (described in **Table 9-16**).

Regular monitoring of key waterways for evidence of initiation of erosion and scour would be conducted for the duration of construction and, if required, appropriate remediation measures would be carried out.

With the implementation of measures, it is expected that impacts to aquatic ecosystems from hydrological changes during construction would be minimal and temporary, and long-term impacts are not anticipated. The potential changes to hydrology during construction of the project are discussed further in **Chapter 10** (hydrology and flooding).

Impacts to groundwater dependent ecosystems

Potential impacts to GDEs would be predominately associated with the following activities:

- Direct clearing of GDE vegetation (refer to **Table 9-7**)
- Localised ground-water drawdown during construction.

It should be noted that potential contamination of groundwater during construction and operation of the project would be minimised and managed via the environmental management measures outlined in the **Chapter 11** (surface water and groundwater quality) and **Chapter 16** (soils and contamination).

GDE vegetation clearing

As described in **Section 9.3.4**, based on the PCTs identified in the construction footprint during field surveys and a review of Bell and Driscoll (2006), Kuginis et al. (2012) and the GDE Atlas, it is likely that some of the PCTs present in the construction footprint would have a degree of groundwater dependence (refer to **Table 9-7**). Impacts associated with vegetation clearance is described in above.

Impacts to GDEs associated with temporary groundwater drawdown are discussed in the sections below.

Localised groundwater drawdown during construction

Chapter 11 (surface water and groundwater quality) identifies that the drawdown effect on groundwater would be short-term and localised. For example, temporary construction dewatering of excavations may be required where excavations are required below the water table. These would typically be of short duration, however, may still result in localised, short term, changes to the water table during some construction activities.

One Coastal Management SEPP coastal wetland located south of the Tarro interchange on the New England Highway has a predicted decrease in water level between 0.75 and 2.0 metres during some construction activities. However, this level of impact is a conservative modelled maximum predicted drawdown and the actual drawdown would likely be less and occur over a short duration (less than 10 days). These short term construction impacts are consistent with fluctuating groundwater levels typically experienced by these floodplain wetlands. As such, these short term changes are not expected to significantly impact on the extent or condition of any of the potential GDEs in or adjacent to the construction footprint, particularly as the GDEs identified are not obligate GDEs, and therefore predominantly rely on surface water.

Fragmentation of identified biodiversity links and habitat corridors

The project would not result in excessive landscape scale habitat fragmentation, due to its location, as there is already a high degree of fragmentation in the landscape associated with a long history of clearing floodplain forests and extensive road, rail and power networks in the area. The project has also been designed to minimise fragmentation by aligning closely to existing infrastructure and land uses.

In general, the project corridor has been well positioned to minimise further fragmentation of habitat and disruption of connectivity for fauna however, construction of the project would result in small-scale localised fragmentation of small patches of habitat (five to 20 hectares) including habitat used by threatened flora and fauna. Although the project has minimal impact on habitat connectivity at a landscape scale, it would result in minor small-scale localised fragmentation of habitat and barriers to fauna movement as described in **Table 9-17**.

These small-scale fragmentation impacts would be addressed by habitat connectivity measures as described in **Section 9.5.1**.

Table 9-17 Habitat fragmentation impacts

Fragmentation	Location
Black Hill About 26 hectares of dry sclerophyll forest with a grassy / shrubby understorey would be fragmented at Black Hill with the habitat surrounded by roads (shown in red hatching). This habitat is part of a larger area of vegetation about 130 hectares that would be divided in two. A small patch (four hectares) would also be temporarily isolated by construction access and an ancillary facility (AS2), however this patch is already somewhat disconnected by the clearing due to the Hunter Water Corporation Trunk Main and overhead electrical corridors to the south. Glider crossing structures, bridge underpass and fencing have been added to the design at this location to reconnect this area for arboreal fauna during operation.	
Tomago Habitat in the area of the Old Punt Road at Tomago is already fragmented by exiting roads and cleared power easements. Further development of the road network in this location would contribute to the cumulative fragmentation of smaller patches of isolated vegetation (around 9.5 hectares) due to widening of the existing Old Punt Road corridor. Sugar Gliders were confirmed in this location from the trapping surveys and the Squirrel Glider has been recorded one kilometre east of this patch (Kleinfelder 2019). Glider crossing structures have been added to the design at this location to reconnect this area for arboreal fauna during operation This fragmented vegetation would remain in the context of development of the approved AGL Newcastle Power Station in this location.	
Heatherbrae The project would result in the fragmentation of blackbutt open forest (around 5.3 hectares) providing potential habitat for the Squirrel Glider, New Holland Mouse and koala near Heatherbrae. This small area of habitat is already bound by industrial land to the north and west and therefore movements for fauna to the north are already limited. Given the small size of the area, and surrounding development, a crossing at this location may draw fauna into a sub-optimal patch and is not warranted, particularly given the extent of habitat to the south. Fauna fencing would be used at this location.	

Edge effects on adjacent native vegetation and habitat

Edge effects may be difficult to identify in the expansive areas of floodplain freshwater wetlands which have been extensively cleared, drained and grazed. Similarly, some forested areas next to the M1 Pacific Motorway and at the far northern end of the construction footprint are already edge affected.

The project has the potential to create edge effects within the newly created edges traversing the dry sclerophyll forests and forested wetland habitats, in particular at Black Hill and Heatherbrae as follows:

- **Black Hill:** where the project deviates from the M1 Pacific Motorway across to the bridge crossing of the Glenrowan Creek. All habitat in this location has already been degraded over time by track development, extensive rubbish dumping, selective clearing, grazing and construction of water pipeline infrastructure. Edge effects from the new road would contribute to this general degradation and could include up to 140 hectares of PCT1593 and PCT1588. This area is calculated based on a 50-metre edge effect from the construction footprint and has been calculated for the southern edge only as the northern edge would largely adjoin the existing cleared Hunter Water Corporation easement
- **Heatherbrae:** from the entrance to the Hunter Region Botanic Gardens north to Masonite Road a potential edge effect of up to 180 hectares of PCT1646 has been calculated. This is based on a 50 metre buffer on the construction footprint mostly on the southern and eastern boundary which would be a newly-created edge.

Degradation of the forest edges would be long-term but impacts would be localised and would not constitute or exacerbate any KTP as defined by the TSC Act or EPBC Act. The potential indirect impacts from edge effects were included in the overall calculation of impacts and offsets for this project, as the broader construction footprint includes a buffer around the design to allow for all potential construction activity.

Fauna injury and mortality

The construction of the project has the potential to result in injury and mortality of fauna. This has the greatest potential to occur from vegetation clearing and the extent of this impact would be proportionate to the extent of vegetation that is cleared. Some mobile species, such as birds, may be able to move away from the path of vegetation clearing and may not be greatly affected unless they are nesting. However, other species that are less mobile (for example, ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (for example arboreal mammals and microchiropteran bat species), may find it difficult to move rapidly when disturbed.

During construction, entrapment of wildlife in any trenches that are dug is a possibility if the trenches are deep and steep sided. Wildlife may also become trapped in machinery that is stored in the construction footprint overnight that may result in injury or death.

Injury and mortality of fauna would be minimised through the implementation of management and mitigation measures, such as pre-clearing surveys and fauna handling procedures, as outlined in **Section 9.5**.

Invasion and spread of weeds, pests, pathogens and disease

Project activities have the potential to disperse and import new weed species into the construction footprint, particularly through earthwork, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery. Without appropriate management strategies, this has potential to compromise the quality and integrity of receptors in areas adjacent to those being cleared, including TECs, remnant vegetation, habitat for threatened species, wetlands and waterways.

The legal requirements associated with weed species identified in the construction footprint is provided in **Table 9-18**.

Table 9-18 Biosecurity duty associated with weeds in the construction footprint

High threat exotic species (BAM)	Priority weed duties (Hunter region)	Weed of National Significance?
Ageratina adenophora	Not a priority weed	No
Alternanthera philoxeroides	Prohibition on dealings Must not be imported into the State or sold Biosecurity Zone The Alligator Weed Biosecurity Zone is established for all land within the state except land in the following regions: Greater Sydney; Hunter (but only in the local government areas of City of Lake Macquarie, City of Maitland, City of Newcastle or Port Stephens). This project is not in the Alligator weed biosecurity zone.	Yes
Andropogon virginicus	Not a priority weed	No
Araujia sericifera	Not a priority weed	No
Asparagus aethiopicus	Must not be imported into the State or sold	Yes
Axonopus fissifolius	Not a priority weed	No
Baccharis halimifolia	Regional Recommended Measure Land Area 1: core infestation within Newcastle, Greater Taree and Lake Macquarie. Land Area 2: rest of region Land Area 1: Land managers should mitigate the risk of new weeds being introduced to their land. Land Area 2: The plant should be eradicated from the land and the land kept free of the plant. Notify the Local Control Authority if found. The plant should not be bought, sold, grown, carried or released into the environment.	No
Chloris gayana	Not a priority weed	No
Cinnamomum camphora	Not a priority weed	No
Cortaderia selloana	Not a priority weed	No
Ehrharta erecta	Not a priority weed	No
Eragrostis curvula	Not a priority weed	No
Hyparrhenia hirta	Regional Recommended Measure The plant should not be bought, sold, grown, carried or released into the environment. Land managers should mitigate the risk of the plant being introduced to their land. Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.	No
Ipomoea cairica	Not a priority weed	No
Juncus acutus	Not a priority weed	No
Lantana camara	Prohibition on dealings Must not be imported into the State or sold	Yes
Ligustrum sinense	Not a priority weed	No

High threat exotic species (BAM)	Priority weed duties (Hunter region)	Weed of National Significance?
Megathyrus maximus	Not a priority weed	No
Ochna serrulata	Not a priority weed	No
Olea europaea subsp. *cuspidata*	Regional Recommended Measure Land managers mitigate the risk of the plant being introduced to their land. Land managers reduce impacts from the plant on priority assets. Land managers prevent spread from their land where feasible. The plant or parts of the plant are not traded, carried, grown or released into the environment	No
Paspalum dilatatum	Not a priority weed	No
Paspalum quadrifarium	Not a priority weed	No
Pennisetum clandestinum	Not a priority weed	No
Phyla nodiflora	Not a priority weed	No
Pinus radiata	Not a priority weed	No
Ricinus communis	Not a priority weed	No
Rosa rubiginosa	Not a priority weed	No
Rubus fruticosus agg.	Prohibition on dealings Must not be imported into the State or sold All species in the *Rubus fruiticosus* species aggregate have this requirement, except for the varietals Black Satin, Chehalem, Chester Thornless, Dirksen Thornless, Loch Ness, Murrindindi, Silvan, Smooth Stem, and Thornfree Regional Recommended Measure The plant should not be bought, sold, grown, carried or released into the environment. Land managers should mitigate the risk of the plant being introduced to their land. Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.	Yes
Senecio madagascariensis	Prohibition on dealings Must not be imported into the State or sold	Yes
Senna pendula	Not a priority weed	No
Stenotaphrum secundatum	Not a priority weed	No
Tradescantia fluminensis	Not a priority weed	No

Construction of linear infrastructure, such as the project, through large patches of intact vegetation can result in the establishment of pest species (particularly predators such as foxes and cats) into areas where they are currently absent or in low numbers due to habitat removal, noise and human presence. However, in the context of the project this impact is predicted to be minimal as all vegetation in the construction footprint is likely to already be impacted by foxes and cats. The magnitude of this impact would be low.

Construction of the project has the potential to introduce pathogens and disease, such as Phytophthora, amphibian chytrid fungus and exotic Rust Fungi, into the construction footprint and adjacent areas. Pathogens were not observed in the construction footprint, however, the potential for pathogens to occur should be treated as a risk during construction as pathogens can be transported by machinery or vehicles. While forested areas are likely at greater risk from plant disease than the freshwater wetland areas of the construction footprint, all areas should be treated equally in terms of the potential risk and managing the spread of pathogens and disease.

Strict hygiene measures will be implemented during construction that would assist in preventing the spread of weeds, pests, pathogens and disease and any potential impacts on native vegetation, threatened species habitat and threatened fauna. These measures are detailed in **Section 9.5** and address the general biosecurity duty, as defined by Part 3 of the *Biosecurity Act 2015*.

Noise, dust, light and contaminants

Construction of the project has the potential to disturb habitats as a result of increased noise and vibration, dust, light and accidental release of contaminants. These impacts are likely to have cumulative effects particularly during a lengthy construction period and in areas where construction activities are adjacent to vegetated areas. These impacts are discussed further in **Table 9-19**.

Table 9-19 Impacts from construction noise, dust, light and contaminants on biodiversity

Potential impact	Description
Noise and vibration	There would be increased noise and vibration levels in the construction footprint and immediate surrounds due to vegetation clearing, ground disturbance, machinery and vehicle movements, and general human presence. The noise and vibration from activities associated with the project would potentially disturb fauna and may disrupt foraging, reproductive (calling behaviour), or movement behaviours. The impacts from noise and vibration emissions on resident fauna would likely be localised to the construction footprint and adjacent areas. However, considering most of the construction would be located along existing road infrastructure, the impacts of noise pollution on wildlife populations would likely be low.
Dust	Dust pollution would be greatest during construction due to earthwork, vegetation clearing, vehicle movements for construction and decommissioning activities and during adverse weather conditions. Areas at greatest risk would be Black Hill and Heatherbrae, where remnant vegetation is to be retained next to the construction footprint. Dust impacts may also occur at the bridge crossing of Hunter River, where adjacent saltmarsh and mangrove forest would remain. The deposition of dust on foliage would likely be highly localised, intermittent, and temporary (can be removed by rain) and is therefore not considered likely to be a major impact of the project. Most of the construction would be carried out along existing road infrastructure so the impact of dust pollution in these areas would likely be low. Further information on air quality impacts on ecological receivers are provided in **Chapter 18** (air quality).
Temporary lighting	The construction footprint would be subject to artificial lighting, essentially creating ‘daylight’ conditions during the night construction works. Ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle. Some species (i.e. light tolerant microchiropteran bats) may benefit from the lighting due to increased food availability (insects attracted to lights) around these areas. Most construction activities would take place over a relatively short period of time. The need for artificial lighting during construction will be minimised where feasible, including directing lighting away from vegetated areas where practicable (refer to **Section 9.5**). As a result, the impacts of light pollution on fauna activity and movements would likely be low and short-term in nature.

Potential impact	Description
Contaminants (i.e. hydraulic fluids, oils, drilling fluids, etc.)	Localised release of contaminants into the surrounding environment (including drainage lines and freshwater wetlands) may accidentally occur. The most likely result of contaminant discharge would be the localised contamination of soil and potential direct physical trauma and or death to flora and fauna that come into contact with contaminants. Accidental spills would be managed during construction in accordance with the CSWMP prepared for the project (refer to **Chapter 11** (surface water and groundwater quality)).

9.4.3 Assessment of potential operational impacts

Removal of native vegetation, flora and fauna habitat

Removal of native vegetation, threatened flora and fauna habitat (including habitat for migratory species) would occur during construction of the project. Operation of the project would not require additional clearing.

Landscape features and values

Impacts on riparian buffer of important rivers, streams and estuaries

All impacts on riparian buffers are discussed in **Section 9.4.2** and would occur during construction of the project. Operation of the project would not impact further on riparian buffers.

Impacts on important wetlands

All impacts on important wetlands would occur during construction of the project, as discussed in **Section 9.4.2**. As described previously, mapped important wetlands associated with the Hunter River floodplain in this location have a long history of impacts. These impacts are associated with clearing and modification for past agricultural land use.

Long-term downstream impacts are expected to be minor as the viaduct (B05) completely spans the Hunter River and existing bridge structures already occur downstream of the construction footprint. Impacts to aquatic habitats during operation of the project are discussed below.

Impacts on Matters of National Environmental Significance

All impacts on MNES would occur during construction of the project, as discussed in **Section 9.4.2**.

As described in **Chapter 11** (surface water and groundwater quality), operation of the project is not expected to result in any significant impacts to water quality at the Hunter Estuary Wetland Ramsar site at Kooragang Nature Reserve. A dilution assessment demonstrated that the minor contribution of basin discharge to the Hunter River would be adequately diluted such that the basin discharges would not contribute to higher turbidity, total nitrogen or total phosphorus at the Hunter Estuary Wetland Ramsar site at Kooragang Nature Reserve.

Operation of the project would not impact further on MNES.

Aquatic impacts and changes to hydrology

Operation of the project has the potential to impact aquatic ecosystems and result in changes to existing hydrology. Aquatic impacts could occur due to changes in water quality, habitat loss, permanent instream barriers and potential impacts to KFH.

The operation of the project would not have significant direct impact on aquatic biodiversity. Following the completion of construction, all temporary instream structures would be removed, riparian and aquatic habitat within disturbed waterways (i.e. in Glenrowan Creek, Coastal wetland (east of the Hunter River) and Windeyers Creek) would be rehabilitated where possible, and disturbed soils in construction areas would be stabilised. Potential impacts as a result of operation of the project are discussed in the sections that follow.

Bridge crossings over waterways and wetlands

As described in **Section 9.4.2**, the project includes three bridge crossings (B05, B11 and B02) over waterways or wetlands.

Shading from bridge or viaduct structures over waterways or wetlands can impact on water quality by influencing temperature and biomass growth. This impact would be unlikely to occur in the Hunter River due to the height of the viaduct and the large and dynamic nature of the waterway. These impacts would be more likely to occur in slow moving aquatic environments, such as Windeyers Creek. However, the area of shading is only a small proportion of the relatively large wetland system, which is already subject to shading from surrounding woodland and pine vegetation. The impacts associated with shading on aquatic environments would be likely to be minor.

Based on the bridge design, scour protection and drainage infrastructure of the viaduct and bridge crossings as well as the implementation of management measures outlined in **Section 9.5**, downstream water quality impacts are considered to be low and any residual impacts (such as minor increases in turbidity and sediment deposition) that are expected would be localised and minor. In addition, the project would implement management measures to mitigate impacts to water quality as described in **Chapter 11** (surface water and groundwater quality).

Potential impacts to aquatic ecosystems

Operation of the project generally has limited potential to impact aquatic ecosystems. The potential impacts to waterways during operation of the project are described in **Table 9-20**.

Potential impacts to fish habitat

As described in **Section 9.3.6**, the project crosses mapped KFH (as identified by DPI and based on field observations) (refer to **Figure 9-8**). The potential impacts to KFH during operation of the project are generally the same as those identified for aquatic ecosystems and are described in **Table 9-20**.

Table 9-20 Potential impacts to aquatic ecosystems during operation of the project

Type of impact	Associated operational activity	Potential impact
Impacts to fish passage	Bridge/culvert design	The design of the bridges and culverts over waterways has complied with DPI Fisheries design guidelines reported in Fairfull & Witheridge (2003) to ensure that barriers to fish passage are not created in the long-term. Based on the assessment of waterway 'class' (Fairfull & Witheridge 2003), fish-friendly bridge crossings are only required over the Hunter River. This waterway was classified as Class 1 – Major fish habitat and therefore require a minimum crossing type of a bridge, arch structure or tunnel (Fairfull & Witheridge 2003). All other waterways where there would be permanent crossings were classified as either 'Class 4 – Unlikely fish habitat' or 'Class 3 – Minimal fish habitat' which only require a minimum crossing type of a culvert or ford (Fairfull & Witheridge 2003). Despite this, bridge structures have been designed at all of these waterway crossing locations, with the exception of Purgatory Creek and a tributary of Viney Creek where culverts have been proposed (discussed below).

Type of impact	Associated operational activity	Potential impact
Changes to water quality	Discharge from permanent water quality basins	While permanent water quality basins are not subject to a dewatering regime during operation, surface water runoff during and following rainfall may result in permanent water quality basins occasionally discharging to downstream receiving environments during large rainfall events that exceed the detention capacity of the basin. Operational discharges may potentially contain contaminants associated with surface water from new impervious surfaces and the operation of a new motorway including sediment and other contaminants (hydrocarbons etc). Operational discharges would be limited to periods of higher rainfall (a rainfall event of 38.9mm or greater), when the wider catchment is also at peak surface water flows (which is when water typically has higher volumes of contaminants). As per the project design, the operational surface water capture and treatment system shall predominately direct basin discharge into the local minor waterways which are not KFH. Ten of the permanent water quality basins that have been proposed would interact with the groundwater table where groundwater quality is saline. For these basins with saline groundwater inflows, the discharge may be more saline than the receiving environment. This risk is most likely at the three basins (PB05, PB06 and PB07) which would discharge into Glenrowan Creek and the tributary of Viney Creek as these waterways are freshwater and typically have lower salinity levels than groundwater. Since both of the waterways are not KFH and do not present significant aquatic habitat features, risks to aquatic biodiversity from saline discharge is considered low. Further, any overflow of the structures would occur during a period of peak charge (during a rainfall event of 38.9mm or greater) in the system, suggesting that the influence of saline water would be minimal. As discussed in **Chapter 11** (surface water and groundwater quality), the quality of the operational discharges would be generally consistent with the range of existing surface water quality and hence is unlikely to have a significant impact of aquatic biodiversity within the waterway.
Changes to water quality	Project operation	The project has been designed to include permanent water quality controls in order to mitigate long-term water quality impacts to downstream waterways including KFH. These controls include permanent water quality basins and vegetated swales. Water quality basins have been designed to contain a 20,000L spill (with the exception of the Tomago Sandbeds Catchment Area where the minimum containment volume is 30,000L) and would promote settlement of sediments by slowing down and temporarily detaining flows. Due to the implementation of these controls during operation, risk of potential changes to water quality within waterways and KFH would be minimised therefore aquatic flora and fauna are is also not expected to be significantly impacted. This is discussed further in the **Chapter 11** (surface water and groundwater quality).

Changes to hydrology

As described in **Chapter 10** (hydrology and flooding), operation of the project has the potential to change surface water hydrology as a result of road paving and soil compaction, changes to drainage paths and catchments, additional stormwater runoff and stormwater discharge from permanent water quality basins.

Similar to the construction phase, potential changes to hydrology include moderate increases to the rate, volume and velocity of stormwater discharged, changes to the existing flow regime at or immediately downstream of stormwater discharge locations during operation, as well as changes on existing drainage. These changes have potential to impact on the aquatic ecosystems of the downstream receiving environment from potential increased erosion and sedimentation, impacts on aquatic organisms such as clogging fish gills or smothering aquatic vegetation, or may result in physical or behavioural barriers to fish passage due to increased velocities, reduced water levels or physical obstructions.

During operation, environmental management measures have been proposed which aim to minimise or avoid hydrology impacts to downstream waterways, including appropriate erosion and sediment controls, site-specific drainage design, scour protection and flow dissipation where required. Further, the adjusted Purgatory Creek and tributary of Viney Creek have been designed with controls to minimise potential areas of erosion and scour and any subsequent downstream impacts.

Permanent waterway crossings have been designed in accordance with NSW Fisheries guidelines 'Why do fish need to cross the road? Fish passage requirements for waterway crossings' (Fairfull & Witheridge 2003) in order to ensure conditions for fish passage are maintained where required.

Regular monitoring of key waterways downstream of the project discharge locations for evidence of initiation of erosion and scour would be conducted for a minimum of twelve months after construction and, if required, appropriate remediation measures would be carried out.

With the implementation of these measures, changes to hydrology within downstream waterways is anticipated to be minor and would not result in a long-term impact to downstream aquatic ecosystems. The potential changes to hydrology during construction of the project are discussed further in **Chapter 10** (hydrology and flooding).

Impacts on groundwater dependent ecosystems

As described in **Chapter 10** (hydrology and flooding) and **Chapter 11** (surface water and groundwater quality), the project would not result in ongoing lowering of the water table during operation of the project suggesting no long-term, permanent impacts on GDEs.

Chapter 10 (hydrology and flooding) provides an assessment of the potential short term increases in flooding heights on the floodplain where PCT1736 (Water Couch – Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter) has been mapped. The assessment discusses minor increases to the duration and depth of inundation for overbank events adjacent to the Hunter River as a result of finished road levels (i.e. the embankment/fill). These localised changes would likely have a negligible impact to the wetland vegetation which is already subject to periodic inundation of different levels and duration. This is further supported by the high groundwater levels in the floodplain surrounding the Hunter River, and the fact that there is no anticipated drawdown

Minor changes to operational drainage structures that service the wetland south of the Hunter Region Botanic Gardens may result in changes of water levels upstream of the existing Pacific Highway of up to 0.2 metres. The area potentially impacted by this change in design is currently a wetland community (sedge spp, typha spp, paperbark spp) that is subject to rainfall dependent changes in surface water levels, and possibly changes in groundwater levels (although not an obligate GDE). The potential changes to water levels due to operational drainage upgrades would generally reflect the existing variations in the hydrological regime and is unlikely to significantly impact on this aquatic environment.

Fauna injury and mortality

It is anticipated that the primary cause of fauna injury and mortality during the operation of the project would be vehicle collisions. This direct impact could reduce local population numbers and is a common occurrence in Australia (Coffin 2007; Rowden et al. 2008). Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly those common species (such as Kangaroos) that are tolerant of disturbance and/or those species that can use roadways for movement pathways or roadside vegetation as foraging habitat.

A population of Eastern Grey Kangaroo (*Macropus giganteus*) was noted in the Black Hill area during the survey which may be at an increased risk over the medium to long term of vehicle strike during the operation of the new motorway at the Black Hill and Beresfield area.

Opportunities to provide crossings for fauna have been considered as part of the habitat connectivity for the project, as described in **Section 9.5.1**.

Koala

The potential for the project to impact koala during operation is generally restricted to injury or mortality from vehicle strike. As the project is located adjacent to existing roads and industrial areas impacts on the movements of koalas, notably the known Port Stephens koala population, would be minimal. With the exception of a small area of potential habitat just south of Heatherbrae (noted in **Table 9-17** above) there are no known areas of koala habitat to the west of the project. As such, it is considered unlikely that koalas would cross from the large extent of habitat east of the project to the highly developed land located to the west of the project. Furthermore, the project includes fauna exclusion fencing at strategic locations to prevent fauna, such as koalas, from entering the road corridor. Operational impacts on the koala are therefore considered to be minimal.

Invasion and spread of weeds, pests, pathogen and disease

Minimal native vegetation, threatened species and agricultural land would be disturbed during operation of the project as described in **Chapter 14** (land use and property) and **Chapter 22** (safety and risk). During operation, the risk of weed dispersal into adjoining bushland is low due to landscaping of bare ground adjacent to the road. However, the road verge environment may create a modified landscape where weeds become established.

The operation of the project has the potential to disperse pest species (such as foxes and cats) across the surrounding landscape due to noise and human presence. However, in the context of the project, this impact is predicted to be minimal as areas within the operational footprint are likely to already be impacted by foxes and cats.

Operation of the project has the potential to introduce pathogens and disease, such as *Phytophthora cinnamomi* (Root Rot Fungus), amphibian chytrid fungus and exotic Rust Fungi, into the construction footprint and adjacent areas by machinery or vehicles. While forested areas are likely at greater risk from plant disease than the freshwater wetland areas of the construction footprint, all areas should be treated equally in terms of the potential risk and managing the spread of pathogens and disease.

Strict hygiene measures will be implemented during operation that would assist in preventing the spread of weeds, pests, pathogens and disease and any potential impacts on native vegetation, threatened species habitat and threatened fauna. These measures are detailed in **Section 9.5** and address the general biosecurity duty, as defined by Part 3 of the *Biosecurity Act 2015*.

Noise, dust, light and contaminants

Operation of the project has the potential to impact fauna and habitats as a result of increased noise, dust and light. These impacts are not considered to be significant.

Table 9-21 Impacts from noise, dust, light and contaminants on biodiversity during operation of the project

Potential impact	Description
Noise and vibration	Potential impacts from noise emissions would be localised to the areas immediately adjacent to the project. Some sensitive species (e.g. woodland birds) may avoid the noise, while some more tolerant species (e.g. small mammals) would habituate over the longer term. All areas of the project are subject to noise impacts on resident fauna, including common and threatened species. Considering most of the construction would be located along existing road infrastructure, the impacts of noise pollution on wildlife populations would likely be low.
Dust	As described in **Chapter 11** (surface water and groundwater quality), project operation would generate litter and transport dust as part of road use by vehicles. Gross pollutants may result in increased levels of nutrients and toxicants which may be harmful to aquatic life and reduce visual amenity in receiving waterways and wetlands. With the implementation of the environmental management measures described in **Section 11.5**, dust and litter, if managed correctly, are not likely to result in a significant impact to water quality.
Lighting	The project would include artificial lighting at interchanges, associated ramps, and roads in the vicinity of interchanges, essentially creating permanent 'daylight' conditions. Ecological light pollution may potentially affect nocturnal fauna by interrupting their life cycle. Some species (i.e. light tolerant microchiropteran bats) may benefit from the lighting due to increased food availability (insects attracted to lights) around these areas. Due to the frequency and sustained nature of the lighting, it is unlikely that animals would habituate to the light disturbance and a long-term impact in the area of lighting is likely.
Contaminants (i.e. hydraulic fluids, oils, drilling fluids, etc.)	Stormwater quality management for road runoff includes managing the export of suspended solids and associated contaminants, namely heavy metals, nutrients, and organic compounds (refer to **Chapter 11** (surface water and groundwater quality)). Pollutants such as nutrients, heavy metals and hydrocarbons are usually attached to fine sediments. To minimise water quality impacts from additional stormwater runoff and spills, the project has been designed to include permanent water quality controls, including permanent water quality basins and vegetated swales as detailed in **Section 11.4.3**. Due to these controls, risk of potential changes to water quality within downstream waterways and wetlands would be minimised. Stormwater runoff from the project would not be expected to have a significant impact on water quality during operation. There would be sufficient opportunity for any spill event to be contained near the project within the permanent water quality basins which include spill containment across the project. The risk associated with accidental spills within the project are considered comparable to those of similar roads. As such, potential risk of poor water quality mobilising to downstream waterways from spills would be negligible and would be sufficiently managed through proposed design and management measures (refer to **Chapter 11** (surface water and groundwater quality).

9.5 Environmental management measures

The management measures that will be implemented to minimise the biodiversity impacts of the project, along with the responsibility and timing for those measures, are presented in **Table 9-22**.

Table 9-22 Environmental management measures (biodiversity)

Impacts	Reference	Management measures	Responsibility	Timing
Loss of vegetation and habitat for flora and fauna including threatened species	B01	A Flora and Fauna Management Plan (FFMP) will be prepared in accordance with the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011). It will address terrestrial and aquatic matters and include, but not necessarily be limited to: • Plans for the construction footprint and adjoining areas showing native vegetation, flora and fauna habitat, threatened species and endangered ecological communities • Procedures addressing relevant matters specified in the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) • Procedures for the protection of aquatic fauna associated with instream works. All personnel working on site will receive training to ensure awareness of requirements of the FFMP and relevant statutory responsibilities.	Contractor	Detailed design/ prior to construction
	B02	Pre-clearing surveys will be carried out in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (Guide 1: Pre-clearing process) (RTA 2011).	Contractor	Prior to construction
	B03	If any threatened species, not assessed in the biodiversity assessment, are identified in the construction footprint, the unexpected species find procedure is to be followed under 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011).	Contractor	Construction
	B04	Vegetation and habitat removal will be carried out in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (Guide 4: Clearing of vegetation and removal of bushrock) (RTA 2011).	Contractor	Construction
	B05	Revegetation will be carried out in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) (Guide 3: Re-establishment of native vegetation) and the Landscape Plan prepared for the project.	Contractor	Construction
	B06	Re-use of woody debris and bushrock and installation of nest boxes would be carried out in accordance with the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011), Guide 5 & Guide 8.	Contractor	Construction

Impacts	Reference	Management measures	Responsibility	Timing
Potential impacts to aquatic habitat	B07	Aquatic habitat will be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) and where practicable, Section 3.3.2 Standard precautions and mitigation measures of the 'Policy and guidelines for fish habitat conservation and management Update 2013' (DPI 2013a)	Contractor	Construction
Fragmentation of habitat and barrier effects and fauna mortality during operation	B08	Fauna crossing and exclusion fencing structures would be designed and constructed to facilitate fauna connectivity and exclusion across the project in accordance with the Biodiversity Assessment Report.	Transport/Contractor	Detailed design/ construction
Edge effects on adjacent native vegetation and habitat	B09	Exclusion zones will be set up at the limit of clearing in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) (Guide 2: Exclusion zones).	Contractor	Construction
Injury and mortality of fauna during clearing and construction	B10	Fauna will be managed in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) (Guide 9: Fauna handling).	Contractor	Construction
Invasion and spread of weeds	B11	Weed species will be managed in accordance with 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011) (Guide 6: Weed management).	Contractor	Construction
Invasion and spread of pest animal, pathogens and disease	B12	Pest species and pathogens will be managed in accordance Guide 2: Exclusion zones of the 'Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects' (RTA 2011), the Commonwealth *Biosecurity Act 2015,* NSW *Biosecurity Act 2015* and where relevant, the Australian Ballast Water Management Requirements.	Contractor	Construction
Noise, light and vibration	B13	The need for artificial lighting during construction and operation will be minimised where feasible, including directing lighting away from vegetated areas where practicable.	Contractor	Detailed design/ construction

Impacts	Reference	Management measures	Responsibility	Timing
Other relevant management measures				
Landscape character and visual impacts including during construction	UD02	Disturbed areas outside the operational footprint and within the construction footprint will be revegetated following completion of construction activities.	Contractor	Construction
	UD03	Cut batters and fill embankments for the project will be designed to allow revegetation to assist with the integration of the project into the surrounding landscape where possible depending on site conditions.	Contractor	Construction

9.5.1 Habitat connectivity measures

Fauna connectivity structures proposed for the project include glider poles and rope crossings to link areas of vegetation and provide connections for tree-dwelling mammals. As the project has been identified as having minimal impact on landscape connectivity for ground-dwelling fauna, dedicated underpass crossing structures are not proposed. The viaduct across the Hunter River and adjacent floodplain will allow the movement of fauna either side of the corridor and retains habitat connectivity of a large scale. Bridges at Black Hill and Windeyers Creek will also provide for incidental movements by fauna across the construction footprint and will be combined with fauna exclusion fencing to aid fauna movements and minimise vehicle strike.

Proposed crossing structures and associated fencing for the project is detailed in **Table 5-8** and shown in **Figure 5-1**.

9.6 Offsetting requirements

9.6.1 Biodiversity offsets

Under the FBA, any residual impacts that cannot be avoided, minimised or mitigated, must be offset, with the offset requirements quantified as biodiversity credits. The BOS provides greater detail regarding the potential mechanisms for meeting this offset obligation, including an assessment of Transport properties adjacent to the construction footprint. The BOS is provided as Appendix I of the BAR (**Appendix I**).

A total of 8,076 ecosystem credits were identified as being required, as summarised in **Table 9-23**.

Table 9-23 Ecosystem credit requirements

Vegetation zone	Plant community type (BVT)	Threatened species with highest credit requirement	Loss in site value score	Project impact within construction footprint (ha)	Ecosystem credits required
1. 1590 – Good	Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest (1590) (HU804)	Powerful Owl	77.08	25.16	1626
2. 1590 – Moderate			64.58	8.35	461
3.1590 – Regenerating			29.17	8.37	240
4.1588 – Moderate	Grey Ironbark – Broad-leaved Mahogany – Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast (1588) (HU802)	Spotted-tailed Quoll	79.69	6.78	397
5.1588 – Regenerating			49.48	0.82	32
6. 1646 – Good	Smooth-barked Apple – Blackbutt – Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (1646) (HU860)	Powerful Owl	59.90	20.76	1074
7.1646 – Poor			50.00	7.83	347

Vegetation zone	Plant community type (BVT)	Threatened species with highest credit requirement	Loss in site value score	Project impact within construction footprint (ha)	Ecosystem credits required
8.1649 – Good	Smooth-barked Apple – Red Mahogany – Swamp Mahogany – *Melaleuca sieberi* heathy swamp woodland of coastal lowlands (1649) (HU863)	Spotted-tailed Quoll	61.33	1.36	72
9.1598 – Poor	Forest Red Gum grassy open forest on floodplains of the lower Hunter (1598) (HU812)	Spotted-tailed Quoll	71.33	0.45	27
10.1716 – Good	Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast (1716) (HU930)	Spotted-tailed Quoll	66.67	1.82	103
11.1717 – Good	Broad-leaved Paperbark – Swamp Mahogany – Swamp Oak – Saw Sedge swamp forest of the Central Coast and Lower North Coast (1717) (HU931)	Spotted-tailed Quoll	62.00	3.85	205
12.1717 – Poor			44.00	6.64	264
13.1724 – Good	Broad-leaved Paperbark – Swamp Oak – Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1724) (HU938)	Spotted-tailed Quoll	53.33	1.61	75
14.1727 – Moderate	Swamp Oak – Sea Rush – *Baumea juncea* swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1727) (HU941)	Spotted-tailed Quoll	55.33	8.76	423
15.1736 – Good	Water Couch – Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter (1736) (HU950)	Little Eagle	48.06	33.23	1424
16.1736 – Moderate			36.43	25.81	881
17.1742 – Good	Jointed Twig-rush sedgeland (1742) (HU956)	Little Eagle	82.17	1.45	99
18.1071 – Good	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion (1071) (HU673)	Little Eagle	47.29	7.71	326
Total				**170.76***	**8,076**

*This total is different to what is listed in **Table 9-12** as it does not include the saline communities Grey Mangrove Low Closed Forest (HU961) or Saltmarsh Estuarine Complex (HU960). These are discussed in **Section 9.6.2**.

Species credits were calculated for four threatened flora species and five threatened fauna species listed under the TSC Act and/or EPBC Act. A total of 17,895 species credits were identified as being required, as summarised in **Table 9-24**.

Table 9-24 Species credit requirements

Species	Extent of impact (ha) or individuals	Species credits required
Eucalyptus parramattensis subsp. *decadens*	34 plants	476
Diuris arenaria	161 plants	12,397
Callistemon linearifolius	157 plants	2,198
Persicaria elatior	3 plants	39
Australian Bittern	43.64ha	567
Black Bittern	61.95ha	805
Koala	51.12ha	1,329
Wallum Froglet	3.21ha	42
Mahony's Toadlet	3.21ha	42
Total		**17,895**

9.6.2 Offsets for impacts to aquatic habitats

According to the FBA, PCTs that are classified under the VIS classification database as being in the saline wetlands vegetation formation must be assessed according to the Fisheries NSW policy and guidelines. Two of the PCTs that would be impacted by the project are saline wetland formations, and monetary offset requirements have been calculated in accordance with policy and guidelines for fish habitat conservation and management (DPI 2013a). These guidelines identify habitat compensation on a minimum 2:1 basis for all KFH (TYPE1-3), which includes 1.26 hectares of Saltmarsh Estuarine Complex (PCT 1746) and 2.27 hectares of Grey Mangrove Low Closed Forest (PCT 1747).

It is recognised that there may also be alternatives to a monetary compensation to provide an adequate offset or compensation (e.g. remediation work) for impacts to saline vegetation types. Consultation with NSW DPI will be carried out to discuss other potential alternative options for compensation that are consistent with meeting the 2:1 offset ratio applied.

The project would also impact around 16.4 hectares of mapped Coastal Management SEPP coastal wetlands, which includes about 3.53 hectares of the saltmarsh and mangrove communities. The remaining areas of the Coastal Management SEPP coastal wetland impacted by the project are covered by the PCTs 1736 and 1071 and will be offset as per the ecosystem credit calculations for these respective PCTs shown in **Table 9-23**.