
ADDITIONAL CROSSING OF THE CLARENCE RIVER AT GRAFTON

Appendix L – Technical Paper: Flora and fauna assessment

AUGUST 2014

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Glossary

AoS	Assessment of Significance – formerly the seven part test
CBD	Central Business District
cm	Centimetres
CMA	Catchment Management Authority
CWD	Coarse Woody Debris
DBH	Diameter at Breast Height
DGRs	Director General's Environmental Assessment Requirements
DPI	Department of Primary Industries
DPE	NSW Department of Planning and Environment formerly NSW Department of Planning and Infrastructure
DoE	Department of the Environment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FM Act	<i>Fisheries Management Act 1994</i>
FW	<i>Freshwater Wetlands on Coastal Plains</i>
ha	Hectares
km	Kilometres
KTP	Key Threatening Process
LEP	Local Environment Plan
LGA	Local Government Area
m	metre/s
mm	millimetre/s

MNES	Matters of National Environmental Significance
NP	National Park
NPWS	National Parks and Wildlife Services
NSW	New South Wales
NV Act	<i>Native Vegetation Act 2003</i>
NW Act	<i>Noxious Weeds Act, 1993</i>
OEH	Office of Environment and Heritage
Project	Additional Crossing of the Clarence River at Grafton
Project area	The area which encompasses the project during operation and construction, including: operational road boundary, ancillary areas, construction work zone, including temporary ancillary sites and the jetty for barge launching and the flood mitigation works areas.
Roads and Maritime	Roads and Maritime Services
RoTAP	Rare or Threatened Australian Plant
SCFF	<i>Subtropical Coastal Floodplain Forest</i>
SEPP	State Environmental Planning Policy
SEPP 44	State Environmental Planning Policy No. 44 – Koala Habitat Protection
SIC assessment	Significant Impact Criteria assessment
SIS	Species Impact Statement
SSI	State Significant Infrastructure
Study area	The area encompassing the project area and any adjoining or adjacent area where potential indirect impacts may occur
TEC	Threatened Ecological Community
TSC Act	<i>Threatened Species Conservation Act 1995</i>

Executive Summary

Biosis Pty Ltd was commissioned by Arup, on behalf of NSW Roads and Maritime Services (Roads and Maritime) to undertake a flora and fauna assessment to support the Environmental Impact Statement (EIS) for the Additional Crossing of the Clarence River at Grafton (the project).

The project is located in a highly modified area associated with the city of Grafton, which is located in NSW approximately 600 kilometres (km) north of the Sydney central business district (CBD). The project area encompasses land subject to various zoning components; infrastructure (railway, tourist and educational establishment), business development, primary production, recreational waterway, public recreation and general residential zones.

The project area for the purpose of this EIS is broken down into four core components (Figure 1):

- Operational road boundary.
- Permanent ancillary elements such as operational detention basin and pump station in Grafton.
- Construction work zone, which includes temporary facilities such as South Grafton ancillary site, Pound Street ancillary site and the jetty for barge launching.
- Flood mitigation works construction zone, which includes temporary stockpile areas.

The project area encompasses project area and any adjoining or adjacent area where potential indirect impacts may occur.

Existing environment

The majority of the project area is represented by a highly modified landscape in poor condition with little or no native vegetation remaining. These areas have been subject to historic and ongoing urbanisation, grazing and cropping which has led to the isolated and fragmented nature of remnant vegetation.

The project area (Figure 1) footprint in total is 49.70 hectares (ha) of which 36.07 ha comprises vegetation and the remaining hard stand, buildings and infrastructure. The vegetation includes 31.25 ha of weeds and exotics, 4.41 ha of native and exotic plantings and 0.41 ha of poor condition threatened ecological communities. This vegetation is generally in low condition in a cleared and highly modified urban and rural environment.

The key ecological values identified within the Project area include:

- Two threatened ecological communities (TEC) totalling 0.41 ha in the project area, listed under the *Threatened Species Conservation Act, 1995* (TSC Act), namely:
 - 0.10 ha of Freshwater Wetlands on Coastal Floodplains (FWCF).
 - 0.31 ha of Subtropical Coastal Floodplain Forest (SCFF).
- Seven trees, including two hollow bearing trees, a *Eucalyptus sp.* and a River She-oak *Casuarina cunninghamiana* and five habitat trees Moreton Bay Fig *Ficus macrophylla* providing potential roosting and foraging resources for threatened avifauna (i.e. bird and bat) species.
- Residential dwellings within the area of the ancillary areas, roads and related infrastructure such as the existing bridge which provide potential roosting resources for threatened TSC Act listed vulnerable microbats; Eastern Bentwing-bat, Southern Myotis, Eastern Long-eared Bat, Eastern Freetail-bat,

Eastern cave bat, Greater broad-nosed bat, Hoary wattled-bat, Hollow bearing trees, existing bridge over the Clarence River, houses and Little bentwing-bat.

- Potential subterranean burrowing habitat for the Three-toed snake-tooth skink (vulnerable, EPBC Act and TSC Act).
- Known breeding colonies of threatened and migratory species in the broader locality, including the:
 - Grey-headed Flying-fox (vulnerable, EPBC Act and TSC Act) colony on Susan Island
 - Cattle egret breeding colony in Grafton (corner of Kirchner and Prince St).
- The Clarence River and adjacent tributaries are classified as CLASS 1 waterways, which within and adjacent to the alignment contains TYPE 2 moderately sensitive key fish habitat as it provides riverine brackish wetland habitats, and has a stable vegetated substrate.
- The Clarence River contains potential suitable habitat for Silver Perch (EPBC Act and FM Act) and Purple-spotted Gudgeon (FM Act).
- Susan Island Nature Reserve, gazetted May 1989 under *National Parks and Wildlife Act 1974* (NPW Act).
- Clarence River Estuary is listed as a nationally important wetland in the Directory of Important Wetlands in Australia (Environment Australia (2001)).

Potential impacts

The project may result in some of the following potential impacts on flora and fauna:

- Seven hollow bearing and habitat trees to be removed providing potential roosting and foraging resources for threatened avifauna (i.e. bird and bat) species.
- Removal of 0.41 ha of native vegetation comprising two TEC.
- Minor increases to local fauna barriers through new road infrastructure as well as development of construction compounds which would potentially affect terrestrial fauna movements during construction.
- There is also potential for indirect impacts such as altered hydrology, weed, pest and pathogen invasion, altered noise, vibration and light levels, and injury to native wildlife.
- The project would involve the inaction of several key threatening processes associated with habitat degradation, feral species, pathogens, weeds, hydrological changes and climate change.

Avoidance and Management

The proposed management measures outlined within this report have been prepared to be consistent with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (RTA, 2011).

Avoidance of impacts has been a major focus for Roads and Maritime since the project inception which saw the development of the route options as documented in the *Preliminary Route Options Report Technical Paper – Ecology* (Biosis, 2011) and analysis and assessment of options as documented in the *Route Options Development Report Technical Paper: Ecology* (Biosis, 2012). These assessments, as well as more recent ecological studies and field work, have been undertaken to ensure that the chosen alignment considers all flora and fauna values and corresponding constraints.

Key management measures to avoid and/or minimise flora and fauna impacts include, but are not limited to:

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- Avoidance and/or minimisation of the 0.41 ha of remnant vegetation (TEC) removal where possible.
 - Undertaking pre-clearing surveys for the Three-toed snake-tooth skink during excavation and demolition for the construction compounds, roads and related infrastructure, in areas in Grafton.
 - Staged clearing of the seven hollow bearing and habitat trees, and the application of the precautionary principle to reduce the risk of fauna mortality associated with their removal.
 - Development of a Microbat Management Sub-plan within the Flora and Fauna Management Plan (FFMP) to include the provision of nest boxes and revegetation of suitable species to mitigate the impacts of removing hollow bearing and habitat trees.
 - Development of a Revegetation Management Sub-Plan within the FFMP to outline the strategy to revegetate key areas within the project area with appropriate TEC species with the aim to provide long term foraging resources, roosting habitat and increase connectivity throughout the landscape.
 - In stream works to be conducted in line with *Policy and guidelines for fish habitat conservation and management* (DPI, 2013).
 - The implementation of silt curtains and appropriate timing of works to avoid high flow events to substantially reduce the amounts of sediments entering the Clarence River.
 - Pre-clearance surveys to be undertaken in ancillary sites not yet surveyed based on the April 2014 project design.

1. Introduction

1.1 Project background

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval for an Additional Crossing of the Clarence River at Grafton to address short-term and long-term transport needs. The project would be assessed against Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) as State Significant Infrastructure (SSI). To support the design and approval of the project, Roads and Maritime is preparing an environmental impact statement (EIS).

Biosis Pty Ltd was commissioned to undertake a flora and fauna assessment of the project area which would support the project EIS and cover the requirements for the project as set out by the Director General's Environmental Assessment Requirements (DGRs), issued by NSW Planning and Environment (DPE) on 3 October 2013.

Prior to this most recent assessment Biosis have undertaken multiple surveys with regard to the various options associated with this project since 2006. Initially Biosis' involvement began with the development of the route options as documented in the; *Preliminary Route Options Report Technical Paper – Ecology* (Biosis, 2011) and analysis and assessment of options as documented in the *Route Options Development Report Technical Paper: Ecology* (Biosis, 2012). Throughout this time a range of qualified and experienced ecologists (zoologists and botanists) have assessed the project area and surrounding environments extensively, across all seasons. Findings from the options assessment as well as the final more recent assessment form the basis of this report.

1.2 Project description

The works required for the project include the construction of an Additional Crossing of the Clarence River at Grafton and associated infrastructure upgrades to street corridors such as intersection upgrades and road widening (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to the Pacific Highway; and Dobie-Villiers St interchange).

A description of the project is provided in Chapter 5 and Chapter 6 of the environmental impact statement. This section provides a summary of the project.

The main components of the Grafton Bridge project are:

- Construction of a new bridge over the Clarence River about 70 metres downstream (east) of the existing road and rail bridge, comprising two traffic lanes.
- Construction of a new road to link the new bridge with Iolanthe Street in South Grafton.
- Construction of a new road to link the new bridge with Pound Street in Grafton.
- An approach viaduct, about 64 metres long, on the South Grafton side of the Clarence River and 29 metres long on the Grafton side.
- Upgrades to the road network in South Grafton to connect the new bridge to the existing road network, including:
 - Widening Iolanthe Street to four lanes.
 - Widening the Gwydir Highway to four lanes between Bent Street and the Pacific Highway.

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- Realigning the existing Pacific Highway to join Iolanthe Street near Through Street.
 - Providing a new roundabout at the intersection of the Pacific Highway and Gwydir Highway.
 - Providing a new roundabout at the intersection of Through Street and Iolanthe Street.
 - Limiting Spring Street and the Old Pacific Highway to left in and left out only where they meet Iolanthe Street.
 - Realigning Butters Lane.
 - Upgrades to the road network in Grafton to connect the new bridge to the existing road network, including:
 - Widening Pound Street to four lanes between Villiers Street and the approach to the new bridge.
 - Providing traffic signals at the intersection at Pound Street and Clarence Street.
 - Closing Kent Street where it is crossed by the bridge approach road.
 - Realigning and lowering Greaves Street beneath the new bridge.
 - Realigning Bridge Street to join directly to the southern part of Pound Street (east of the new bridge approach). There would be no direct connection between Pound Street south and the new bridge approach.
 - Widening Clarence Street to provide formal car park spaces.
 - Minor modifications to the existing Dobie Street and Villiers Street roundabout.
 - Replacement of the existing three span concrete arch rail viaduct which crosses Pound Street in Grafton with a single span steel truss bridge.
 - Construction of a pedestrian and cycle path to provide connectivity between Grafton, South Grafton and the new bridge.
 - Provision of two signalised pedestrian crossings in South Grafton to improve safety for pedestrians crossing Iolanthe Street and Gwydir Highway.
 - Construction of new pedestrian links to connect the new bridge with the existing bridge.
 - Provision of designated car park spaces in Pound Street and Clarence Street, including some off street parking, to maintain a similar number of existing car park spaces currently available in those two streets.
 - Flood mitigation works, which include raising the height of sections of the existing levee upstream from the new bridge in Grafton and South Grafton.
 - Construction of a stormwater detention basin and pump station in Grafton to manage local flooding.
 - Public utilities adjustment.
 - Ancillary facilities required for the construction of the project, including some or all of the following: site compounds, concrete batching plant, pre-cast facilities, and stockpile areas for materials and temporary storage of spoil and mulch.

1.3 Project definitions

The following definitions apply to the project and are used throughout this document:

The **project area** encompasses the project during operation and construction, including:

- Operational road boundary.
- Permanent ancillary elements such as operational detention basin and pump station in Grafton.
- Construction work zone, which includes temporary facilities such as South Grafton ancillary site, Pound Street ancillary site and the jetty for barge launching.
- Flood mitigation works construction zone, which includes temporary stockpile areas.

The **study area** encompasses project area and any adjoining or adjacent area where potential indirect impacts may occur.

1.4 Objectives and scope of assessment

The objectives of the previous assessments undertaken in 2011 and 2012 have been to:

- Describe the vascular flora (ferns, conifers, and flowering plants), vertebrate fauna (birds, mammals, reptiles, frogs, fish and decapod crustacea (e.g. crayfish).
- Map vegetation communities and other habitat features within the project area.
- Undertake targeted surveys for threatened terrestrial species.
- Undertake a baseline aquatic assessment.
- Review the implications of relevant biodiversity legislation and policy.
- Identify potential implications of the proposed development options and provide recommendations to assist with development design and avoidance of constraints.

The objectives of this assessment undertaken during 2013 and 2014 are to:

- Combine the results of all survey efforts undertaken to date, including the *Preliminary Route Options Report Technical Paper – Ecology* (Biosis, 2011) and the *Route Options Development Report Technical Paper: Ecology* (Biosis, 2012). The accumulative results have then be used to inform a gap analysis completed for the chosen alignment option, the primary purpose of which was to identify the need for further survey effort.
- Undertake additional surveys to ensure that the project area has been assessed to comply with OEH *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (DEC, 2004), the *Draft Guidelines for Threatened Species Assessment* (DEC, 2005) and the biodiversity assessment guidelines set out in the *Roads and Maritime (2013) Biodiversity Assessment Practice Note*.
- Identify threatened biota that has a moderate or greater likelihood of occurrence within the project area, based on the most current information available from various Federal, State, Local and regional ecological databases/literature.
- Undertake surveys to target any gaps found through the gap analysis process, relative to threatened biota considered likely to be impacted by the project.
- Assess the significance of the potential direct and indirect impacts of the project on threatened biota considered likely to occur within the project area.

- Identify potential implications of the project and proposed management strategies in order to mitigate potential impacts on the ecological values of the project area.

The scope of this report has been developed to satisfy the DGRs relating to Biodiversity (terrestrial and aquatic). The specific DGRs and the relevant sections of this report that address them are outlined in Table 1 below:

Table 1: Director General's Requirements relating to biodiversity

Number	Director General's Requirement	Report Section
An assessment of the potential (direct and indirect) ecological impacts of the project, with specific reference to vegetation and habitat clearing, connectivity, edge effects, riparian and aquatic habitat impacts and soil and water quality impacts. The assessment of these impacts must:		
1	<i>Detail the existing environment, including discussion of flora and fauna characteristics to be affected by the project.</i>	Section 4
2	<i>Make specific reference to impacts on threatened species, populations and endangered ecological communities, and any Rare or Threatened Australian Plant species.</i>	Section 7
3	<i>Consider impacts to the receiving environment, including adjoining waterways, riparian vegetation and aquatic habitats. This must include consideration of water quality, marine vegetation, fish passage, soil types (including salinity), erosion and sedimentation, weed management and ongoing water management.</i>	Section 5
4	<i>Identify appropriate avoidance, mitigation and management measures, including details of alternative options considered, and proposed arrangements for long term management.</i>	Section 6
5	<i>Take into account the draft Guidelines for Threatened Species Assessment (Department of Environment and Conservation/Department of Primary Industries 2005), Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Department of Environment and Conservation 2004), and the Guidelines for Aquatic Habitat Management and Fish Conservation (Department of Primary Industries 1999).</i>	Section 3
6	<i>Include details of any offset of ecological impacts and native vegetation clearing, taking into account the Principles for the use of biodiversity offsets in NSW (Department of Environment, Climate Change and Water 2008).</i>	Section 6

2. Legislation and policy

The implications for this SSI project have been assessed in relation to key biodiversity legislation and policy including:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- NSW *Threatened Species Conservation Act 1995* (TSC Act).
- NSW *Fisheries Management Act 1994* (FM Act).
- NSW *Noxious Weeds Act 1993* (NW Act).
- NSW *Native Vegetation Act 2003* (NV Act).
- NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), including:
 - State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44).
 - State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP14).
- Clarence Valley Local Environmental Plan (LEP), 2011.

2.1 Commonwealth

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any action which has, would have, or is likely to have a significant impact on a Matter of National Environmental Significance (NES) or on Commonwealth land, triggers the EPBC Act and may require Commonwealth assessment and approval from the Commonwealth Minister for the Environment. The nine matters of national environmental significance protected under the EPBC Act are:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (listed under the Ramsar Convention).
- Listed threatened species and ecological communities.
- Migratory species protected under international agreements.
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mines).
- A water resource, in relation to coal seam gas development and large coal mining development.

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DEWHA 2009a). In considering the impacts on listed species, ecological communities and migratory species, the assessment must refer to the Significant Impact Guidelines 1.1 under the EPBC Act (DEWHA 2009b).

Based on the results of the environmental investigations carried out for this EIS, it is considered that no NES matters or areas of Commonwealth land are likely to be significantly impacted upon by the project. Accordingly, referral of the project is not considered to be required at this stage.

2.2 State

2.2.1 Environmental Planning and Assessment Act 1979

The project is being assessed as SSI under Part 5.1 of the EP&A Act and therefore an EIS is required.

Clause 94 of the State Environmental Planning Policy (Infrastructure) 2007 (the Infrastructure SEPP) applies to development for the purpose of a road or road infrastructure facilities and provides that these types of works are development which is permissible without consent. The project is appropriately classified as 'road works' under the Infrastructure SEPP.

Clause 14 of the State Environmental Planning Policy (State and Regional Development) 2011 declares development as SSI if it is permissible without consent and specified in Schedule 3.

Clause 1 of Schedule 3 of the State Environmental Planning Policy (State and Regional Development) 2011 specifies infrastructure or other development that would be an activity for which the proponent is also the determining authority and would, in the opinion of the proponent, require an EIS to be obtained under Part 5 of the Act.

Roads and Maritime formed the opinion that the project is likely to significantly affect the environment and would require an EIS to be obtained and consequently the project is SSI under Part 5.1.

According to Part 5.1 of the EP&A Act, the EIS must address important factors and/or assessment of significance with respect to assessing potential impacts on threatened species, populations or ecological communities, or their habitats as listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act). The EIS must consider the DGRs from Planning and Infrastructure. These requirements are presented in Section 1.4 (Table 1).

2.2.2 Threatened Species Conservation Act 1995

The objects of the TSC Act are:

- To conserve biological diversity and promote ecologically sustainable development.
- To prevent the extinction and promote the recovery of threatened species, populations and ecological communities.
- To protect the critical habitat of those threatened species, populations and ecological communities.
- To eliminate or manage certain processes that threatens the survival or evolutionary development of threatened species, populations and ecological communities.
- To ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed.
- To encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

The TSC Act identifies threatened species, populations and ecological communities, as listed under Schedules 1, 1A and 2 which may require the preparation of an Assessment of Significance (AoS) under section 5A of the EP&A Act, if the project is considered likely to have an adverse impact.

2.2.3 Fisheries Management Act 1994

The FM Act identifies threatened aquatic species, populations and ecological communities, as listed under Schedules 4, 4A, and 5A which may require a significance assessment under section 5A of the EP&A Act, if the project is considered likely to have an adverse impact. Furthermore, a number of approvals that generally apply under the FM Act are not required for a project approved under Part 5.1 of the EP&A Act (EP&A Act s.115ZG), including permits under sections 201, 205 and 219.

2.2.4 Noxious Weeds Act 1993

The NW Act defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The NW Act sets up categorisation and control actions for the various noxious weeds, according to their potential to cause harm to the local environment.

The objectives of the NW Act include:

- Identify noxious weeds in respect of which particular control measures need to be taken.
- Specify those control measures.
- Specify the duties of public and private landholders as to the control of those noxious weeds.
- Provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

Under this Act, noxious weeds have been identified for Local Government Areas (LGAs) and assigned Control Classes. Part 3 provides that occupiers of land (this includes owners of land) have responsibility for controlling noxious weeds on the land they occupy.

2.2.5 Native Vegetation Act 2003

The NV Act was established to prevent broad scale clearing, protect native vegetation of high conservation significance, improve the condition of existing native vegetation and encourage the regeneration of native vegetation in NSW. In assessing applications, consent authorities apply the 'maintain or improve test', which means assessing how the project maintains or improves environmental values such as salinity, water, soils and biodiversity. However approvals to clear native vegetation under the NV Act are no longer required for a project approved under Part 5.1 of the EP&A Act (EP&A Act s.115ZG).

State Environmental Planning Policies (SEPP)

Environmental planning instruments (EPIs) do not apply to SSI, except in very limited circumstances, such as where they apply to the declaration of infrastructure as SSI or critical SSI (CSSI) (Section 115ZF (2) of the EP&A Act)¹. This project is declared to be SSI through Clause 13 and Schedule 3 (Part 1(1)) of the State Environmental Planning Policy (State and Regional Development) 2011. Therefore the following EPI's which may have otherwise applied now do not apply to the project:

- *SEPP No.44 – Koala Habitat Protection*

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) does not apply to the project, however in accordance with best practice - SEPP 44 has been considered. The

¹ EDO, 2013

Minister for Planning and Infrastructure may take into account SEPP 44 when deciding to approve the project. SEPP 44 is considered further in Section 4.14.

- **SEPP No.14 – Coastal Wetlands**

State Environmental Planning Policy No 14 – Coastal Wetlands (SEPP 14) does not apply to the project, however in accordance with best practice - SEPP 14 has been considered. Land subject to this policy does not apply to the project area. The closest SEPP14 listed wetland (No. 292) is located eight kilometers to the east of the project area and is part of the Upper Coldstream Wetlands, associated with Coldstream River and Pillar Valley Creek.

2.3 Legislation and the project

An assessment of the project against key biodiversity legislation and policy is provided and summarised in Table 2 below. *Note: Guidance provided in this report does not constitute legal advice.*

Table 2: Summary of legislation for the project

Legislation / Policy	Relevant ecological feature on site	Permit / Approval required
Environment Protection and Biodiversity Conservation Act 1999	No Commonwealth listed TEC were found to occur in the project area. The project area contains potential habitat for one threatened flora species, Hairy-joint Grass <i>Arthraxon hispidus</i>. The project area contains suitable habitat for the following threatened fauna species: - Grey-headed Flying-fox - Three-toed Snake-tooth Skink - Silver Perch The project area contains suitable habitat for the following migratory species: - Cattle Egret - White-bellied Sea eagle - Rainbow Bee-eater - Clamorous reed-warbler - Common Tern	Significant Impact Criteria (SIC) assessments have been undertaken in accordance with the threatened and migratory species identified here. Refer to Appendix 4.
Threatened Species Conservation Act 1995	Two state listed TEC - Freshwater Wetlands on Coastal Floodplains and Subtropical Coastal Floodplain Forest, occur within the project area. The project area contains potential habitat for one threatened flora species, Hairy-joint Grass <i>Arthraxon hispidus</i>. The project area contains suitable habitat for threatened fauna species and populations, including: - Wetland birds: Magpie goose, Black-necked Stork, Brolga, Comb-crested jacana - Flightless birds: Emu population - Birds of Prey: Osprey and Square-tailed Kite - Owls: Masked Owl - Flying-foxes: Grey-headed flying-fox	Assessments of Significance (AoS) under Section 5A of the EP&A Act have been undertaken in accordance with the TEC's and threatened species identified here. Refer to Appendix 3.

Legislation / Policy	Relevant ecological feature on site	Permit / Approval required
	- Reptiles: Three-toed snake-tooth skink - Cave-dependent microbats: Little bentwing-bat, Eastern bentwing-bat, Eastern cave bat - Hollow-dependent microbats: Yellow-bellied sheath-tail-bat, Greater broad-nosed bat, Hoary wattled Bat, Southern myotis, Eastern long-eared bat and the Eastern freetail-bat	
Fisheries Management Act 1994	The project area contains suitable habitat for the following threatened aquatic fish species: - Freshwater catfish¹ - Olive perchlet¹ - Purple-spotted Gudgeon - Silver perch (pers.comm. G. Butler, DPI-Fisheries 2013) ¹ Endangered populations outside natural range	Assessments of Significance (AoS) under Section 5A of the EP&A Act have been undertaken as relevant to the project in accordance with the TEC's and threatened species identified here. Refer to Appendix 3.
Environmental Planning & Assessment Act 1979	Threatened species and ecological communities occur within the project area.	Impacts to the threatened species and communities present or likely to occur within the project area must be assessed through undertaking an AoS.
National Parks & Wildlife Act 1974	The project does not require the removal of vegetation within a National Park.	No permits or approvals are required under the current scope of works.
Native Vegetation Act 2003	The project would require the removal of 0.4 ha of native vegetation comprising two TEC, - <i>Freshwater Wetlands on Coastal Floodplains</i> and <i>Subtropical Coastal Floodplain Forest</i> , occurring within the project area.	Assessments of Significance (AoS) under Section 5A of the EP&A Act have been undertaken in accordance with the TEC's and threatened species identified here. Refer to Appendix 3.

Legislation / Policy	Relevant ecological feature on site	Permit / Approval required
Noxious Weeds Act 1993	The following noxious weeds are present within the project area: - Crofton weed - Alligator weed - Green cestrum - Camphor laurel - Rubber vine - Water hyacinth - Lantana - Lemon-scented tea tree - Broad-leaved privet - Small-leaved privet - Prickly pear - Crack willow - Giant Parramatta grass	Duty to control noxious weeds as per NW Act control requirements for each noxious weed found within the project area.

3. Methods

3.1 Literature and database review

In order to provide a context for the project area, information about flora and fauna from within 10 km (the 'locality') was obtained from relevant public databases. A search of aquatic fauna records was conducted for the Northern Rivers basin/catchment. Records from the following databases were collated and reviewed:

- Commonwealth Department of the Environment (DoE) EPBC Protected Matters Search Tool (14/10/2013).
- NSW Office of Environment and Heritage (OEH) BioNet - *Atlas of NSW Wildlife*. For threatened species listed under the TSC Act (01/10/2013).
- NSW Department of Primary Industries (DPI) *Threatened and protected species – records viewer*. Threatened species listed under the FM Act (14/10/2013).
- PlantNET (The Royal Botanic Gardens and Domain Trust, 2013) for Rare or Threatened Australian Plants (RoTAPs) (15/11/2013).
- Commonwealth Bureau of Meteorology (BOM), Groundwater Dependent Ecosystems Atlas (04/11/2013).
- NSW DPI Noxious Weeds database for the Clarence Valley Local Government Area (LGA) (15/11/2013).
- NSW OEH Vegetation Types Database.
- NSW OEH BioBanking Threatened Species Profile Database.
- BirdLife Australia (BA), the New Atlas of Australian Birds 1998-2013.

Other sources of biodiversity information:

- Relevant vegetation mapping, including:
 - Thackway R, Cresswell ID, 1995, *An interim biogeographic regionalisation for Australia: a framework for setting priorities in the National Reserve System Cooperative Program*. (Version 4.0. ANCA: Canberra).
- The following reports and listings were also reviewed:
 - Biosis Research, 2011, *Main Road 83 Summerland Way Additional Crossing of the Clarence River at Grafton: Preliminary Route Options Report. Technical Paper: Ecology*. Report to Arup on behalf of the NSW Roads and Traffic Authority – Northern Regional Office. Authors: J. Charlton, J Dessmann & A. Troy. Biosis Pty Ltd, Sydney. Project no. 12605.
 - Biosis, 2012, *Main Road 83 Summerland Way – Additional Crossing of the Clarence River at Grafton: Route Options Development Report. Technical Paper: Ecology*. Report to Arup on behalf of the Roads and Maritime Services – Northern Regional Office. Authors: J. Charlton, M. Campbell, B. Coddington & A. Troy. Biosis Pty Ltd, Sydney. Project no. 13967.

- Commonwealth Preliminary Determinations by the Threatened Species Scientific Committee (TSSC) listing advices on threatened species, ecological communities and key threatening processes.
- NSW Scientific Committee Preliminary Determinations by the NSW Scientific Committee for Threatened Species, populations and ecological communities and key threatening processes.

3.2 Nomenclature

The flora taxonomy (classification) used in this report follows the most recent Flora of NSW (Harden 2002). All species names in doubt were verified with the on-line Australian Plant Name Index (Australian National Botanic Gardens 2007). Flora species, including threatened species and introduced flora species, are referred to by both their common and scientific names when first mentioned. Subsequent references to flora species cite the scientific names only. Common names, where available, have been included in threatened species tables and the complete flora list in Appendix 3.

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by the Commonwealth DoE (DEWHA 2009a). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the fauna list in Appendix 2.

3.3 Field survey and techniques

The field survey methods employed comply with OEH (DEC, 2004) *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft*, the Draft Guidelines for Threatened Species Assessment (Department of Environment and Conservation 2005), *Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the EPBC Act* (DSEWPaC, 2011) and the biodiversity assessment guidelines set out in the Roads and Maritime (2013) *Biodiversity Assessment Practice Note*.

The field surveys methods employed also comply with the guidance provided in DEWHA (2009a) *Matters of National Environmental Significance, Significant Impact Criteria Guidelines 1.1 Environmental Protection and Biodiversity Conservation Act 1999*, and where existing, the relevant species specific EPBC Act policy statements.

3.3.1 Field survey effort

Specific details of flora survey effort with respect to the number of random meanders sampled per habitat type are summarised in Table 3.

Table 3: Summary of flora survey effort per habitat stratification unit

Dates of Survey/Season	Objectives	Survey Type	Survey effort
August 2010 Winter	General habitat condition assessment, vegetation community association and targeted searches for threatened species and their habitat.	Random meander and one plot survey	84 person hours

Dates of Survey/Season	Objectives	Survey Type	Survey effort
July 2011 Winter	Mapping of vegetation units across the broader area of Grafton and South Grafton. Completed to provide context for proposed impacts to vegetation.	Foot and vehicle based ground-truthing of vegetation units shown on aerial photography.	30 person hours
February and April 2012 Summer/Autumn	More comprehensive assessment of the six route options including community association and mapping and targeted searches for threatened species and their habitat.	Random meander	96 person hours
October and December 2013 Spring/Summer	Ground truthing of previously mapped vegetation along the final route alignment and comprehensive assessment of the levees on both sides of the Clarence River for threatened species searches and survey techniques listed in Table 4.	Random meander	25 person hours

The total fauna survey effort per technique is summarised in Table 4.

Table 4: Summary of fauna survey effort

Fauna Group	Technique	Survey effort			Total effort
		August 2010	April 2012	October and December 2013	
Diurnal birds	Diurnal bird counts	2 person hours	2 person hours	2 person hours	6 person hours
Reptiles	Active reptile searches	6 person hours	6 person hours	18 person hours	30 person hours
	Funnel trapping	-	-	4 trap nights	96 trap nights
Frogs	Active amphibian searches	2 person hours	2 person hours	-	4 person hours
Nocturnal birds and mammals	Spotlighting	3 person hours	3 person hours	3 person hours	9 person hours
Microbats	Anabat recording	4 trap nights	-	6 trap nights	10 trap nights
	Echometer recording	-	-	0.5 person hours	0.5 person hours
	Harp Trapping	-	-	4 trap nights	4 trap nights
Flying-foxes	Sunset Flying-fox observations	2 person hours	2 person hours	2 person hours	6 person hours
All species	Track, Scat and Scratch searches	2 person hours	2 person hours	2 person hours	6 person hours
	Opportunistic and incidental observations	48 person hours	32 person hours	32 person hours	112 person hours

Fauna Group	Technique	Survey effort			Total effort
		August 2010	April 2012	October and December 2013	
Aquatic fauna	Fyke nets	192 net Hours	-	-	192 net hours
	Bait traps	288 net Hours	-	-	288 trap hours
	Habitat assessments	22 Person Hours	-	-	22 person hours

3.3.2 Vegetation

The flora assessment was undertaken from 1 October 2013 to 4 October 2013 and 24 October 2013 in addition to previous flora surveys carried out as part of the development of the route options as documented in the *Preliminary Route Options Report Technical Paper - Ecology* (Biosis, 2011) and analysis and assessment of options as documented in the *Route Options Development Report Technical Paper: Ecology* (Biosis, 2012) in February 2012, April 2012, July 2011, April 2010 and August 2010. The survey effort across all surveys completed by Biosis is outlined in Table 3. Flora surveys were conducted using a combination of 20 x 20 metres (m) quadrats, spot locations and random meanders to determine the vegetation types present within the project area. Survey data results were compared with existing vegetation maps and Scientific Committee Determinations in order to confirm the identification and extent of plant communities, particularly those that correspond to TECs.

Random Meander

Vegetation across the study area and adjacent land was predominantly assessed using the Random Meander technique, as described in Management of Endangered Plants (Cropper, 1993). An inventory of flora species recorded across all surveys was compiled and key indicator species for each community were noted. During the assessment, detailed high resolution aerial imagery was marked up with the observed vegetation communities to assess connectivity and condition. Recent random meander transects were undertaken by two botanists in October 2013 traversing the site, focussing on areas of retained native vegetation within the finalised study area for the project and the proposed flood mitigation works area (levees) on both the northern bank and southern bank of the Clarence River.

Targeted searches

Targeted searches for threatened plant species involved random meander transects as well as incidental observations carried out in selected areas of known or potential habitat.

Targeted surveys were undertaken for the following RoTAPs, threatened species and ecological communities considered to have the greatest potential to occur within the study area based on previous survey effort, previous records and the presence of potential habitat:

- Subtropical Coastal Floodplain Forest – EPBC Act not listed, TSC Act Endangered (not seasonally dependant - surveys undertaken in August 2010 and July 2011).
- Freshwater Wetlands on Coastal Floodplains – EPBC Act not listed, TSC Act Endangered (not seasonally dependant - surveys undertaken in August 2010 and July 2011).
- Sandstone Rough-barked Apple *Angophora robur* – EPBC Act Vulnerable, TSC Act Vulnerable (not seasonally dependant - surveys undertaken in August 2010 and July 2011).

- Hairy Jointgrass *Arthraxon hispidus* – EPBC Act Vulnerable, TSC Act Vulnerable (seasonally dependant - surveys undertaken in February 2012 during the active growth period of the species)
- Square-fruited Ironbark *Eucalyptus tetrapleura* – EPBC Act Vulnerable, TSC Act Vulnerable (not seasonally dependant - surveys undertaken in August 2010 and July 2011).
- Frogbit *Hydrocharis dubia*² – EPBC Act no longer listed, TSC Act not listed, however still a RoTAP species (not seasonally dependant – surveys undertaken in August 2010, July 2011 and the October-December 2013).
- Spiny Mint-bush *Prostanthera spinosa* – EPBC Act not listed and TSC Act Vulnerable (not seasonally dependant - surveys undertaken in August 2010 and July 2011)

Plot-based survey (quadrats)

Plot-based surveys are used to comprehensively describe the structure and floristics of each plant community, and also provide a concentrated search area for the detection of inconspicuous plant species that may be present at a particular site. Given the highly disturbed nature of the locality and the fragmentation and modification of the native vegetation within the study area and levees, multiple quadrats were not considered appropriate for the 2011, 2012 and 2013 assessments. One quadrat was undertaken in the riparian vegetation to the east of the mouth of Alipou Creek during the August 2010 surveys. The structure and floristics of this degraded plant community were sampled using one 20 x 20 m quadrat.

Vegetation condition assessment

The condition of the vegetation was assessed according to the degree to which it resembled relatively natural, undisturbed vegetation, using the following criteria which have been based upon the Bran-Blanquet cover-abundance scale (1978), vegetation community structural descriptions and botanical observations:

- Species composition (species richness, extent of weed invasion).
- Structure (representation of each of the original layers of vegetation).

Plant community condition was categorised as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and/or track margins; vegetation community containing original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) intact.

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation modified; vegetation layers (ground, shrub, canopy etc.) largely intact.

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation highly modified; one or more original vegetation layers (ground, shrub, canopy etc.) modified or missing.

² Frogbit *Hydrocharis dubia* was deleted from the EPBC Act vulnerable list on 3 December 2013.

Planted Vegetation: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; limited floristic value however may provide potential fauna habitat for threatened and non threatened species.

A full list of flora species for the project as compiled (Appendix 1, Table 22). Records of threatened flora species will be submitted to OEH for incorporation into the BioNet Wildlife Atlas.

3.3.3 Terrestrial fauna and habitat

The study area was investigated during a series of surveys conducted between 9 – 11 August 2010, 7 – 8 February 2012, 2 – 3 October 2013, and 9 – 3 December 2013 to determine the study area's values for fauna. These were determined primarily on the basis of the types and qualities of habitat(s) present. All species of fauna observed during the assessment were noted and active searching for fauna was undertaken. This included direct observation, searching under rocks and logs, examination of tracks and scats and identifying calls. Particular attention was given to searching for threatened biota and their habitats. Fauna species were recorded with a view to characterising the values of the site and the investigation was not intended to provide a comprehensive survey of all fauna that has potential to utilise the site over time.

Fauna records were submitted to OEH for incorporation into the NSW OEH BioNet Wildlife Atlas.

Targeted fauna surveys for the Three-toed snake-tooth skink (vulnerable TSC Act and EPBC Act) were carried out on 9 – 13 December 2013, with additional observations made on 9 – 11 August 2010, 7 – 8 February 2012 and 2 – 3 October 2013. The targeted surveys were undertaken at a latter stage in the project as a result of the release of the Commonwealth *EPBC Act Survey guidelines for Australia's threatened reptiles* (DSEWPac, 2011) stipulating detailed survey guideline requirements for this species. The survey techniques employed were consistent with the requirements of both these EPBC Act survey guidelines and the NSW *Threatened Biodiversity and Assessment Guidelines for Developments and Activities Working Draft* (DEC, 2004), and guided by communications with various scientific experts. The results of this study are provided in Appendix 5.

Surveys were targeted towards the threatened fauna species identified in the desktop review as potentially occurring within the study area (refer to Appendix 2; Table 26), and based on the results of habitat assessments conducted during field surveys. Techniques included: diurnal bird surveys, active reptile searches, funnel trapping (with drift fence), amphibian searches, walking transects, spotlighting, nocturnal call playback, anabat recording, track scat and scratch searches, and opportunistic observations. Fauna survey methods are outlined in detail below.

Diurnal Bird Counts

Diurnal bird counts were undertaken during the 9, 10 and 11 August 2010 field survey, with additional opportunistic observations made on the 7 - 8 February 2012, 2 - 3 October 2013, and 9-13 December 2013.

Diurnal bird counts involved the completion of timed surveys with the time allocated proportionate to the area covered by the survey. Searches were conducted for approximately 60 minutes per stratification, over two days by two people (a total of two person hours per stratification unit), or until no new species were being observed, with each search area ranging in size from one ha to five ha. Surveys were conducted early in the morning (between approximately 6.00 – 8.00 am) and later in the afternoon (between approximately 3:00 – 5:00 pm) when bird species were observed to be the most active within the study area. Survey locations were selected on the basis of vegetation community, suitable habitat, and by the presence of birds. The locations of diurnal bird survey sites are given in Figure 2.

Opportunistic observations were recorded at all times throughout each field survey. Species were identified visually or by call, and abundance, behaviour, breeding activity and habitat types were documented. Additional bird surveys were undertaken via vehicular surveys whilst travelling in and around the study area. Opportunistic bird surveys were also undertaken at any time when birds were observed to be particularly active in the study area.

Threatened species targeted during the bird surveys included:

- Wetland birds: Magpie Goose *Anseranas semipalmata*, Black-necked Stork *Ephippiorhynchus asiaticus*, Brolga *Grus rubicunda*, Comb-crested Jacana *Irediparra gallinacea*,
- Flightless birds: Emu *Dromaius novaehollandiae*
- Birds of Prey: Square-tailed Kite *Lophoictinia isura*, Osprey *Pandion cristatus*
- Large Forest Owls: Masked Owl *Tyto novaehollandiae*

Active Reptile Searches

Active reptile searches were undertaken during the 9, 10 and 11 August 2010 and 7 – 8 February 2012 field surveys. Active searches were undertaken, over two days for each field survey, with each search lasting approximately 30 minutes, over approximately six person hours. Active searches included turning rocks and fallen timber within the project area.

Much of the suitable habitat for reptile species within the project area exists as sparsely embedded and loose rocky outcrops and scattered fallen timber within grasslands and areas of remnant vegetation. Active searches involved turning and searching all potential habitat features encountered within the project area, including logs, fence posts, sheets of iron, rocks and rubbish. Rocks and timber were turned in a random manner in order to avoid broad scale habitat disturbance or destruction. Survey locations are shown on Figure 2.

One threatened species, the Three-toed Snake-tooth Skink *Coeranoscincus reticulatus*, was specifically targeted during active reptile searches.

Funnel Trapping (with drift fence)

Funnel traps were paired and set along a drift fence line of three m in length in South Grafton. In Grafton, due to the nature of the available survey sites, funnel traps were set without drift fence lines to reduce visibility and detectability by the public. Wood pickets were used to keep the traps tight against the fence, as it is important that animals cannot make their way between the fence and the trap. The ends of the trap were 'ramped' by using loose soil/sand to form a smooth transition into the trap. Funnel traps were placed in shaded locations, and not in the open, to ensure that any animals captured were not exposed to the elements.

Funnel trapping was undertaken during the 9-13 December 2013 field survey to directly target the Three-toed Snake-tooth Skink. A total of 24 funnel traps were deployed at six sites within the project area and set over a four night / five day period. Appendix 5 outlines the full survey effort and results.

Active Amphibian Searches

Active amphibian surveys were undertaken during the 9, 10 and 11 August 2010 survey period and involved two ecologists actively searching suitable habitat, and listening for frog vocalisations.

Threatened species targeted during the amphibian searches included the:

- Stuttering Frog *Mixophyes balbus*.
- Giant Barred Frog *Mixophyes iteratus*.

Spotlighting

Spotlighting surveys were performed in the evenings during the 9, 10 and 11 August 2010, 7 - 8 February 2012, and 2 - 3 October 2013 field surveys and involved two ecologists using a 50-watt spotlight and walking random meander transects for 45 minutes each night for a total of two nights per survey period, equating a total of nine person hours. Additional spotlighting surveys were undertaken from within a vehicle driven at five km per hour for 30 minutes in South Grafton whilst entering and exiting the site (i.e. in the area between Bent Street, Charles Street and Alipou Creek) (refer to Figure 2).

Threatened species targeted during the spotlighting surveys included:

- Large Forest Owls: Barking owl *Ninox connivens*, Powerful Owl *Ninox strenua*, Masked Owl *Tyto novaehollandiae*.
- Arboreal Mammals: Yellow-bellied glider *Petaurus australis*, Squirrel glider *Petaurus norfolcensis*, Koala *Phascolarctos cinereus* and Brush-tailed Phascogale *Phascogale tapoatafa*.

Spotlighting surveys were undertaken in areas of potential habitat, namely areas with some canopy, or midstorey/ groundstorey species present. There is considered to be minimal potential suitable habitat within the project area in Grafton, and as such, the spotlighting effort was concentrated on areas of remnant canopy vegetation within the project area in South Grafton. Spotlighting transects were undertaken in the riparian stratification, along Alipou Creek from its confluence with the Clarence River. Spotlighting within the grassland stratification was undertaken from a moving vehicle due to the potential habitat being limited to the few paddock trees in these areas.

Ultrasound Bat Detectors

Anabat Recording

Passive anabat surveys were conducted at four locations during the 9, 10 and 11 August 2010 survey, and at three locations during the 2–3 October 2013 field survey period. The August 2010 survey period deployed four anabats within the project area for one night each, whilst the October 2013 survey period deployed three anabats within the project area for two nights each. Detectors were set to record from one hour before dusk until one hour after dawn the following morning. Survey locations are shown on Figure 2. Detectors were placed in areas of potential habitat, such as the existing bridge, likely flyways in scarce remnant woodland patches, near water within the project area. Anabat recordings were identified to genus, or species level where possible by a qualified anabat analyst (refer to Annex A).

Threatened species targeted during the anabat surveys included:

- Cave-dependent microbats: Little bentwing-bat (*Miniopterus australis*), Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern cave bat (*Vespadelus troughtoni*).
- Hollow-dependent microbats: Yellow-bellied sheath-tail-bat (*Saccolaimus flaviventris*), Greater broad-nosed bat (*Scoteanax rueppellii*), Hoary wattled bat (*Chalinolobus nigrogriseus*), Southern myotis (*Myotis macropus*), Eastern long-eared bat (*Nyctophilus bifax*), Eastern freetail-bat (*Mormopterus norfolkensis*).

Echometer recording

An active echometer transect was undertaken during the 2–3 October 2013 field survey. This involved one ecologist walking along Bent, Fitzroy and Villiers streets in Grafton. The survey transect, as part of the active searches, is shown in Figure 2.

Harp trapping

Harp trapping was undertaken during the 2–3 October 2013 field survey effort. Two harp traps were set for two consecutive nights at a site in South Grafton at the one area which represented the only suitable flyways within a remnant woodland patch. Harp trapping was undertaken to target species that are considered difficult to identify through anabat analysis, or could not be accurately identified further than genus (i.e. *Nyctophilus*).

Sunset Flying-fox observations

Passive observations of flying foxes were performed at dusk during the 9, 10 and 11 August 2010, 7 - 8 February 2012, and 2-3 October 2013 field survey periods, and involved two ecologists observing the flight path of flying-foxes from Susan Island, and collecting abundance data. These observational surveys targeted the threatened Grey-headed flying-fox *Pteropus poliocephalus*.

Track, Scat and Scratch Searches

Opportunistic track, scat and scratch searches were conducted throughout the project area during the 9, 10 and 11 August 2010, 7 – 8 February 2012, and 2 – 3 October 2013 field survey periods. Any tracks were noted, and identified where possible. Any unknown scats were collected for further analysis, with an emphasis on any carnivore scats – identified by the presence of fur, insect or bone material. Ecologists were constantly looking for scratches on trees that may indicate the presence of arboreal mammals.

Threatened species targeted during these track, scat and scratch track search surveys include:

- Large Forest Owls: Barking owl *Ninox connivens*, Powerful owl *Ninox strenua*, Masked owl *Tyto novaehollandiae*.
- Arboreal Mammals: Yellow-bellied glider *Petaurus australis*, Squirrel glider *Petaurus norfolcensis*, Koala *Phascolarctos cinereus*.
- Terrestrial mammals: Spotted-tail Quoll *Dasyurus maculatus*, Long-nosed Potoroo *Potorous tridactylus tridactylus*.

Opportunistic and Incidental Observations

Opportunistic and incidental observations for fauna species were recorded at all times during all field surveys from 2010 – 2013.

Fauna Habitat and Identification

Habitat assessment data was collected from all sites to gather information on the type and condition of fauna habitat considered to be present. Surveys were undertaken to investigate and document fauna habitat features, by assessing the condition and abundance of a set of habitat criteria which included the:

- Type and structure of the vegetation, including an assessment of the 'naturalness' in terms of the presence of remnant vegetation or planted/garden landscaped areas.
- Presence and frequency of large mature trees, tree hollows and their size classes, standing dead trees (stags), coarse woody debris (CWD) and rocky outcrops.

- Dominant flora species and a subjective assessment of floristic diversity at different structural layers, flowering and fruiting resources.
- Presence of significant keystone species and critical habitat elements for threatened fauna.
- Representation of the habitat type on a local and regional scale.
- Disturbance regimes, both past and ongoing including fire regime and weed abundance.
- Density of each vegetation strata (structural diversity).
- Presence and quality of wet areas or waterbodies, significant aquatic habitats where present.
- Size of remnant patches and extent of connectivity, movement corridors and refuge value.

The surveys identified and mapped the distribution of broad habitat types in relation to the predicted presence of threatened fauna species. This included identifying important habitat characteristics required for each species (i.e. keystone food plants, locations with abundant tree hollows or CWD, or preferences for a particular habitat type and structure). This information, in conjunction with targeted fauna surveys and a review of regional records, was used to assess the likely extent and magnitude of impacts on threatened species habitat.

3.3.4 Aquatic fauna

Aquatic fauna surveys were undertaken in August 2010 as a component of the *Route Options Development Report Technical Paper: Ecology* (Biosis, 2012) investigations. Aquatic assessments undertaken during this stage were considered within the scope of this broad assessment. The findings of this assessment in 2010 has been incorporated into the current report to assess the project at its current stage in relation to aquatic ecological values, relevant legislation and provide recommendations for management.

Waterbodies assessed included Carrs, Cowan and Alipou Creeks and the Clarence River. Aquatic fauna surveys and habitat assessments were undertaken by two qualified aquatic ecologists at the aforementioned waterbodies within and adjacent to the project area (refer to Figure 3). Surveys were undertaken in accordance with the *Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the EPBC Act* (DSEWPac, 2011). While surveys adhered to these guidelines where possible, the following limitations apply.

- Depth and bank form precluded the use fyke nets within the Clarence River.
- High electrical conductivity in all waterways prevented electrofishing.
- Current permits and legislation prevent the use of mesh/gill nets as a survey method for aquatic fauna investigations in NSW, which would be deemed the most suitable method in these waterways.

Aquatic fauna survey methods deployed included fyke nets and bait trapping. High electrical conductivity and water depth precluded the use of electrofishing. Habitat assessments included *in situ* measurement of water quality, estimates on physical and biological attributes and notes on existing sources of disturbance using the HABSCORE methodology.

Fyke netting

At each suitable site two large dual wing fyke nets with 10 millimetres (mm) mesh size were set along with two single wing fyke nets with six mm mesh. The use of nets of multiple sizes and gauge increases the range of fish species and size susceptible to capture, with both large-bodied and small-bodied species susceptible to capture. Fyke nets were set in the afternoon (approx.1600) and retrieved the following morning (approx. 0800). Fyke nets were set amongst suitable habitat to depths of 1.2 m.

Bait trapping

At each suitable site six bait traps constructed of two mm mesh with entrance funnels of 40 mm in diameter were set overnight. Bait traps were set with cyalume light sticks and were generally deployed in depths of 0.25 to 0.5 m, typically amongst cover of aquatic vegetation or other forms of cover. Bait traps were set in the afternoon (approximately 1600) and retrieved the following morning (approx. 0800). Bait traps were deployed to target threatened small bodied fish species; Olive Perchlet and Southern Purple-spotted Gudgeon.

Habitat assessments

Aquatic habitat assessments were conducted at all the Clarence River and Carr's, Cowan's and Alipou Creeks, in order to assess the potential to support threatened species. The aquatic habitat assessment utilised standardised methods including the allocation of HABSCORE indices. Barbour et al. (1999) describes HABSCORE as a 'visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community'. This method provides a recognised means of assessing the condition of fish habitat within waterways. *The Policy and guidelines for fish habitat conservation and management* (DPI, 2013) have also been used to provide a TYPE classification of key fish habitat and associated sensitivity, and a CLASS of waterways for fish passage.

HABSCORE assessments utilise visually based habitat characteristics to classify the quality of the water resource and the condition of the resident aquatic community. HABSCORES range from Poor to Optimal condition and reflect the current category condition of the water resource. Categories are derived from the sum of scores divided by the sum of the characters assessed.

HABSCORE assessments are based on the presence and condition of the following features pool substrate characterisation, pool variability, channel flow status, bank vegetation, bank stability, width of riparian zone and epifaunal substrate / available cover.

The aquatic habitat within the project area was described in terms of four category types (Fairfull and Witheridge 2003; Barbour et al. 1999). The four categories used to evaluate habitat value were Optimal, Suboptimal, Marginal or Poor, as detailed below:

- **Optimal:** watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.
- **Suboptimal:** watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought, although, become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.
- **Marginal:** watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.
- **Poor:** water courses or drainages that only flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

Water quality assessments

Water quality sampling was undertaken at each site using a Horiba U22-XD Multi-parameter Water Probe. Measurements were taken approximately 30 centimetres (cm) below the surface. Variables measured *in situ* included pH, dissolved oxygen (DO), temperature, turbidity and electrical conductivity (EC). Water quality sampling provides an insight into current baseline conditions of aquatic habitats within the project area and assists in determining suitability of targeted fish survey techniques.

3.3.5 Permits and licences

The flora and fauna assessment was conducted under the terms of Biosis' Scientific Licence issued by the OEH under the *National Parks and Wildlife Act 1974* (SL100758, expiry date 31 March 2015) to harm/trap/pick/hold/study protected fauna and native flora, and a current Animal Research Authority (ARA) (issued under the NSW Animal Research Act, 1985 Certificate of Approval by the Animal Ethics Committee (AEC) of the Director-General of NSW Agriculture) to conduct fauna survey work carried out as part of Environmental Impact Statements, Species Impact Statements and general wildlife research. A variation request to our ARA protocol was submitted for the targeted Three-toed Snake-tooth Skink survey in order to undertake VIE tagging and/ or UV fluorescent tattooing for the species if captured, and was approved by the AEC before undertaking the survey on 3 December 2013 (TRIM 11/355) (expiry date 31 January 2014).

Aquatic fauna survey was conducted under NSW DPI Fisheries - Licence Numbers PO05/0016 & OUT10/4198, NSW National Parks and Wildlife Act 1974 - License Number S10318 and a Certificate of Approval under the NSW Animal Research Act 1985.

3.4 Limitations

Ecological surveys provide a sampling of flora and fauna at a given time and season. There are a number of reasons why not all species will be detected at a site during survey, such as species dormancy, seasonal conditions, ephemeral status of waterbodies and migration and breeding behaviours of some fauna. In many cases these factors do not present a significant limitation to assessing the overall biodiversity values of a site.

The flora and fauna assessments undertaken within the project area across key seasons in order to target surveys for the threatened species identified as having a moderate or high likelihood of occurrence (Appendix 1, Appendix 2). Field surveys were conducted in Winter (August, 2010), Summer (February, 2012), Spring (October, 2013), and Summer (December 2013).

It should be noted that due to the nature of the project, a proportion of the project area was not accessible and/or not yet identified through earlier design in order to undertake surveys, namely some of the indicative ancillary site locations (Figure 2). For example suitable habitat exists through a number of historical records for the Three-toed Snake-tooth Skink within the locality of the ancillary sites, which, at the time of survey within privately owned and occupied residential blocks.

Aquatic fauna surveys were subject to the following limitations:

- Depth and bank form precluded the use fyke nets within the Clarence River.
- High electrical conductivity in all waterways prevented electrofishing.
- Current permits and legislation prevent the use of mesh/gill nets as a survey method for aquatic fauna investigations in NSW, which would be deemed the most suitable method in these waterways.

While these limitations restricted the field survey for specific species they do not limit the confidence with which the likelihood of occurrence (Appendix 2) is determined. A habitat based precautionary approach

was applied to significant aquatic fauna with the single snapshot survey undertaken in 2010 used to supplement determinations. Furthermore the precautionary approach as been applied to the significant impact assessments, found in Appendix 3 and 4.

All vegetation calculations and areas of impact are based on the most recent project area, as provided by Arup on April 2014. Database searches, and associated conclusions on the likelihood of species to occur within the project area, are reliant upon external data sources and information managed by third parties.

3.5 Likelihood of occurrence of threatened species

The criteria used to assess the likelihood for threatened flora and fauna species to occur within the project area is outlined below in Table 5.

Table 5: Criteria for likelihood of occurrence assessment

Likelihood of occurrence	Potential criteria
High	Species recorded in study area during current or previous assessment/s. Aquatic species recorded from connected waterbodies in close proximity to the study area during current or previous assessment/s. Sufficient good quality habitat is present in study area or in connected waterbodies in close proximity to the study area (aquatic species). Study area is within species natural distributional range (if known). Species has been recorded within 10 km or from the relevant catchment/basin.
Medium	Records of terrestrial species within 10 km of the study area or of aquatic species in the relevant basin/neighbouring basin. Habitat limited in its capacity to support the species due to extent, quality, or isolation.
Low	No records within 10 km of the study area or for aquatic species, the relevant basin/neighbouring basin. Marginal habitat present (low quality and extent). Substantial loss of habitat since any previous record(s).
Negligible	Habitat not present in study area Habitat for aquatic species not present in connected waterbodies in close proximity to the study area. Habitat present but sufficient targeted survey has been conducted at an optimal time of year and species wasn't recorded.

3.6 Key personnel

The duration of the project over numerous seasons and three separate ecology reports has required the involvement of multiple staff members, the details of which are outlined in Table 6 below.

Table 6: Name, qualifications and role of key project staff

Name	Qualifications and Experience	Role
Jane Murray	B.App.Sc. Environmental Management, 11+ Years Experience.	Project management, botanical assessment and reporting for the 2013/2014 flora and fauna assessment.
Alexandra Cave	M.Sc. Wildlife Conservation, B.Sc. Biodiversity and Conservation, 5 years experience.	Fauna assessment and reporting for the 2013/2014 flora and fauna assessment.
Kathleen Beyer	Ph.D. Fisheries Studies, M.Sc. Aquatic Tropical Ecology, 10 years experience.	Aquatic reporting for the 2013/2014 flora and fauna assessment.
Ed Cooper	B.Sc. Hons Environmental Biology, 5 Years Experience.	Background research, botanical assessment and reporting for the 2013/2014 flora and fauna assessment.
Josephine Dessmann	BSc Hons Ecology, 7 years experience.	Fauna assessment and reporting for the 2013 flora and fauna assessment, the <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012) and the <i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011).
James Shepherd	B.A. Hons Informatics, 7 years experience.	Mapping and spatial analysis for the 2013/2014 flora and fauna assessment.
Aaron Troy	B.Sc. Hons Environmental Management and Ecology, 11 years experience.	QA of aquatic sections for the 2013 flora and fauna assessment and aquatic assessment and reporting for the <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012) and the <i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011)
Robert Speirs	B.App.Sc Ecology and Environmental Science, 8 years experience.	QA of the 2013 flora and fauna assessment. Fauna assessment and reporting for the 2013 flora and fauna assessment, the <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012) and the <i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011).
Monica Campbell	Ph.D. Plant Ecology, B.Sc. Hons, 12 years experience.	QA of the 2013 flora and fauna assessment. Botanical assessment and reporting for the 2013 Flora and Fauna Assessment, the <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012) and the <i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011).
Jennifer Charlton	B.Sc. Zoology, 7 years experience.	Fauna assessment and reporting for <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012) and the <i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011)
Ben Coddington	Bachelor of Landscape Management and Conservation, 12 years experience.	Botanical assessment and reporting for the <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012)

Name	Qualifications and Experience	Role
Brett Morrisey	B.App.Sc. Coastal Management, 10 years experience.	QA of the <i>Route Options Development Report Technical Paper: Ecology</i> (Biosis, 2012)
Brendan Smith	B.Sc. Environmental Biology, 10 years experience.	<i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011)
Jane Rodd	B.Sc. Ecology, 10 years experience.	<i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011)
Brendan Ryan	M.Env.Sc., BSc (Zoology/Ecophysiology), 12 years experience.	<i>Preliminary Route Options Report Technical Paper - Ecology</i> (Biosis, 2011)

3.7 Mapping

Aerial photography and site plans (131028 - Strategic Concept Plans) were supplied to Biosis by Arup on 29 October 2013 and again on 8 November 2013.

Vegetation mapping was conducted using a combination of high resolution aerial imagery interpretation and ground truthing by random meander. Mapping was conducted using hand-held (uncorrected) GPS units (GDA94) and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally $\pm$ seven m) and dependent on the limitations of aerial photo rectification and registration.

Mapping has been produced using Geographic Information System (GIS) software. Electronic GIS files containing the relevant flora and fauna spatial data are available to incorporate into design concept plans. However this mapping may not be sufficiently precise for detailed design purposes.

4. Existing Environment

4.1 Landscape context

The project area is located in the city of Grafton in northern NSW, approximately 600 km north-east of the Sydney CBD (Figure 1). The project area encompasses 49.70 ha of private and public land and the adjacent road reserves. The project area is subject to various Local Environment Plan (LEP) zoning restrictions including; *RE1 Public Recreation*, *R1 General Residence*, *SP2 Infrastructure*, *B3 Commercial Core*, *RU1 Primary Production* and *B5 Business Development*.

The project area is located within the:

- NSW North Coast Bioregion.
- Northern Rivers Catchment management Area (CMA).
- Clarence Local Government Area (LGA).
- Clarence River Basin of which the Clarence River Estuary is listed as a nationally important wetland in the Directory of Important Wetlands in Australia (Environment Australia (2001) including the Susan Island Nature Reserve, gazetted May 1989 under NPW Act.

The Clarence River dissects the central portion of the project area flowing from west to east with an average width of approximately 200 m. Significant tributaries of the Clarence River at Grafton are Alipou Creek which is located in the south east of the project area and Carrs Creek, which is located north of the project area. Alipou and Carrs Creeks include substantial areas of permanent water and potential habitat for aquatic fauna. An extensive system of flood levees is located in the project area, including on both banks of the Clarence River Grafton (Grafton Levee and Alipou Basin Levee) extending onto the floodplain in South Grafton (Heber Street Levee).

4.2 Landuse

The project area is predominantly cleared of native vegetation with current land uses including public open space, rail infrastructure, industrial and residential areas and agricultural land including areas used for cattle grazing and cropping. Outside of urbanised Grafton and particularly along the extent of the levees, land use is agricultural and extensive past clearing of native vegetation and intensive grazing by cattle is evident.

4.3 Topography and soils

The landscapes of NSW were mapped at a broad scale (1: 250,000) using land systems, geology, geomorphology and elevation data (DECCW, 2003). The project area which lies within the Clarence-Moreton Basin, has been identified as comprising one soil landscape type throughout, Clarence – Richmond alluvial plains, outlined below.

Clarence-Richmond alluvial plains

Wide valleys, channels, floodplains, terraces and estuaries of the Clarence and Richmond Rivers and other coastal streams on Quaternary alluvium, which have a general elevation of 0 meters to 50 m, with a local relief of 15 m. The alluvium in the Clarence River valley at Grafton is estimated to be about 40 m thick (Department of Primary Industries, 1970). These alluvial soils (structure loams) are characterised as being

deep brown earths and structured brown clays on floodplains. These soils are fertile having a high organic content and are generally not considered to have high erosion potential.

Soils within the project area have been substantially disturbed through peri urban, agricultural and industrial land uses. Severe floods in the 1940s and 1950s prompted the development of an extensive levee and drainage network to mitigate the effects of major flooding events. The levee system was completed in the 1970s with levees present on both sides of the bank of the Clarence River and extending across the floodplains in South Grafton.

Less disturbed portions of the project area where topsoils remain at least partially intact include isolated patches of native vegetation that is typical floodplain vegetation of the lower Clarence.

4.4 Flora

The majority of the project area, including the flood mitigation works area (levee), is represented by a highly modified landscape in poor condition with little or no native vegetation remaining. These areas have been subject to historic and ongoing urbanisation, grazing and cropping which has led to the isolated and fragmented nature of remnant vegetation.

A total of 217 flora species (90 native and 127 exotic) have been recorded across the project area and immediate surrounds, during the assessments to date. Species recorded during the flora assessment are listed in Appendix 1; Table 22 (flora). Unless of particular note, these species are not discussed further. A list of threatened biota recorded or predicted to occur in the local area is also provided in those appendices, along with an assessment of the likelihood of the species occurring within the project area.

No RoTAPs were found during the survey effort, note of the three RoTAPs identified through desktop research (15/11/2013), only Frogbit *Hydrocharis dubia* was considered likely to occur. There was no suitable habitat or landscape features relative to RoTAPS, *Boronia chartacea* and Rusty Plum *Niemeyera whitei*.

Flora surveys were undertaken in public, private and Australian Rail Track Corporation (ARTC) owned lands where access was granted. Generally, survey effort was focused on habitats with a greater potential to contain native species, i.e. remnant native vegetation and waterbodies (Clarence River, wetlands, soaks). Less effort was expended on highly modified areas such as cropped pastures, suburban streets and residential housing.

4.5 Noxious Weeds

Thirteen flora species recorded across the project area are listed as noxious weeds in the Clarence Valley local government area (Table 7).

Table 7: Noxious weeds recorded in the Grafton and South Grafton area

Weed species	Common Name	Noxious Weed Class
<i>Ageratina adenophora</i>	Crofton weed	4
<i>Alternanthera philoxeroides</i>	Alligator weed	2
<i>Cestrum parqui</i>	Green cestrum	3
<i>Cinnamomum camphora</i>	Camphor laurel	4
<i>Cryptostegia grandiflora</i>	Rubber vine	1
<i>Eichhornia crassipes</i>	Water hyacinth	4

Weed species	Common Name	Noxious Weed Class
<i>Lantana camara</i>	Lantana	4
<i>Leptospermum petersonii</i>	Lemon-scented tea tree	4
<i>Ligustrum lucidum</i>	Broad-leaved privet	4
<i>Ligustrum sinense</i>	Small-leaved privet	4
<i>Opuntia stricta</i>	Prickly pear	4
<i>Salix fragilis</i>	Crack willow	5
<i>Sporobolus fertilis</i>	Giant Parramatta grass	4

The legal requirements of the NW Act stipulated various weed control classes, as outlined above and described below:

- Class 1 - The plant must be eradicated from the land and the land must be kept free of the plant.
- Class 2 - The plant must be eradicated from the land and the land must be kept free of the plant.
- Class 3 - The plant must be fully and continuously suppressed and destroyed.
- Class 4 - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
- Class 5 - The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

These weeds are generally located along the banks of the Clarence River and within the paddocks traversed by the levee. Recommendations regarding hygiene protocols to minimise the potential spread of any noxious weeds are outlined in Section 6.

4.6 Vegetation communities and fauna habitat

The vegetation communities throughout the study area were broadly categorised into four vegetation communities:

- *Freshwater Wetlands on Coastal Floodplains* TEC (0.10 ha).
- *Subtropical Coastal Floodplain Forest* TEC (0.31 ha).
- Native and exotic plantings (4.41 ha).
- Weeds and exotics (31.25 ha).

The floristic composition of each strata along with the associated fauna habitat values for each of the vegetation communities is outlined in Figure 4 and 5 and across Table 8 to Table 11.

Table 8: Freshwater Wetlands on Coastal Floodplains TEC

Freshwater Wetlands on Coastal Floodplains

Extent within project area	Approximately 0.10 ha of Freshwater Wetlands TEC was recorded within the current project area predominantly as narrow linear patches along the banks of the Clarence River within the project area and up and down stream in disjunct patches. It was also recorded within a number of the flood gate channels along the length of the levee and within some wet depressions adjoining the River, however these were located outside of the project area.
Description	This community is found in predominantly inundated wet depressions and along the banks of the Clarence river in low lying areas with relatively poor drainage. Soils are often heavy alluvial deposits. Species present in the mid strata include monocultures and dominance of Common Reed <i>Phragmites australis</i>, Cumbungi <i>Typha orientalis</i> and <i>Ricinus communis</i> with groundstorey strata including; <i>Schoenoplectus mucronulatus</i>, <i>Cyperus eragrostis</i> <i>Bolboschoenus fluviatilis</i>, <i>Elaeocarpus obovatus</i>, <i>Persicaria hydropiper</i> and <i>Rumex brownii</i>. Common paddock weeds have integrated substantially into many of the areas identified as the FWCF since the small patch sizes increase edge effects. Although degraded, this community is considered to be consistent with the FWCF.
Condition	The community is generally in poor condition with heavy recruitment of exotic species due to surrounding land use and associated edge impacts.
Threatened ecological community	Commonwealth EPBC Act: Not listed NSW TSC Act: Endangered Justification: FWCF can be present in the form of large monocultures of reed species such as Common Reed and/or Cumbungi (DECC, 2008).
Threatened species / fauna habitat	The freshwater wetlands are considered to provide marginal habitat for threatened flora including Hairy Joint Grass <i>Arthraxon hispidus</i> and prior listed and current RoTAP, Frogbit <i>Hydrocharis dubia</i> however targeted searches did not identify these species.
Picture: Freshwater Wetlands on Coastal Floodplains	

Table 9: Subtropical coastal floodplain forest TEC

Subtropical Coastal Floodplain Forest

Extent within project area	This community was predominantly located on the south bank, downstream of the existing bridge with small scattered patches throughout the surveyed area. Approximately 0.31 ha of SCFF was recorded within the current project area, the largest patch of which is approximately 1500 meters upstream of the existing bridge, on the northern bank of the River.
Description	SCFF occurs on exposed dry sites on hills and foot slopes, as well as dry, steep, rocky sites. Often on poorly developed or skeletal soils. The canopy is predominantly native with some exotic species including garden escapees and noxious weeds in the mid storey and shrub strata. Paddock and roadside exotic grasses are dominant in the groundstorey and exotic vines and scramblers are present. The SCFF community is typically present in the form of isolated remnant canopy species with little connectivity and a lack of native shrubs, grasses and ground covers. The canopy is dominated by species; <i>Eucalyptus tereticornis</i>, <i>Casuarina cunninghamiana</i> and <i>Casuarina glauca</i> and midstorey species either being absent or comprising weeds such as; <i>Cinnamomum camphora</i>, <i>Erythrina crista-galli</i>, <i>Lantana camara</i> and Small-leaf Privet <i>Ligustrum sinense</i> and Wild Tobacco <i>Solanum mauritianum</i>. The groundstorey comprised, <i>Ageratum houstonianum</i> <i>Cynodon dactylon</i> and <i>Tradescantia fluminensis</i>
Condition	The SCFF within the project area is in poor condition based on the historic disturbance regimes outlined previously.
Threatened ecological community	Commonwealth EPBC Act: Not listed NSW TSC Act: Endangered Justification: Clause 10 of the SCFF final determination (NSW Scientific Committee, 2011) outlines that the EEC has been historically cleared and modified by changes in land use. Clause 11 outlines that isolated paddock trees may locally be the only remnants of the community. This is the case within the study area.
Threatened species / fauna habitat	The SCFF habitat consists mainly of scattered mature <i>Eucalyptus tereticornis</i> , providing potential habitat mainly for woodland birds and microbats species due to the sparse nature of the community, especially nesting resources, hollows and perch sites for birds of prey in the locality. Some sparse CWD may provide limited habitat for reptile species, however habitat resources are generally limited in this area. In some areas, pockets of scattered Lantana offer a complex shrub layer understorey that may provide foraging and shelter resources for small mammals and birds.

Picture: Subtropical Coastal Floodplain Forest

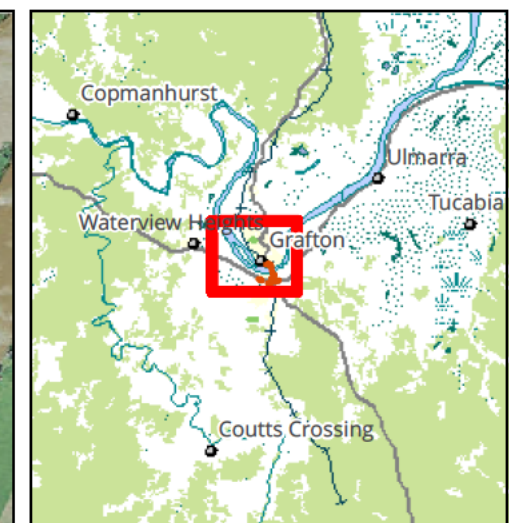
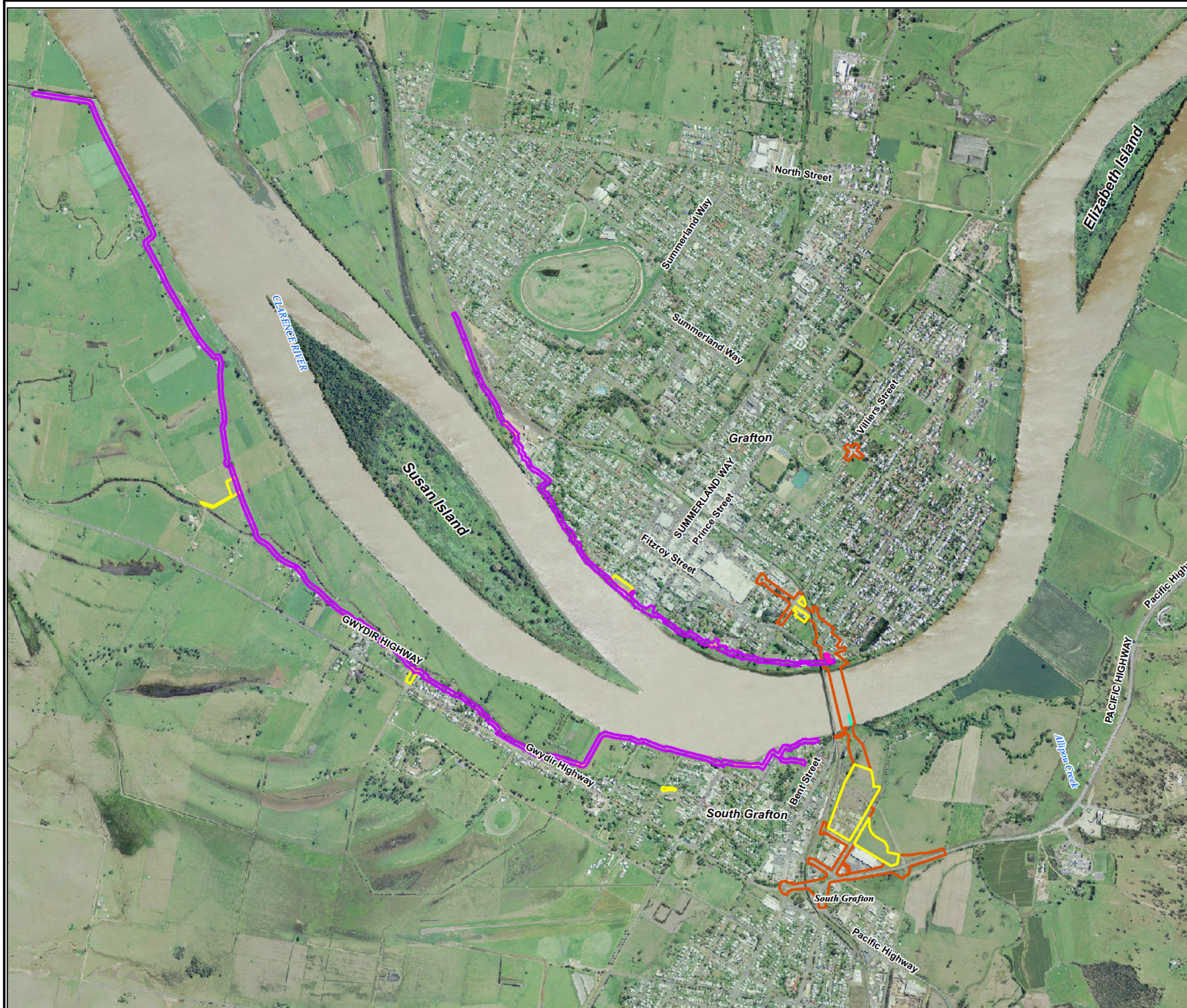


Table 10: Native and exotic plantings

Native and exotic plantings	
Extent within project area	A total of 4.41 ha of native and exotic plantings were found to be dominant throughout the urbanised portion of project area through Grafton and South Grafton.
Description	This community comprises a high level of exotic canopy species and landscaping natives that are not native to the locality. It typically encompasses roadside verges and nature strips where planted <i>Jacaranda mimosifolia</i> and <i>Ficus macrophylla</i> are thriving. The shrub and understorey are dominated by exotic shrubs, grasses and annuals including <i>Pennisetum clandestinum</i> , <i>Axonopus fissifolius</i> . Other commonly planted species in this community included; <i>Jacaranda mimosifolia</i> , <i>Ficus macrophylla</i> , <i>Eucalyptus microcorys</i> , <i>Cinnamomum camphora</i> and <i>Melaleuca leucodendron</i> .
Condition	Poor condition was noted based on the highly modified landscape containing few or no indigenous species, where exotic species are dominant, original native vegetation layers removed, the natural soil profile disturbed and limited floristic value however may provide potential fauna habitat for threatened and non threatened species.
Threatened ecological community	No
Threatened species / fauna habitat	Due to the highly modified nature of the urban environment, it is considered to provide poor condition habitat for native species in terms of connectivity. However, a number of native and exotic plantings within the project area comprising various habitat trees (i.e. Moreton Bay Fig, <i>Jacaranda mimosifolia</i> and <i>Cinnamomum camphora</i>) provide good quality habitat and foraging resources for a range of bird and mammal species (i.e. including the Grey-headed flying-fox <i>Pteropus poliocephalus</i>).
Picture: Native and exotic plantings	

Table 11: Weeds and exotics

Native and exotic plantings	
Extent within project area	A total of 31.25 ha of weeds and exotics dominate the project area through Grafton and South Grafton.
Description	This community occurs throughout the project area amongst the native and exotic plantings community. The species composition varies according to land use with exotic grasses dominant within mown areas and annuals and shrubs dominant through the riparian sections adjoining the Clarence River. Found in wet depressions and along the banks of the Clarence River in low lying areas with relatively poor drainage. Soils are often heavy alluvial deposits. The effects of grazing are evident, particularly along the levees where the community is generally dominated by exotic mown grasses and annuals such as <i>Pennisetum clandestinum</i>, <i>Chloris gayana</i> and <i>Bidens pilosa</i>. Within the urbanised area, garden escapees and landscaping plants were more prevalent, with very low native diversity recorded. Common weed and exotic species include: <i>Erythrina crista-galli</i>, <i>Ricinus communis</i>, <i>Argemone ochroleuca</i>, <i>Tradescantia fluminensis</i>, <i>Ipomoea indica</i>, <i>Vicia sativa</i>, <i>Sporobolus fertilis</i>, <i>Argemone ochroleuca</i>, <i>Lolium perenne</i>, <i>Holcus lanatus</i> and <i>Phalaris aquatica</i>.
Condition	Poor condition was noted based on the low number of indigenous species, high level of weed invasion, weeds occurring throughout and the fact that the original vegetation layers (ground, shrub, canopy etc.) modified or missing.
Threatened ecological community	No
Threatened species / fauna habitat	Paddock habitat within the project area provides somewhat limited habitat resources for fauna, but instead supports foraging and browsing habitat for larger mammals (i.e. Eastern Grey kangaroo <i>Macropus giganteus</i> and Common wombat <i>Vombatus ursinus</i>), threatened microbats that exploit foraging opportunities in more open habitat, and various diurnal and nocturnal birds of prey.
Picture: Weeds and Exotics	



Legend

Project Area

- ▭ Construction works zone
- Indicative location of pump station infrastructure
- Temporary Jetty (Indicative)
- ▭ Indicative location of ancillary sites
- ▭ Flood mitigation works construction zone

Figure 1: Location of the project area in a regional context

0 200 400 600 800 1,000
Metres

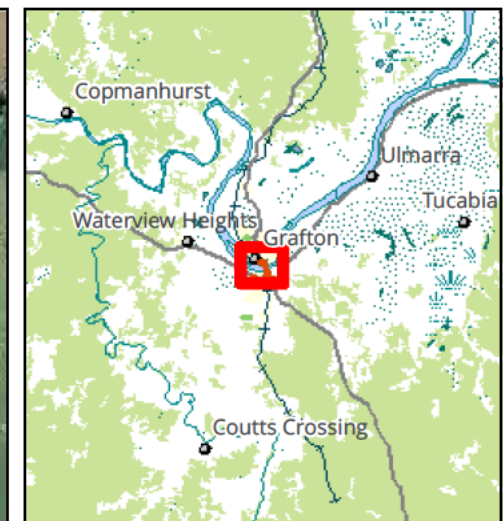
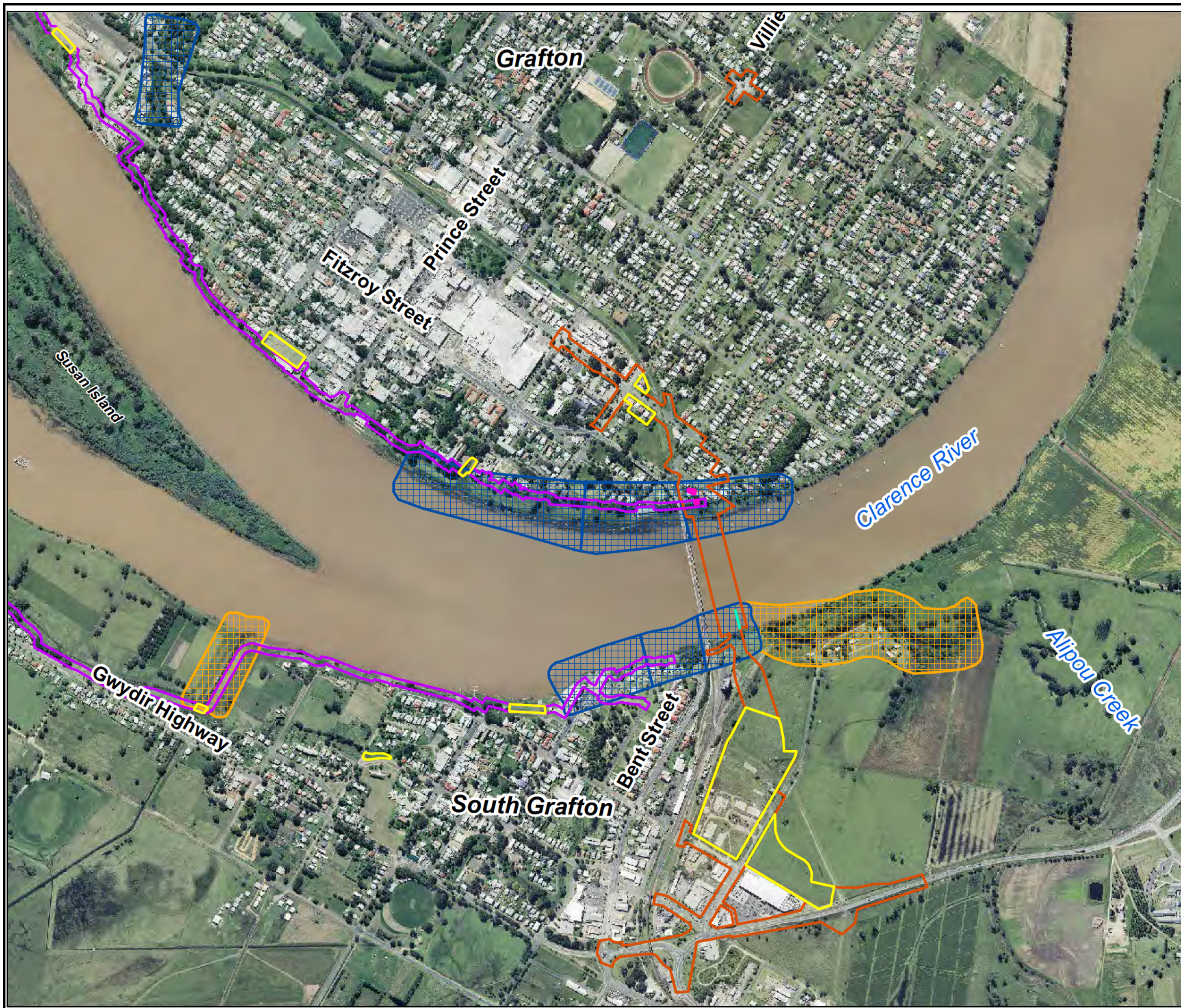
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Coordinate System: GDA 1994 MGA Zone 56



Ballarat, Brisbane, Canberra, Melbourne,
Sydney, Wangaratta & Wollongong

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Date: 06 May 2014
Checked by: JMM, Drawn by: JMS, Last edited by: jshepherd
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Legend

Project Area

- Construction works zone
- Indicative location of pump station infrastructure
- Temporary Jetty (Indicative)
- Indicative location of ancillary sites
- Flood mitigation works construction zone

Aquatic Survey Effort

- Fyke nets & Bait traps
- Habitat assessment

Figure 3: Aquatic fauna survey effort

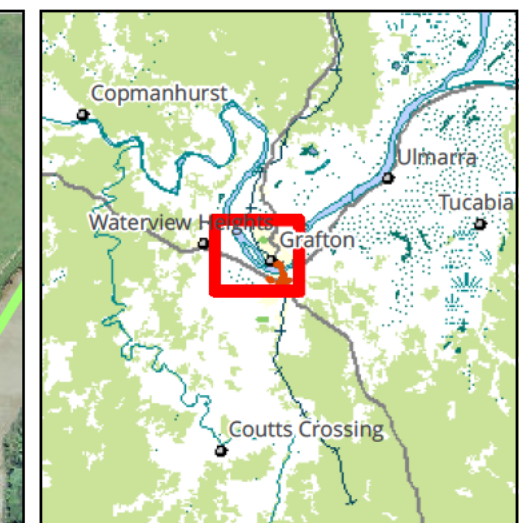
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Legend

Project Area

- Construction works zone
- Indicative location of pump station infrastructure
- Temporary Jetty (Indicative)
- Indicative location of ancillary sites
- Flood mitigation works construction zone

Potential habitat

- + Hollow-bearing tree
- + Habitat tree

Threatened Ecological Communities

- Freshwater wetlands on coastal floodplain TEC
- Sub-tropical coastal floodplain forest TEC

Other Vegetation Types

- Native and exotic plantings
- Weeds and exotics

Groundwater Dependent Ecosystems

- Reliant on subsurface groundwater (GW)
- High potential for GW interaction
- Moderate potential for GW interaction
- Reliant on surface groundwater
- High potential for GW interaction

Figure 4: Vegetation community mapping and values (full extent)

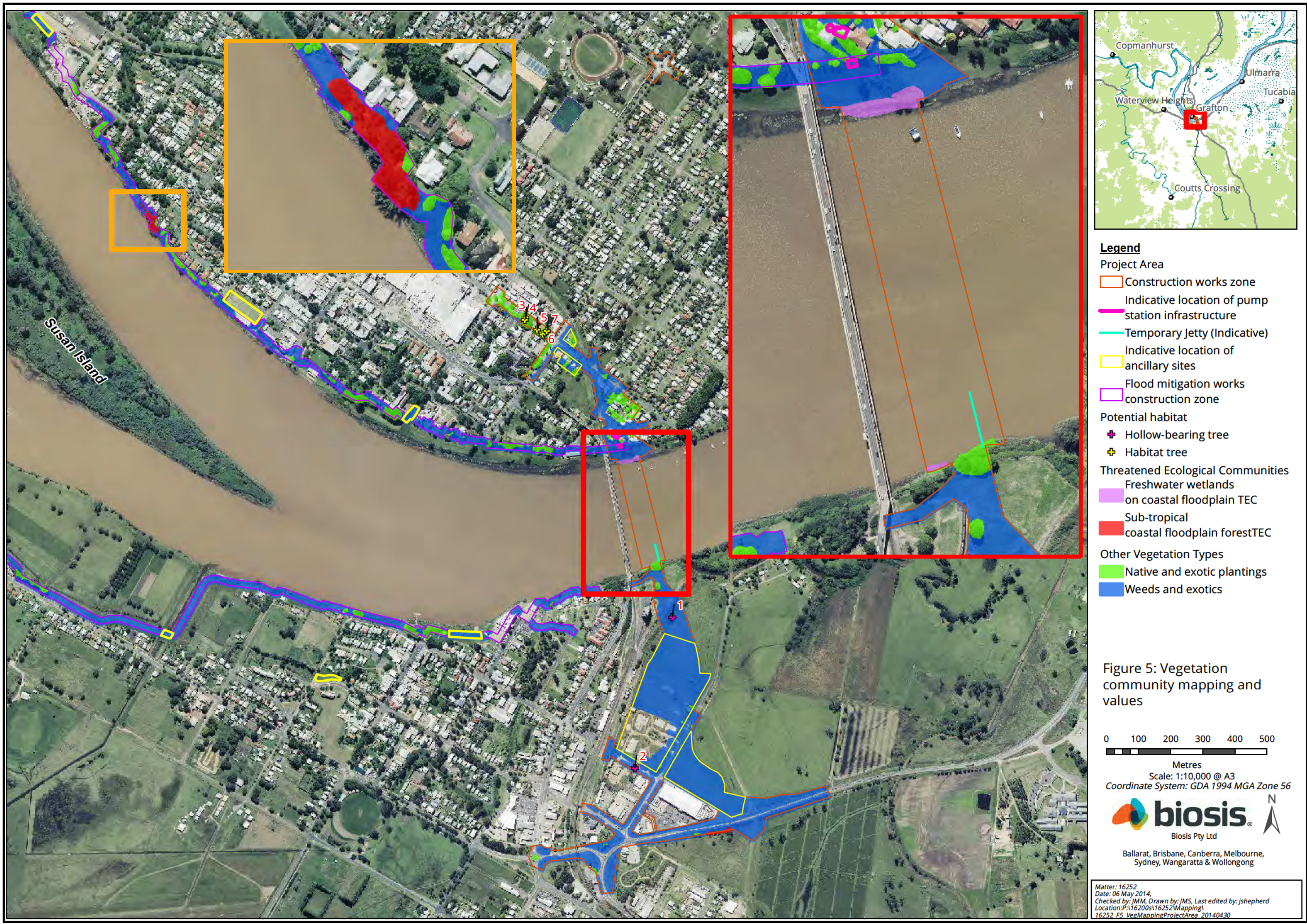
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Metres

Scale: 1:20,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56



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Fauna

A list of fauna species recorded within the project area is provided in Appendix 2; Table 24 and includes 83 species of bird, 22 mammals, seven reptiles, two frogs and 10 fish species.

Fauna surveys were undertaken in public, private and Australian Rail Track Corporation (ARTC) owned lands where access was granted. Generally, survey effort was focused on habitats with a greater potential to contain native species, i.e. remnant native vegetation and waterbodies (Clarence River, wetlands, soaks). Less effort was expended on highly modified areas such as cropped pastures, suburban streets and residential housing.

4.7 Threatened biota

4.7.1 Threatened flora

Lists of threatened flora species recorded or predicted to occur within 10 kilometers of the project area, based on database information and are provided in Appendix 1 (flora) and Figure 6. Threatened flora listed under the TSC Act and EPBC Act previously recorded within the project area is shown in Table 12. An assessment of the likelihood of these species occurring in the project area, and an indication of where within the site (i.e. which habitats or features of relevance to the species), is included.

No threatened flora species were recorded in the project area despite targeted searches during optimal periods. The results of the habitat assessment indicate that one threatened flora species, Hairy-joint Grass *Arthraxon hispidus* is considered to have a medium to high likelihood of occurrence, as shown in Table 23 in Appendix 1.

It should be noted that Frogbit *Hydrocharis dubia*, previously listed as vulnerable under the EPBC Act and listed as a RoTAP, the subject of targeted surveys, was delisted as of 3 December 2013 (Commonwealth of Australia, 2013). Potential marginal habitat for Frogbit was identified within the project area; however following the removal of the species from the vulnerable list, the consideration of potential impacts on the formerly threatened species is no longer required.

Table 12: Threatened flora species considered likely to occur in the project area

Species name	Area of value within the project area
<u>EPBC Act listed threatened species</u>	
Hairy-joint Grass - <i>Arthraxon hispidus</i>	0.10 ha of FWCF TEC was identified as providing marginal potential habitat.
<u>TSC Act listed threatened species and populations</u>	
Hairy-joint Grass - <i>Arthraxon hispidus</i>	0.10 ha of FWCF TEC was identified as providing marginal potential habitat.

4.7.2 Threatened ecological communities

Two of the vegetation communities recorded within the project area were determined to be consistent with TECs listed under the TSC Act, namely FWCF and SCFF. The vegetation composition of these TEC is outlined in Section 4.6 and the area of value is outlined in Table 13 and shown in Figure 4 and Figure 5.

Table 13: Threatened ecological communities within the project area

Species name	Area of value within the project area
TSC Act listed Threatened Ecological Communities	
<i>Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions</i>	A total of 0.10 ha of FWCF was identified as occurring within the project area which includes two narrow linear patches along the northern and southern edges of the Clarence River (Figure 5). The most important patches within the project area are located on the northern and southern bank, immediately east of the existing bridge alignment. The community is generally in poor condition with heavy recruitment of exotic species due to surrounding land use.
<i>Subtropical coastal floodplain forest of the NSW North Coast bioregion</i>	A total of 0.31 ha of SCFF was identified as occurring within the project area. The TEC is limited to isolated patches of remnant vegetation. The canopy is predominantly native with some exotic species including garden escapees and noxious weeds in the mid storey and shrub strata.

4.7.3 Threatened fauna

Lists of threatened fauna species recorded or predicted to occur within 10 kilometers of the project area, based on Biosis records, are provided in Figure 7 and based on database information, are provided Appendix 2 (fauna) and Figure 8. Threatened fauna and migratory species listed under the TSC Act, FM Act and EPBC Act previously recorded within the project area are shown in Table 26, Table 27 (Appendix 2) as well as Figure 7, Figure 8 and Figure 9. An assessment of the likelihood of these species occurring in the project area, and an indication of where within the site (i.e. which habitats or features of relevance to the species), is included.

On the basis of regional records, literature reviews and the presence of suitable habitat, a total of 21 threatened fauna species are known to occur or are considered to have a medium or high potential to occur in the project area. The list of threatened fauna species and assessment of the likelihood for each species to occur is provided in Table 26 (Appendix 2).

While the fauna surveys conducted in August 2010, February 2012, October 2013 and December 2013 were thorough and covered a large portion of the project area, site accessibility was a constraint for some of the surveys (i.e. the privately owned lands contained within the construction compound area). A total of nine threatened fauna species were recorded during field surveys, including:

- Masked owl *Tyto novaehollandiae*, TSC Act Vulnerable.
- Hoary wattled-bat *Chalinolobus nigrogriseus*. TSC Act Vulnerable.
- Little bent-wing bat *Miniopterus australis*, TSC Act Vulnerable.
- Eastern bent-wing bat *Miniopterus schreibersii oceanensis*, TSC Act Vulnerable.
- Eastern freetail-bat *Mormopterus norfolkensis*, TSC Act Vulnerable.
- Southern myotis *Myotis macropus*, TSC Act Vulnerable.
- Grey-headed flying-fox *Pteropus poliocephalus*, EPBC Act Vulnerable, TSC Act Vulnerable.
- Greater-broad nosed bat *Scoteanax rupelli*, TSC Act Vulnerable.

- Eastern cave bat *Vespadelus troughtoni*, TSC Act Vulnerable.

In addition to those species recorded during field surveys, the results of the habitat assessment indicate that a number of additional threatened fauna species are considered to have a moderate to high likelihood of occurrence, as shown in Table 14 as well as Appendix 2; Table 26, including:

- Black-necked stork *Ephippiorhynchus asiaticus*, TSC Act Endangered.
- Brolga *Grus rubicunda*, TSC Act Vulnerable.
- Comb-crested Jacana *Irediparra gallinacea*, TSC Act Vulnerable.
- Eastern long-eared bat *Nyctophilus bifax*, TSC Act Vulnerable.
- Magpie goose *Anseranas semipalmata*, TSC Act Vulnerable.
- Osprey *Pandion cristatus*, TSC Act Vulnerable.
- Square-tailed Kite *Lophoictinia isura*, TSC Act Vulnerable.
- Purple-spotted gudgeon *Mogurnda adspersa*, FM Act Endangered.
- Silver perch *Bidyanus bidyanus* EPBC Act Critically Endangered FM Act Vulnerable
- Three-toed Snake-tooth skink *Coeranoscincus reticulatus*, EPBC Act and TSC Act Vulnerable.
- Yellow-bellied sheathtail bat *Saccolaimus flaviventris*, TSC Act Vulnerable.

4.7.4 Endangered populations

The desktop review of those endangered populations listed under the TSC Act, and recorded or predicted to occur within 10 km of the project area, identified one endangered fauna population associated with the project area, namely the Emu population *Dromaius novaehollandia* in the NSW North Coast Bioregion and Port Stephens Local Government Area.

The results of the desktop review did not identify any TSC Act listed endangered flora populations for the region.

In regards to FM Act listed endangered populations, two endangered fish populations listed under Part 2 of Schedule 4 of the FM Act were recorded during surveys by Biosis (2010) including:

- Western population of the Olive perchlet *Ambassis agassizii*.
- Murray-Darling Basin population of the Freshwater catfish *Tandanus tandanus*.

The distribution of these endangered populations do not overlap into the Grafton region and in fact occur well outside of the project area (i.e. Murray-Darling Basin). For this reason, neither of these species constitute part of the endangered populations listed above and for this reason have not been considered further in this assessment.

4.7.5 Migratory species

The results of the desktop review of the Commonwealth Protected Matters Search Tool (PMST) identified a total of 32 migratory species listed under the EPBC Act that were predicted to occur within a 10 kilometer radius of the project area (refer to Appendix 2 and Figure 9). Of these 32 migratory species, six are considered to have a high and three are considered to have a medium potential to utilise habitats within the project area based on the availability of suitable habitat in the locality (refer to Table 27 in Appendix 2).

The results of the field investigations recorded five listed migratory species within the project area, including:

- Cattle egret *Ardea ibis*.
- Clamorous reed-warbler *Acrocephalus stentoreus*.
- Common tern *Sterna hirundo*.
- Rainbow bee-eater *Merops ornatus*.
- White-bellied sea-eagle *Haliaeetus leucogaster*.

4.8 Habitat assessment

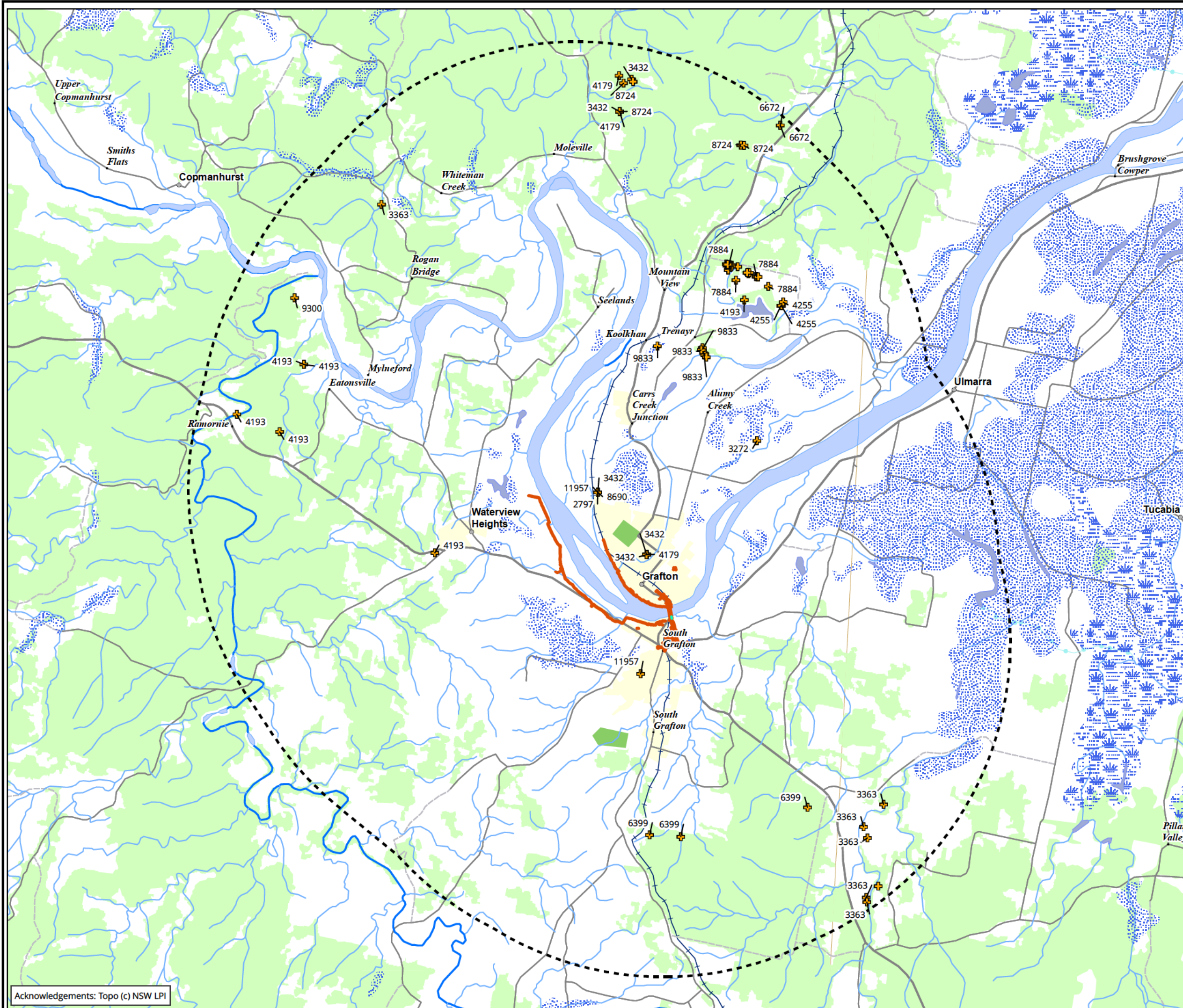
The results of the habitat assessment indicate that a number of threatened fauna species are considered to have a moderate to high likelihood of occurrence, as shown in Table 14 and to be referenced with Figure 5.

Table 14: Summary of threatened fauna considered likely to occur in the project area

Species	Status		Potential to occur in the project area/study area	Suitable habitat
	FM/ TSC Act	EPB C Act		
Black-necked stork	E1	-	Medium	Open paddocks, Susan Island, parklands, waterways.
Brolga	V	-	Medium	Open paddocks, Susan Island, parklands, waterways.
Comb-crested Jacana	V	-	Medium	Open paddocks, Susan Island, parklands, waterways.
Eastern bentwing-bat	V	-	High (recorded during surveys)	Existing bridge over the Clarence River, infrastructure, houses.
Eastern cave bat	V	-	High (recorded during surveys)	Existing bridge over the Clarence River, infrastructure, houses.
Eastern freetail-bat	V	-	High (recorded during surveys)	Hollow bearing trees.
Eastern long-eared bat	V	-	Medium	Hollow bearing trees.
Emu	E2	EX	Medium	Woodland and open paddocks.
Greater broad-nosed bat	V	-	High (recorded during surveys)	Hollow bearing trees, existing bridge over the Clarence River, houses.
Grey-headed flying-fox	V	VU	High (recorded during surveys)	Susan Island, Fig and other suitable foraging trees within North and South Grafton.
Hoary wattled-bat	V	-	High (recorded during surveys)	Hollow bearing trees.
Little bentwing-bat	V	-	High (recorded during surveys)	Existing bridge over the Clarence River, infrastructure, houses.
Magpie goose	V	-	Medium	Open paddocks, Susan Island, parklands, waterways.

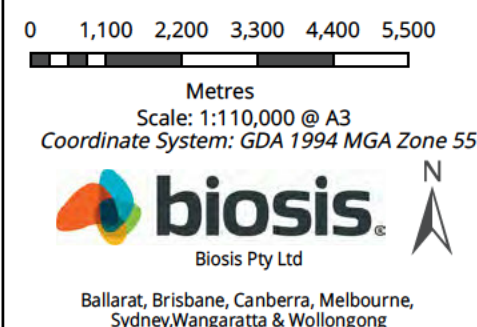
Species	Status		Potential to occur in the project area/study area	Suitable habitat
	FM/ TSC Act	EPB C Act		
Masked owl	V	-	Medium (potentially recorded during surveys)	Tall trees, woodland and forested areas, paddocks.
Osprey	V	-	Medium	Open paddocks, Susan Island, parklands, waterways.
Purple-spotted gudgeon	EN	-	High	Clarence River and adjoining; creeks Alipou, Cowan's and Carr's Creeks.
Silver perch	V	CR	Medium	Clarence River and adjoining; creeks Alipou, Cowan's and Carr's Creeks.
Square-tailed kite	V	-	Medium	All vegetated areas.
Southern myotis	V	-	High (recorded during surveys)	Hollow bearing trees.
Three-toed snake-tooth skink	V	VU	High	Ancillary areas. Residential areas not yet demolished.
Yellow-bellied sheathtail bat	V	-	Medium	Hollow bearing trees.

Note: E1 – endangered species (TSC Act), E2 – endangered population (TSC Act), V – vulnerable (TSC Act), EN – Endangered (FM Act), VU – vulnerable (EPBC Act), CR - Critically Endangered (EPBC Act), EX – Extinct (EPBC Act).

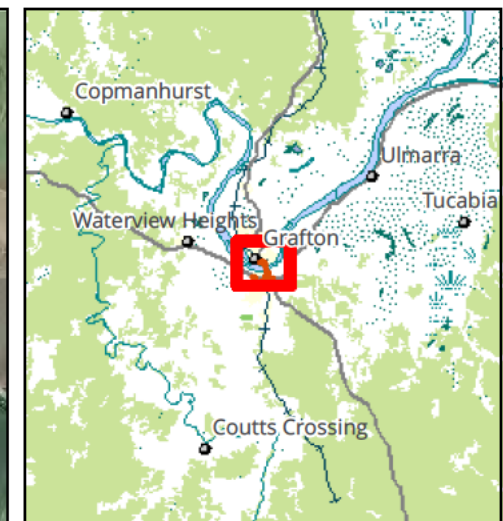
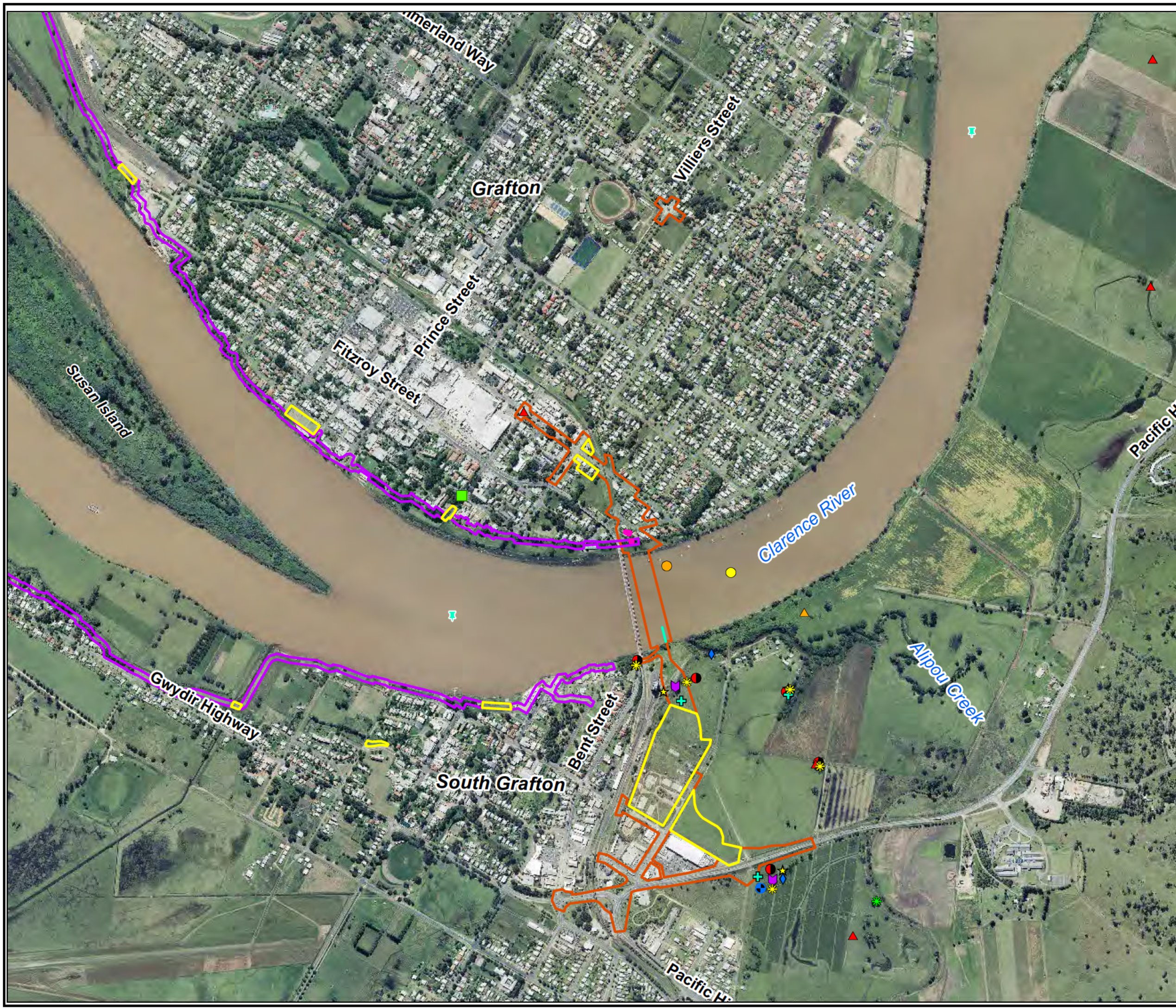


- Legend**
- Project Area
 - Locality
- Threatened flora**
- 11957; *Niemeyera whitei*
 - 2797; *Chorizema parviflorum*
 - 3272; *Hydrocharis dubia*
 - 3363; *Maundia triglochinosides*
 - 3432; *Prostanthera spinosa*
 - 4179; *Eucalyptus seeana*
 - 4193; *Eucalyptus tetrapleura*
 - 4255; *Melaleuca irbyana*
 - 6399; *Cymbidium canaliculatum*
 - 6672; *Geodorum densiflorum*
 - 7884; *Centranthera cochinchinensis*
 - 8690; *Lespedeza juncea* subsp. *sericea*
 - 8724; *Angophora robur*
 - 9300; *Macrozamia johnsonii*
 - 9833; *Phyllanthus microcladus*

Figure 6: Threatened flora records



Matter: 16252
Date: 01 May 2014
Checked by: EC, Drawn by: JMS, Last edited by: jshepherd
Location: P:\16200s\16252\Mapping\16252_F6_ThrFlora_20140430



- Legend**
- Project Area**
- Construction works zone
 - Indicative location of pump station infrastructure
 - Temporary Jetty (Indicative)
 - Indicative location of ancillary sites
 - Flood mitigation works construction zone
- Recorded Threatened Species**
- ▲ Cattle Egret
 - Australian Reed-warbler
 - ✦ Common Tern
 - ★ Eastern Bentwing Bat
 - ✱ Eastern Freetail Bat
 - ✚ Greater Broad-nosed Bat
 - Grey-headed Flying-fox (20+)
 - Little Bentwing Bat
 - ✱ Masked Owl
 - ▲ Rainbow Bee-eater
 - ◆ Southern Myotis
 - White-bellied Sea-Eagle
 - ✱ Hoary Wattled Bat
 - Eastern Cave Bat

Figure 7: Fauna survey results

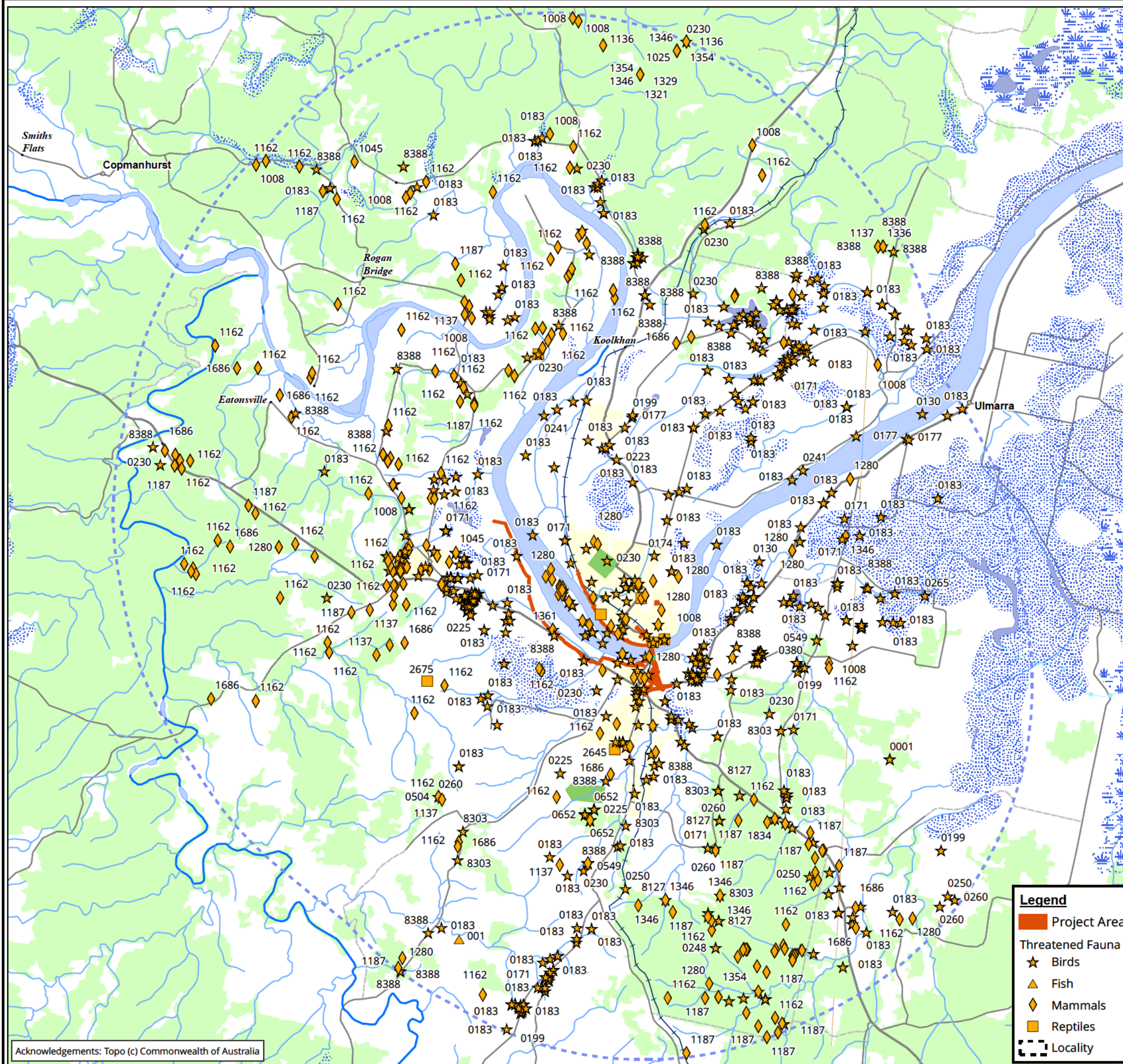
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Metres

Scale: 1:12,500 @ A3
Coordinate System: GDA 1994 MGA Zone 56

biosis
Biosis Pty Ltd

Ballarat, Brisbane, Canberra, Melbourne,
Sydney, Wangaratta & Wollongong

Matter: 16252
Date: 06 May 2014
Checked by: JMM, Drawn by: JMS, Last edited by: jshepherd
Location: P:\16200s\16252\Mapping\16252_F7_FaunaSurveyResults_20140430



Species list

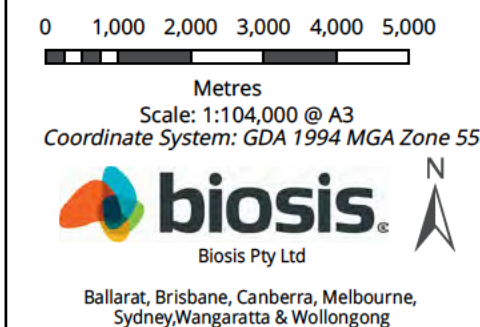
Birds

0001 - Emu
 0120 - Sooty Tern
 0130 - Pied Oystercatcher
 0171 - Comb-crested Jacana
 0174 - Bush Stone-curlew
 0177 - Brolga
 0183 - Black-necked Stork
 0199 - Magpie Goose
 0214 - Freckled Duck
 0218 - Spotted Harrier
 0223 - Red Goshawk
 0225 - Little Eagle
 0230 - Square-tailed Kite
 0241 - Osprey
 0246 - Barking Owl
 0248 - Powerful Owl
 0250 - Masked Owl
 0260 - Little Lorikeet
 0265 - Glossy Black-Cockatoo
 0380 - Scarlet Robin
 0382 - Flame Robin
 0504 - Speckled Warbler
 0549 - Varied Sittella
 0652 - Diamond Firetail
 0972 - White Tern
 8127 - Brown Treecreeper (eastern subspecies)
 8303 - Black-chinned Honeyeater (eastern subspecies)
 8388 - Grey-crowned Babbler (eastern subspecies)

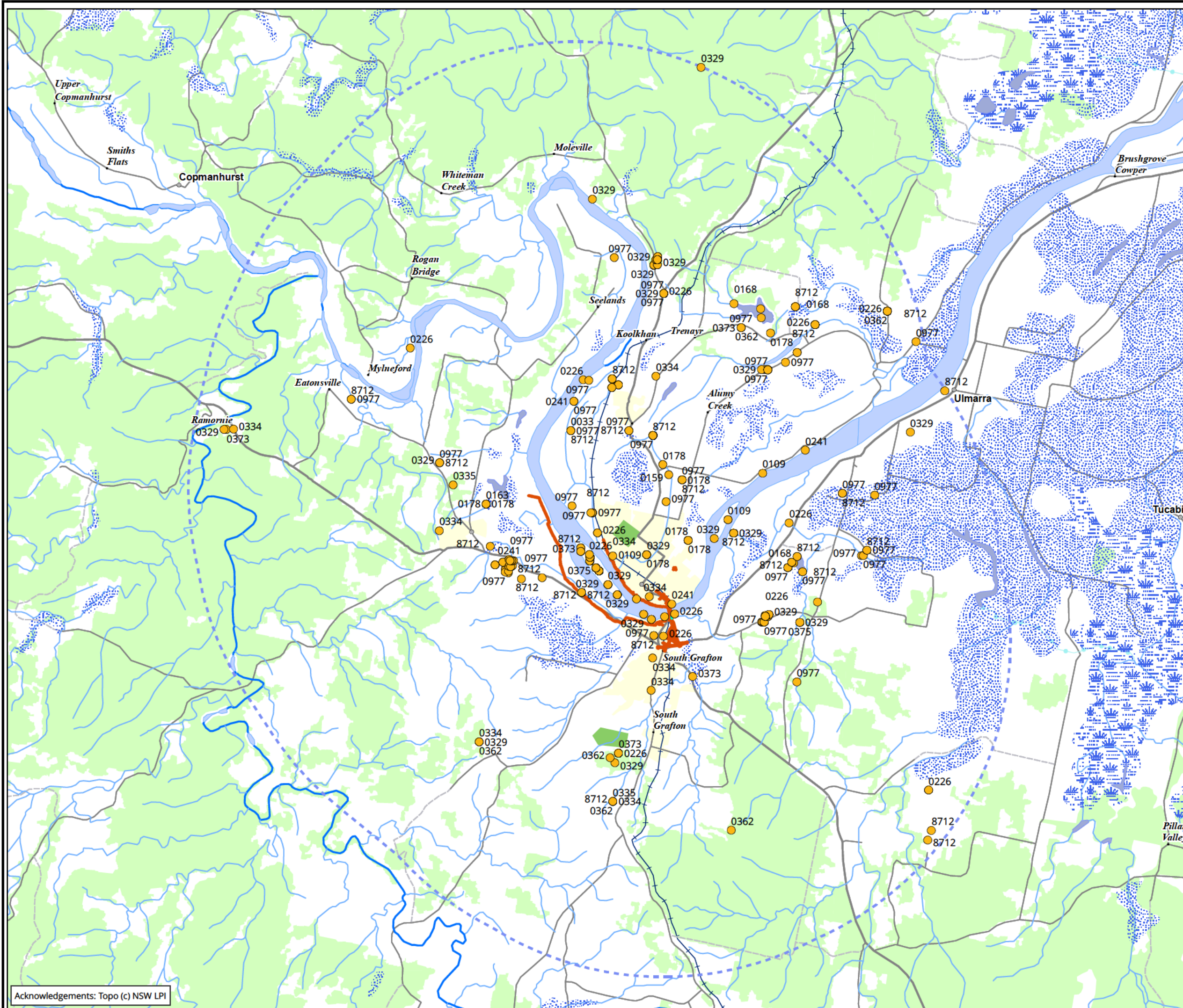
Fish

001 - Eastern cod
Mammals
 1008 - Spotted-tailed Quoll
 1025 - Eastern Cave Bat
 1045 - Common Planigale
 1136 - Yellow-bellied Glider
 1137 - Squirrel Glider
 1162 - Koala
 1187 - Rufous Bettong
 1280 - Grey-headed Flying-fox
 1321 - Yellow-bellied Sheath-tail-bat
 1329 - Eastern Freetail-bat
 1336 - Eastern Long-eared Bat
 1346 - Little Bentwing-bat
 1354 - Hoary Wattled Bat
 1357 - Southern Myotis
 1361 - Greater Broad-nosed Bat
 1686 - Brush-tailed Phascogale
 1834 - Eastern Bentwing-bat
Reptiles
 2293 - Three-toed Snake-tooth Skink
 2645 - White-crowned Snake
 2675 - Pale-headed Snake

Figure 8: Threatened fauna records



Matter: 16252
 Date: 01 May 2014
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 Location: P:\16200s\16252\Mapping\16252_F8_ThrFauna_20140430



Legend

Project Area

Locality

Migratory fauna

- 0033; Emerald Dove
- 0109; White-winged Black Tern
- 0112; Caspian Tern
- 0159; Marsh Sandpiper
- 0163; Sharp-tailed Sandpiper
- 0168; Latham's Snipe
- 0178; Glossy Ibis
- 0226; White-bellied Sea-Eagle
- 0241; Osprey
- 0329; Rainbow Bee-eater
- 0334; White-throated Needletail
- 0335; Fork-tailed Swift
- 0362; Rufous Fantail
- 0366; Satin Flycatcher
- 0373; Black-faced Monarch
- 0375; Spectacled Monarch
- 0977; Cattle Egret
- 8712; Eastern Great Egret
- 9936; Himalayan Cuckoo

Figure 9: Migratory species records

0 1,100 2,200 3,300 4,400 5,500

Metres
Scale: 1:110,000 @ A3
Coordinate System: GDA 1994 MGA Zone 55



Ballarat, Brisbane, Canberra, Melbourne,
Sydney, Wangaratta & Wollongong

Matter: 16252
Date: 01 May 2014
Checked by: EC, Drawn by: JMS, Last edited by: jshepherd
Location: P:\16200s\16252\Mapping\16252_F9_MigFauna_20140430

4.9 Critical habitat

Critical habitat can be declared under both the EPBC Act and TSC Act. Under the EPBC Act, it is an offence for a person to take an action that the person knows will significantly damage the critical habitat of a listed threatened species. Under the TSC Act, the declaration of critical habitat serves primarily as a guide for planning under Part 5 of the EP&A Act and a trigger which ensures a rigorous environmental assessment of all activities and development proposed, and any other action that has the potential to damage the species or its habitat.

No areas of critical habitat for flora or fauna have been declared within the project area.

4.10 Fauna movement corridors

The project area is largely isolated from those optimal habitats and regional corridors occurring within the Clarence Valley LGA. The surrounding landscape has historically been modified to an urban landscape of predominately residential developments, farming lands and associated road infrastructure.

At a regional scale, the key habitats and corridors mapping undertaken by the Department of Environment, Climate Change and Water (DECCW) (Scotts, 2003) provides an appropriate corridor matrix for biodiversity protection and maintenance in the Clarence Valley. The corridors are shown in Figure 2 of the *Clarence Valley Council Biodiversity Management Strategy* (Wright, 2010). However, the project area is not identified to be in the vicinity of any areas classified as 'significant vegetated corridors' or 'stepping stone corridors and priority restoration areas'.

The Clarence River is subject to the proposed development, with the project area occurring within the interface of fresh and tidal waters. This saltwater interface represents a corridor for diadromous fish species; those fish that migrate from freshwater to saltwater or vice versa, to complete life cycles. Aside from diadromous species most locally occurring freshwater fish will utilise the Clarence River to migrate to and from spawning sites and exploit resources throughout the system.

4.11 Aquatic ecology

The Clarence River at Grafton flows from west to east within the proposed concept option Study Area. The Clarence River Basin covers an area of approximately 22,700 km² and is located in the far north coast of New South Wales. Tidal influences extend to the town of Copmanhurst approximately 30km upstream of Grafton. The River rises near the Queensland border and flows south and northeast for 394 km before emptying into the Pacific Ocean at Yamba.

Alipou, Cowan's and Carr's Creeks are tributaries of the Clarence River at Grafton and are within the study area. These waterways are influenced by the tidal movements that affect the Clarence River. These three waterways have all been heavily modified by previous agricultural activities, in particular Alipou and Cowan's Creek which are regulated via floodgates.

The Clarence River within the vicinity of the project area and local tributaries are influenced by tidal waters and as such the aquatic ecological community is comprised of a combination of freshwater and estuarine/marine species. The Clarence River is classified as a CLASS 1 waterway as defined in *Policy and guidelines for fish habitat conservation and management* (DPI, 2013) as it is an estuarine waterway, permanently flowing or flooded freshwater waterway. The Clarence River within and adjacent to the alignment contains TYPE 2 moderately sensitive key fish habitat as it provides riverine brackish wetland habitat and has a stable vegetated substrate.

Alipou, Cowan's and Carr's Creeks are classified as CLASS 1 waterways and contain TYPE 2 moderately sensitive key fish habitat as they provide a combination of freshwater habitats and brackish wetlands.

The Clarence River has experienced regular floods with records indicating that since 1839 the Clarence River has experienced 71 major and moderate floods the most recent being in 2001 when the river peaked at 7.70m (Clarence Valley City Council Website). The floods typically occur from relatively low rainfall events upstream, lasting for several days or weeks, rather than high intensity rains. Long periods of dry followed by flooding events are normal environmental conditions given the size of the catchment and rainfall for the region.

It was determined that the NSW DPI Fisheries Database and Records Viewer data was not comprehensive for the Clarence River catchment, therefore the use of expected distributions of threatened species was found to be a better measure of the potential occurrence of threatened species within the project area.

Aquatic fauna captured during surveys comprised 10 species of fish (including two introduced species), one reptile and one decapod crustacean. No aquatic flora species listed as threatened under the EPBC Act or the FM Act were recorded during the aquatic surveys. For the full of aquatic species found during surveys refer to Table 25, Appendix 2.

Based on desktop and field based assessments, seven threatened aquatic fauna species occur or were considered to potentially occur within the project area (Appendix 2; Table 26). Two of these species were collected during survey; Freshwater Catfish *Tandanus tandanus* and Olive Perchlet *Ambassis agassizii*. A further 2 species were considered to have a medium to high likelihood of occurrence; Purple-spotted Gudgeon *Mogurnda adspersa* and Silver Perch *Bidyanus bidyanus*.

Freshwater Catfish and Olive Perchlet were recorded within the study area; however the Murray-Darling Basin population of the Freshwater Catfish and the Western population of the Olive Perchlet are listed as Endangered Populations under the FM Act. The Clarence River at Grafton is outside the expected distribution of these populations and therefore these listings were not relevant to current investigations but according to due diligence their Likelihood of Occurrence was assessed accordingly (Appendix 2; Table 26). The endangered Eastern Freshwater Cod (FM Act and EPBC Act) is known within the Clarence River system, however, this species is expected to be absent in the vicinity of the project area due to degraded nature of the riparian vegetation along the Clarence River at Grafton and due to limited anecdotal records placing them within the project area. Silver Perch (FM Act and EPBC Act) are known to occur within the area, however DPI-NSW does not require them to be considered as this region is occupied by translocated populations outside of their natural distribution (pers comm. G. Butler, DPI, 2013). Australian Bass *Macquaria novemaculeata* were observed within the project area, although not listed under the EPBC or FM Acts the species is under significant decline and is an important angling species within the vicinity of the project area.

No aquatic vegetation, seagrasses were considered likely to be present following Roads and Maritime consultation with the Seagrass Working Group on 8 of November 2014. The working group confirmed there would not be any seagrass (*Posidonia* sp.) in the Clarence River where the additional river crossing is to be located.

4.12 Groundwater dependant ecosystems

Vegetation communities in the project area are considered to have a high level of groundwater dependence considering the proximity of the area to the Clarence River. As such, there are two vegetation communities impacted by the project which are considered to be a form of groundwater dependent ecosystem. They comprise vegetation occurring on waterways and floodplains which are likely to be reliant on groundwater, particularly during drought periods. In the project area, there are two vegetation communities and habitats that have the potential to be affected by impacts to groundwater, including:

- *Freshwater Wetlands on Coastal Floodplain* TEC (0.10 ha).
- *Sub-tropical Coastal Floodplain Forest* TEC (0.31 ha).

These communities are in part supported by shallow groundwater systems that effectively arrest the infiltration of surface waters. Road crossings and infrastructure upgrades, involving soil cutting and excavation in close proximity to these communities can impact on the subsurface flows by blocking drainage passages and groundwater flows. Potential impacts on groundwater recharge rates from general road construction are generally greatest in areas where significant cuttings are required as they have the potential to intersect the water table and affect groundwater levels downstream.

The project is likely to involve cutting and excavation however as at April 2014 these areas are located away from identified groundwater dependent ecosystems and would be less than 2 meters depth.

Groundwater Dependent Ecosystem Map Report

The results of the Bureau of Meteorology (BOM) Groundwater Dependent Ecosystem (GDE) Atlas search undertaken on the 4 November 2013 identified the following GDE's within the project area (refer to Figure 4), including:

- The Clarence River, as a GDE reliant on surface expression of groundwater (rivers, springs, wetland), identified in previous fieldwork studies.
- Vegetation, as a GDE reliant on subsurface groundwater, which is identified as having a high, moderate and low potential for groundwater interaction (refer to patch located in South Grafton).

Vegetation communities within the project area are considered to have a high-level of groundwater dependence due to the proximity of the project area to the Clarence River (Figure 4).

4.13 State environmental planning policies

4.13.1 SEPP 44 koala habitat protection

A habitat assessment was undertaken within the project area, in accordance with the Interim Koala Referral Advice for Proponents (DSEWPoC, 2012) and SEPP 44 criteria.

No core Koala habitat was observed within the Grafton or South Grafton area. Forest Red Gum *Eucalyptus tereticornis*, a listed preferred feed tree of the Koala under SEPP44 was recorded, however only as scattered trees with open paddocks. Due to the low number of trees and their isolation from other stands of eucalypts they are not considered to be suitable habitat to support breeding or foraging activities of a population of Koalas. In addition the Forest Red Gum was recorded as remnant roadside paddock tree amongst a few other scattered trees with less than a 15 per cent canopy cover. This vegetation type does not classify as 'potential Koala habitat' under SEPP 44 as the area does not equal or exceed one hectare in area.

In reference to the DSEWPac (2012) guidelines, records of Koala were mapped using data obtained from the NSW OEH BioNet Wildlife Atlas. Only a few scattered records have been documented for the species in the locality, and it is noted that the species has not been recorded in the project area. Scattered historical Koala records exist from the South Grafton area, however the closest current population to the project area occurs in the suburb of Waterview Heights, to the west of Grafton, and there are some records in Bom Bom State Forest, to the south-east of Grafton (refer to Plate 1).

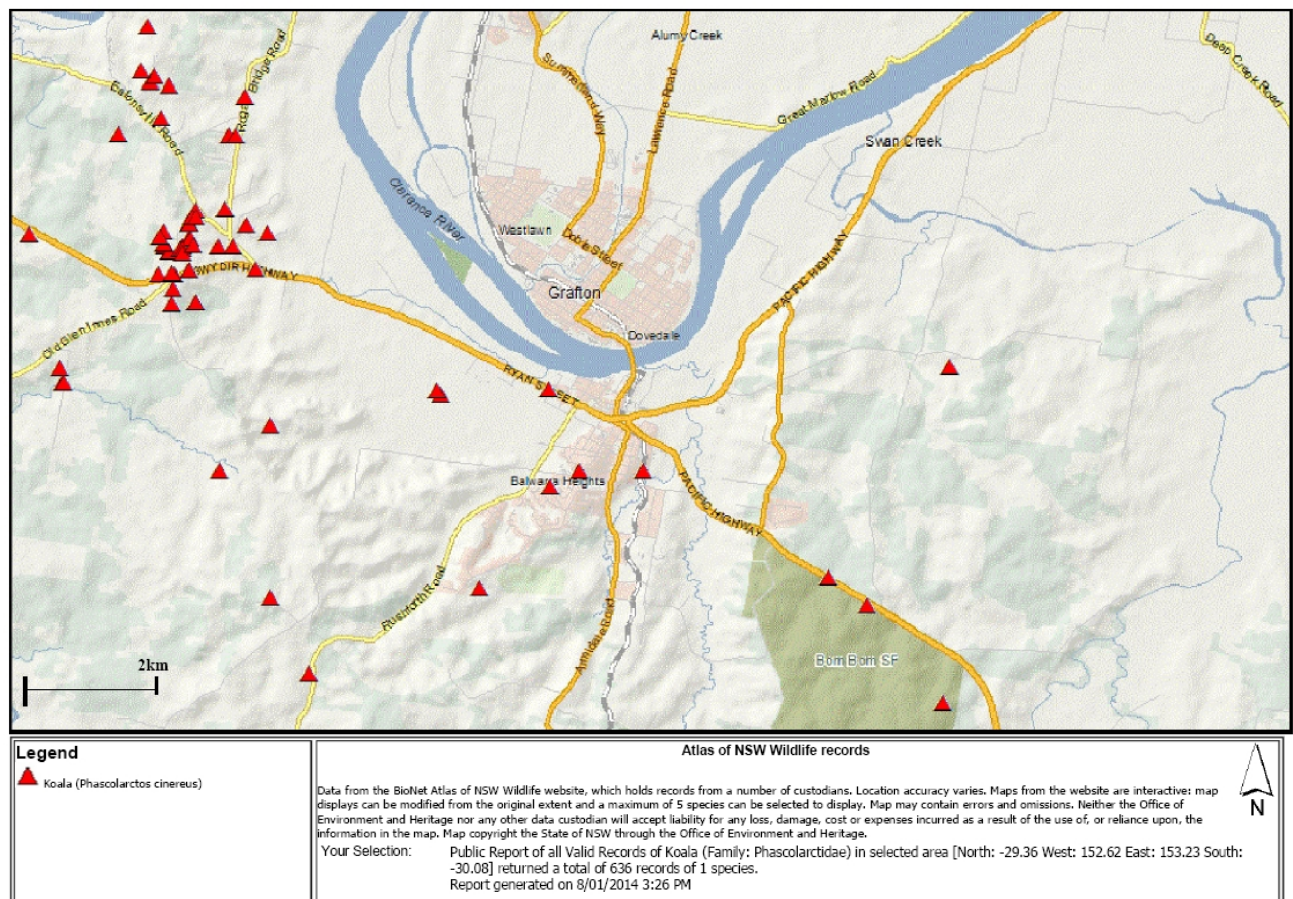


Plate 1: Koala records in the project area (BioNet, 2013)

4.13.2 SEPP 14 – Coastal Wetlands

The closest SEPP14 listed wetland (No. 292) is located eight kilometers to the east of the project area and is part of the Upper Coldstream Wetlands, associated with Coldstream River and Pillar Valley Creek.

5. Potential Impacts

5.1 Construction and operational impacts

The project has the potential to trigger a range of direct impacts on flora and fauna and specifically to threatened flora and fauna and ecological communities (Table 18). Such impacts are detailed below and identified as to whether they are either construction or operational based impacts, or both.

Table 15: Impacts to threatened biota

Species name	Area of value within the project area
<u>EPBC Act listed threatened species</u>	
Grey-headed flying-fox	A total of approximately 0.12 ha of suitable foraging habitat for the Grey-headed Flying-fox occurs within the project area in the form of planted Moreton Bay Figs on Pound Street (Figure 5). No roost sites are located within the project area; however do occur on nearby Susan Island.
Three-toed snake-tooth skink	A total of approximately 4.82 ha of potentially suitable habitat for the Three-toed snake-tooth skink exists within the project area in the form of Sub-coastal Floodplain Forest and Freshwater Wetlands TEC's, and Native and exotic plantings throughout the town. In addition to the 4.82 ha suitable habitat exists within the indicative ancillary sites by the Clarence River in North Grafton, where surveys have not been undertaken due to access restrictions.
Silver Perch	In stream works within the Clarence River are likely to cause temporary disbursal of Silver Perch and Purple-spotted Gudgeon as they are likely to inhabit lowland, turbid and slow-flowing rivers. Both species are known to refuge in large woody debris, rocks and reeds/weeds.
<u>EPBC Act listed migratory species</u>	
Migratory species - Cattle egret, White-bellied sea eagle, Rainbow bee-eater, Clamorous reed-warbler, Common tern	A total of 36.07 ha of potentially suitable foraging habitat for these migratory species exist within the project area in a variety of vegetation types; however no breeding habitat exists within the project area for any of these species.
<u>TSC Act listed threatened species and populations</u>	
Wetland Birds - Magpie goose, Black-necked Stork, Brolga, and Comb-crested Jacana	A total of approximately 31.66 ha of potentially suitable foraging habitat for these wetland birds exists within the project area, in the form of Reedlands, Degraded Riparian Forest (TEC) and drainage soaks in Paddocks (weeds and exotics).
Flightless birds - Emu	A total of approximately 31.25 ha of potentially suitable foraging habitat for the Emu occur within the project area in the form of exotic pastures and paddocks.
Birds of Prey - Osprey, and Square-tailed Kite	The project would remove potential roosting habitat in the form of roadside vegetation and paddock trees, and foraging habitat in the form of open paddocks and grasslands to total 36.07 ha of potential foraging habitat for

Species name	Area of value within the project area
	these species, in various forms of native and exotic vegetation.
Forest Owls - Masked Owl	The project would remove potential roosting habitat in the form of roadside vegetation and paddock trees, and foraging habitat in the form of open paddocks and grasslands. The project would also remove 36.07 ha of potential foraging habitat for this species, in various forms of native and exotic vegetation.
Flying foxes - Grey-headed Flying-fox	The project would remove potential roosting habitat in the form of roadside vegetation and paddock trees, and foraging habitat in the form of open paddocks and grasslands. The project would also remove 36.07 ha of potential foraging habitat for this species, in various forms of native and exotic vegetation.
Reptiles - Three-toed Snake-tooth Skink	A total of approximately 4.82 ha of potentially suitable habitat for the Three-toed snake-tooth skink exists within the project area in the form of Sub-coastal Floodplain Forest and Freshwater Wetlands TEC's, and Native and exotic plantings throughout the town. In addition to the 4.82 ha suitable habitat exists within the indicative ancillary sites by the Clarence River in North Grafton, where surveys have not been undertaken due to access restrictions.
Cave-dependent microbats - Little bentwing-bat, Eastern bentwing-bat, and Eastern cave bat	Suitable artificial roost habitat for these Cave-dwelling microbats exists in buildings found in the residential dwellings located within the proposed construction compound in the project area. The project would also remove 36.07 ha of potential foraging habitat for these species throughout the project area, in various forms of native and exotic vegetation.
Hollow-dependent microbats - Yellow-bellied sheath-tail-bat, Greater broad-nosed bat, Hoary wattled-bat, Southern myotis, Eastern long-eared bat, Eastern freetail-bat	A total of approximately 0.12 ha of suitable roost habitat for these Hollow-dependent microbats occurs within the project area in the form of planted Moreton Bay Figs. The project would also remove 36.07 ha of potential foraging habitat for these species throughout the project area, in various forms of native and exotic vegetation.
<u>FM Act listed threatened species</u>	
Fish - Silver perch, Purple-spotted gudgeon	The project would involve some high level disturbance to the Clarence River and riparian vegetation in areas associated with the project. However, the project would only cause temporary disturbance to these areas during construction works.

Community Name	Area of value within the project area
<u>Threatened Ecological Communities</u>	
Freshwater Wetlands on Coastal Floodplains Subtropical Coastal Floodplain Forest	A maximum of approximately 0.41 ha of poor condition TEC (0.10 ha of FWCF and 0.31 ha of SCFF) will be removed by the project. Vegetation assessment of the broader area by Biosis, 2012, determined that larger and marginally higher quality examples of both TEC occur outside of the current project area. Vegetation mapping of an appropriate resolution is not available for the Clarence Valley CMA or for the 10 kilometer locality and therefore the proportion of TEC to be impacted by this project would be

Community Name	Area of value within the project area
	negligible. The FWCF and SCFF to be impacted by the project are considered to be of relatively low regional and local importance based on the small patch size, degraded nature of the examples within the project area and their location within a peri-urban area.

5.1.1 Native vegetation

Vegetation clearing within the project area associated with the **construction** of the project is likely to have both direct and indirect impacts upon the ecological values of the project area due to the loss of native vegetation as discussed below.

Overall, four different vegetation communities (including the predominantly exotic communities), outlined in Section 4.6 would be impacted by the project, including fragmentation of the poor condition linear patches of TEC, totalling 0.41 ha. The majority of native vegetation within the project area is present in small patches which have been highly modified by previous disturbance, such as light industry, residential and rural land uses. The impacts of this vegetation clearing on threatened species habitat are discussed in Section 5.1.3.

The project would result in the permanent removal of up to 36.07 ha of vegetation including 31.25 ha of weeds and exotics, 4.41 ha of native and exotic plantings and 0.41 ha of poor condition threatened ecological communities. Riparian vegetation clearance, by community, comprises the following:

- 0.31 ha of two isolated poor condition patches of *Sub-coastal Floodplain Forest* TEC.
- 0.10 ha of poor condition linear areas of *Freshwater Wetlands on Coastal Floodplains* TEC.

Other non-native vegetation clearance comprises the following:

- 4.41 ha of native and exotic plantings.
- 31.25 ha of weeds and exotics.

The areas of impact quoted above are considered to be worst case scenario as they have been calculated based on the project area. For example, the setback of the piers along the Clarence River would likely negate the requirement for the removal of the 0.10 ha of FWCF along the northern and southern river banks. In addition the two TEC are fragmented into isolated patches and are both in low condition with little diversity as described in Section 4.6.

No threatened flora species were recorded within the project area and, as such, it is not anticipated that the development would have any significant impacts on threatened flora species or their habitat. Two mature trees, a mature planted *Eucalyptus sp.* (in poor condition, borers present) and a planted *Casuarina cunninghamia* would be removed along with five mature planted Moreton Bay Fig trees located to the north of the current bridge. The impacts of this with regard to fauna foraging habitat is discussed further in Section 5.1.3. Safeguards including but not limited to, temporary fencing to protect from damage, pre-clearance surveys and other mitigation measures to avoid, minimise and mitigate the above impacts have been included in Section 6.

Additional impacts that may result to retained or adjoining vegetation includes the following:

- Damage to retained native vegetation during tree trimming and tree removal.
- Damage to retained native vegetation resulting from trampling and soil compaction.

- Increased edge impacts on the adjoining vegetation causing higher likelihood of weed (including noxious weeds) infiltration and reduced resilience.
- The introduction of soil pathogens through construction equipment and personnel.

It is anticipated that the indirect impacts and potential damage (rather than removal) to native vegetation would be restricted to the project area outlined in Figure 4 and Figure 5.

5.1.2 Exotic vegetation

Weed invasion can be a considerable problem along the edges of native plant communities and the habitat these provide for native flora and fauna. Along these boundaries there are changes in the environment (edge effects) including, altered light levels, wind speed, temperature, humidity and runoff. These altered conditions allow the colonisation and growth of weeds which would themselves result in further environmental changes that promote the colonisation and growth of other weed species within the area. Due to these environmental changes, weeds may be able to out-compete native plant species and could result in the deterioration or loss of the native plant community in that area. In addition, activities associated with land use including agriculture, urban development and infrastructure provide pathways for the introduction and establishment of new weeds through a range of dispersal mechanisms.

Table 7 outlines the 13 noxious weeds (including three notifiable weeds) that have been identified within the project area during the previous and current site investigations. Division 1 of Part 3 of the NW Act outlines the requirements of public authorities to control weeds on their own land with the exception of roads defined as a freeway, toll way or State work under the *Roads Act 1993*. The presence of up to 13 noxious weed species within the project area provides the potential for further spread of these both within the project area and to adjoining land. Recommendations regarding hygiene protocols to minimise the spread of currently present noxious weeds and prevent the introduction of new noxious species are made in Section 6.

Control of weeds should be a priority for the **construction** and **operational** stages of the project to ensure that remaining and newly revegetated native vegetation can create valuable habitats.

5.1.3 Loss of habitat resources

Removal of habitat resources, hollow bearing trees and housing infrastructure would take place as part of the **construction** stage of the project and their impacts are outlined below.

Hollow bearing and habitat trees

Hollow bearing trees are a critical habitat feature for a number of threatened species, providing breeding and/or sheltering habitat. Hollow bearing trees are considered to be more common in older stands, gullies, vegetation that has not been logged previously, and on flat terrain (Gibbons and Lindenmayer, 2002). Habitats with high productivity were also noted to support a higher number of hollow bearing trees.

A total of two hollow bearing trees and five habitat trees would be removed as part of the project (refer to Table 15 and Figure 5). These seven trees are numbered on Figure 5 and the species likely to depend on these resources is outlined in Table 16. The number of hollows is difficult to ascertain in the recorded Moreton Bay Fig trees, although it is estimated to be a significantly higher number than in Eucalyptus and River She-Oak based on the growth and mature nature of these trees. The loss of hollow bearing trees is listed as a key threatening process under the TSC Act.

Table 16: Hollow bearing/habitat trees to be removed

No.	Species	Feature	Description	Location (Refer to Figure 5)
1	River She-oak	Hollows in branches and fissures	Multiple hollows suitable for small birds and microchiropteran fauna.	South Grafton
2	<i>Eucalyptus tereticornis</i>	Hollows in trunk and branches	Several small hollows possibly resulting from insect activity, potentially suitable for microchiropteran bat roosts. Note this tree is in a poor condition with borers present throughout. The tree is in the initial senescence stages.	South Grafton
3-7	Moreton Bay Fig	Foraging resources and numerous fissures	These five mature Moreton Bay Figs provide significant habitat for avifauna (i.e. bird and bat species), in terms of microbat roosting habitat within fissures and crevices as well as valuable foraging resources for Grey-headed Flying-foxes, frugivorous birds and nocturnal birds such as large forest owls.	Grafton

In NSW, terrestrial vertebrate species that are reliant on tree hollows for shelter and nests include at least 46 mammals, 81 birds, 31 reptiles and 16 frogs (Gibbons and Lindenmayer 1997, 2002). Of these, seven hollow-dependent listed threatened species (TSC Act or EPBC Act) have either been identified within the project area or considered likely to occur have been tabled below (Table 16).

Table 17: Threatened species potentially affected by loss of hollow bearing trees

Common name	Scientific name	TSC Act	EPBC Act
Eastern freetail-bat	<i>Mormopterus norfolkensis</i>	V	-
Eastern long-eared bat	<i>Nyctophilus bifax</i>	V	-
Greater broad-nosed bat	<i>Scoteanax rueppellii</i>	V	-
Hoary wattled-bat	<i>Chalinolobus nigrogriseus</i>	V	-
Masked Owl	<i>Tyto novaehollandiae</i>	V	-
Southern myotis	<i>Myotis macropus</i>	V	-
Yellow-bellied sheath-tail bat	<i>Saccolaimus flaviventris</i>	V	-

Note: V – Vulnerable under the TSC Act

Housing and Infrastructure

As part of the project it is planned that a number of residential dwellings, roads and related infrastructure would be removed to make way for the bridge, supporting road infrastructure, flood mitigation works and ancillary sites.

Such infrastructure currently provides potential habitat for the; Three-toes Snake-tooth Skink as well as potential roosting resources for threatened TSC Act listed vulnerable microbats; Eastern Bentwing-bat, Southern Myotis, Eastern Long-eared Bat, Eastern Freetail-bat, Eastern cave bat, Greater broad-nosed bat, Hoary wattled-bat.

5.1.4 Wildlife connectivity and habitat fragmentation

Removal of vegetation and thus habitat resources would take place as part of the **construction** stage of the project and the impacts, outlined below.

Road infrastructure can decrease the amount and quality of habitat available to wildlife, and can subdivide populations, leading to reduced genetic exchange. Smaller, more isolated populations also experience higher risk of local extinction from significant disturbance events such as bushfire.

Habitats in the locality are already highly fragmented. It is unlikely that the project works would cause any further fragmentation. The most vulnerable species are those with poor dispersal abilities, sedentary habits, specialised habitat and foraging requirements, and those endemic to an area (such as the Three-toed snake-tooth Skink) (Andrews 1990). The most robust species to habitat fragmentation are highly mobile generalists, such as some of the more common birds and microbats and pest species such as foxes and cats.

However, the project would include mitigation measures to facilitate wildlife connectivity and supplementary habitat features such as nest microbat boxes and revegetation efforts along the foreshores of the Clarence River for the project area.

5.1.5 Edge effects

Removal of vegetation, causing edge effects would take place as part of the **construction** stage of the project and the impacts, outlined below.

Edge effects are zones of changed environmental conditions (i.ee altered light levels, wind speed, temperature and noise) occurring along the edges of habitat fragments. These new environmental conditions along the edges can promote the growth of different vegetation types (including weeds), allow invasion by pest animals specialising in edge habitats, and/or change the behavior of resident animals (Moenting and Morris, 2006). Edge zones may also be subject to higher levels of predation by introduced mammalian predators and native avian predators.

Species with excellent dispersal abilities, capable of invading and colonising disturbed habitats, are attracted to edges, and move into the core of natural habitat if a road or utility corridor carries the edge into a previously undisturbed area (Andrews, 1990). The edge experiences a different wind and radiation effect, leading to a different microclimate. If habitats become too fragmented such that the ratio of edge to interior favours edges, the habitat would no longer be suitable for the interior species (Ranney et al, 1981).

Edge effects have been recorded at distances greater than 1000 m from road surfaces (Forman *et al.* 2000). However in a comparison of edge effects in a variety of different habitat types (Bali, 2000; 2005) estimated that average edge effects generally occur up to 50 meters away from the road edge.

The native vegetation communities recorded within the project area are generally present in the form of small isolated patches. Edge effects were found to be present throughout all remnant vegetation, including

the foreshores of the Clarence River, due to previous disturbance regimes which include clearing for residential development, grazing and the introduction of exotic species in parks and gardens.

There is an existing edge effect evident along the Summerland Way highway associated with increased weed abundance and areas of soil disturbance and erosion. The project would involve road widening and the construction of an additional road along the project length and potentially increasing the extent of the edge effect on the southern side. Based on a nominal 50 meters disturbance zone, this could potentially increase edge effects in South Grafton where vegetation is more intact, including potential weed invasion and modification of habitat characteristics. Edge effects are expected to be less evident in Grafton where weeds are dominant, vegetation is currently severely degraded and habitat fragmentation is extensive due to the highly urbanised nature of this area. Edge effects to the FWCF, depending on the set back of the bridge pier location, are also likely to disrupt the narrow linear nature of the community despite its already poor condition.

5.2 Indirect impacts

The project has the potential to trigger a range of indirect impacts on flora and fauna of which are detailed below. These impacts are either associated with construction or operational based impacts, or both.

5.2.1 Injury and mortality

Fauna injury or death can occur during the clearing phase of **construction** via the removal of hollow bearing and habitat trees, as well as throughout the **operational** stage of the road as a result of collision with vehicles.

There is the potential for injury and mortality to fauna species during vegetation clearing activities. The most vulnerable species are those who take refuge in trees (i.e. hollows, under bark, in nests, and in fallen logs) and in the ground, and/or have low agility. A range of ground-dwelling mammals, microbats, possums, reptiles, birds (particularly fledglings) and frogs are likely to be affected. Macropods, larger reptiles and adult birds are least likely to be affected by vegetation clearing activities because they are able to flee to unaffected areas of suitable habitat.

As there are currently several barriers to fauna crossing including the existing Summerland Way and the North Coast railway line, implementation of revegetation and landscape plantings would assist in providing refuge and reducing the number of fauna injuries and/or mortality associated with vehicle collisions. Section 6 outline s mitigation measures to ensure minimal fauna injury and mortality.

5.2.2 Pests and pathogens

Pest vertebrate fauna species have been recorded in the current and previous fauna surveys in the project area and include the following:

- Indian Myna *Acridotheres tristis*.
- Rock Dove *Columba livia*.
- European House Sparrow *Passer domesticus*.
- European Fox *Vulpes vulpes*.
- Feral and domestic Cats *Felis catus*.
- European Rabbit *Oryctolagus cuniculus*.
- Common Asian House Gecko *Hemidactylus frenatus*.

The project would trigger some ecological processes and features that may promote and provide for the dispersal and establishment of pest fauna species such as edge effects and increased or improved passage (e.g. larger culverts). Nevertheless, it is not considered likely that there would be a significant increase in the existing pest species populations or introductions of new pest vertebrate fauna as a result of the **construction** and **operational** phases of the project.

According to the Myrtle Rust management zone mapping by the NSW Department of Primary Industries (2012), Clarence Valley LGA is located within the Red Zone and it is considered to be widely distributed within the area. It is assumed that this plant fungus is present in the locality therefore Myrtle Rust would not be introduced to the project area or surrounds as result of the construction and operation of the project. Section 6 outlines management measures to ensure it is not further spread.

Phytophthora cinnamomi is not widely reported from the Clarence Valley LGA, however there is a confirmed site located between Grafton and Tenterfield (DECC, 2008) and the entire eastern seaboard of NSW is highlighted as the area of greatest impact for the species. Although Phytophthora was not recorded during the surveys of the project area, there is some level of risk during the construction phase that this pathogen could be introduced to the project area in soil on machinery or plant that has been previously used in an infected area. Section 6 outlines management measures to ensure it is not further spread.

The presence of amphibian chytrid fungus has been historically confirmed in the Grafton locality (DECCW, 2009). As such, there is some potential that the project may introduce amphibian chytrid fungus to the project area during the construction phase through the transport on vehicles or personnel previously working in infected wetland habitats of the LGA (DECC 2009). Section 6 outlines management measures to ensure it is not further spread.

5.2.3 Aquatic habitat

The EIS outlines methods to reduce impacts to aquatic habitat; scour protection and erosion and sediment controls. Although it is unlikely able to be undertaken in a manner that completely avoids impacts to aquatic habitat some minor impacts are expected during the **construction** phase. Potential minor impacts to aquatic fauna and habitat include; loss of bank stability, increased sedimentation, disturbance of aquatic and riparian vegetation and alteration to hydrology.

A short term reduction in species diversity may occur in the project area as a result of a combination of the aforementioned potential impacts during the construction phase. Appropriate timing of in stream works to take advantage of low flows or avoid impacts to spawning migrations of diadromous species would reduce the effects of construction on species diversity.

Some potential exists for a loss in bank stability in the immediate vicinity of the proposed construction area during high flow events. The current design (April 2014) incorporates a parallel duplication of the existing bridge structure (in stream piers) and as such the existing bridge upstream would buffer banks within and downstream of the construction area from flow related disturbances.

The construction of the in stream pylons represents the most significant potential for impacts to aquatic fauna through an increase in sedimentation. This is expected to be a short term impact as a result of construction, with appropriate management measures implemented to minimise the increase of suspended sediments in the Clarence River. Post-construction it is likely that some ongoing minor sedimentation would occur during high flow events as a result of bed scouring downstream of the pylons.

Aquatic vegetation within the alignment of the project is expected to be subject to disturbance, in particular at the location of the in stream pylons during construction and immediately downstream of the pylons post-construction as a result of scouring. Such disturbance has the potential to impact Silver Perch and Purple-

spotted Gudgeon, in that refuge habitat would be lost in those immediate areas and species disbursed upstream or downstream to adjoining habitat.

Alterations to the local hydrology are expected to occur as a result of the proposed construction of bridge pylons adjacent to the current pylons. In stream, these structures may alter the direction of flow from its natural course. This would result in increased scouring of the stream bed and may affect banks downstream of the directed flows. A thorough hydrological assessment is beyond the scope of this report which focuses on the potential ecological impacts posed by the project. A hydrological assessment is included in the EIS.

5.2.4 Groundwater dependent ecosystems

Despite the two TEC vegetation communities in the project area having a high dependence on groundwater resources and the proximity of the works to the Clarence River, the project has low potential to impact on groundwater dependent ecosystems. During the **construction** stage the project is likely to involve cutting and excavation however as at April 2014 these areas are located away from identified groundwater dependent ecosystems and would be less than 2 meters depth. In addition various management measures have been proposed in Section 6 (Table 19) which should negate any significant impacts to Groundwater Dependent Ecosystems (Figure 4).

5.2.5 Noise, vibration and light

Considering the existing levels of noise, vibration and light from the Summerland Highway onto Grafton Bridge, it is considered unlikely that there would be an increase to the existing noise, vibration and light levels, major enough to result in any significant impacts to native fauna species. There is however, the potential for impacts to local mobile fauna such as birds, fish and microbats from increased noise, light and vibration during **construction**, which may result in fauna intermediately avoiding habitats adjacent to the project.

Through the addition of the additional bridge over the Clarence River, the light levels beneath the bridge structure would be reduced, however given the height of the bridge structure this should not inhibit the growth of aquatic vegetation or any plantings associated with landscaping activities or existing vegetation. The low light levels are not envisaged to significantly deter aquatic or terrestrial fauna movements or foraging activities in this area.

5.2.6 Key threatening processes

Key threatening processes (KTP) listed under the TSC Act, FM Act and EPBC Act and considered likely to be increased by the project are listed below in Table 18. KTP identified as being impacted by the **construction** and **operational stages** of the project comprise those associated with habitat degradation including vegetation clearing, bush rock removal and removal of hollow bearing trees and fallen timber. The severity of impact has been rated as low medium or high to align with the scale of the project and/or quality of the ecological value impacted. Mitigation measures, proposed in Section 6 would be implemented to minimise the extent of vegetation clearing and habitat disturbance.

There is also the potential for other KTP to be increased (e.g. weed invasion, introduction of pests and diseases and alteration of hydrological regimes). However, where these are predictable, mitigation measures would be implemented to minimise their impact.

Table 18: Key threatening processes relevant to the project

Key threatening process	Legislation	Trigger
<i>Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands</i>	TSC Act	Medium, in stream piers would cause low level hydrological change
<i>Bush rock removal</i>	TSC Act	Low, minimal bush rock present
<i>Clearing of native vegetation</i> <i>Land clearance</i>	TSC Act EPBC Act	Low, 0.41 ha of poor quality TEC to be cleared.
<i>Competition and land degradation by rabbits</i> <i>Competition and grazing by the feral European rabbit (Oryctolagus cuniculus)</i>	EPBC Act TSC Act	Low, there are currently a high number of rabbits.
<i>Infection of native plants by Phytophthora cinnamomi</i> <i>Dieback caused by the root-rot fungus (Phytophthora cinnamomi)</i>	TSC Act EPBC Act	Low, further spread to be managed
<i>Infection of amphibians with chytrid fungus resulting in chytridiomycosis</i> <i>Infection of frogs by amphibian chytrid causing the disease chytridiomycosis</i>	EPBC Act TSC Act	Low, further spread to be managed
<i>Installation of in stream structures and other mechanisms that alter natural flow</i>	FM Act	High, in stream piers being installed
<i>Invasion and establishment of exotic vines and scramblers</i>	TSC Act	Low, there are currently a high number of exotics.
<i>Invasion, establishment and spread of Lantana camara</i>	TSC Act	Low, there are currently a high number of exotics.
<i>Invasion of native plant communities by African Olive Olea europaea L. subsp. cuspidata</i>	TSC Act	Low, there are currently a high number of exotics.
<i>Invasion of native plant communities by exotic perennial grasses</i>	TSC Act	Low, there are currently a high number of exotics.
<i>Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris</i> <i>Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments</i>	EPBC Act TSC Act	Low, construction materials to be managed
<i>Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants</i>	EPBC Act TSC Act	Low, there are currently a high number of exotics.

Key threatening process	Legislation	Trigger
<i>Loss of hollow-bearing trees</i>	TSC Act	Low, two hollow bearing trees to be lost.
<i>Anthropogenic Climate change</i> <i>Human-caused climate change</i> <i>Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases</i>	TSC Act FM Act EPBC Act	Low, traffic flow and volume should maintain at current levels.
<i>Novel biota and their impact on biodiversity</i>	EPBC Act	Low, impacts to biodiversity from novel biota is of low likelihood.
<i>Predation by European red fox</i> <i>Predation by the European red fox (Vulpes vulpes)</i>	EPBC Act TSC Act	Low, there is currently foxes present within the landscape.
<i>Removal of dead wood and dead trees</i>	TSC Act	Low, there are not many dead wood/trees to be removed.
<i>The degradation of native riparian vegetation along New South Wales water courses</i>	FM Act	Low, 0.10 ha of poor quality FWCF to be removed.
<i>The removal of large woody debris from NSW rivers and streams</i>	FM Act	Low, unlikely that this would be triggered.

5.3 Cumulative impacts

The project would increase the existing area of disturbance within North and South Grafton, created by the existing infrastructure and associated local roads in the area. It can be therefore assumed that through construction and operation of the project that there would be cumulative impacts as a result of potential future upgrades on North and South Grafton or the immediate vicinity.

Assessments to determine the significance of such impacts on all threatened species recorded in the project area, or regarded as having a moderate – high likelihood of occurrence have been subjected to NSW Assessments of Significance (AoS), and Commonwealth Significant Impact Criteria assessments (SIC) where required (refer to Appendix 3 and 4).

6. Managing potential impacts on biodiversity

Biodiversity Guidelines (RTA, 2011) provide guidance on addressing the management of flora and fauna during the planning, construction and operation stages of the project in view of the following key aims:

- Avoid and minimise impacts where possible.
- Mitigate impacts where avoidance is not possible.
- Offset where impacts cannot be avoided.

During the design stages of the project the ecological values identified by Biosis during 2010, 2011 and 2012, have been taken into consideration during the options and route selection as well as EIS stage to minimise impacts upon these values.

Recommendations previously (2011, 2012) made regarding the setback of bridge piers to minimise impacts of the development on riparian vegetation have been taken into consideration during the concept design phase. The locations of temporary construction ancillary facilities associated with the project have been informed by Biosis, 2011, and Biosis, 2012, constraints and route analysis. This proactive planning includes consideration of key environmental values such as amenity (noise, visual and air), water quality and flooding and terrestrial and aquatic ecology.

Biodiversity offsets have been considered taking into account the *Principles for the use of biodiversity offsets in NSW* (Department of Environment, Climate Change and Water, 2008). Biodiversity offsets would not be required given that the amount of threatened ecological communities to be cleared is minimal in nature (0.41 ha of NSW TSC Act listed TEC vegetation), in poor condition and disconnected within the landscape.

Biodiversity Guidelines (RTA, 2011) provides the key reference to implementing safeguards and management measures. An overview of mitigation measures that will be implemented for the project is provided in Table 19, Section 6.

Table 19: Overview management measures

Impact	Environmental safeguards	Responsibility	Timing
<u>Vegetation clearing and flora habitat loss</u>			
Flora and fauna management	- A Flora and Fauna Management Plan (FFMP) will be prepared as part of the project Construction Environmental Management Plan prior to construction in accordance with Roads and Maritime Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects (RTA, 2011). - The FFMP will detail how impacts to biodiversity are to be minimised and managed during construction and operation and will incorporate specific management measures identified in the EIS. - Measures outlined within this table to be outlined within the FFMP, including timeframes for implementation and monitoring to be developed post EIS and project approval.	Contractor	Pre-construction
Hollow bearing trees and foraging resources	- Disturbance and clearing of native vegetation will be minimised, particularly avoiding and minimising vegetation removal wherever possible through the detailed design process. Detailed design to investigate opportunities to retain the two hollow bearing and five habitat trees within the project area. - Develop a Revegetation Management Sub-Plan as part of the FFMP to revegetate with species suitable for the creation of hollows and foraging resources. Strategies to compensate for the loss of hollow bearing/habitat trees will focus on revegetation and rehabilitation activities along riparian and adjoining areas.	Roads and Maritime	Detailed Design

Impact	Environmental safeguards	Responsibility	Timing
Vegetation clearing / habitat clearance	In order to mitigate some of the impacts of vegetation clearing and habitat loss it is recommended that: • Clearing of vegetation will be undertaken in accordance with <i>Guide 1 Pre-clearing Process of Biodiversity Guidelines</i> (RTA, 2011). The guidelines cover the felling of both non-habitat and habitat trees and the rescue and relocation of fauna. • The pre-clearing process will be consistent with <i>Guide 2 Exclusion zones of Biodiversity Guidelines</i> (RTA, 2011) and include: - Pre-clearing surveys by an experienced/qualified ecologist. - Mapping and delineating the boundaries of threatened flora and/or fauna species, TEC and/or suitable habitat (hollow bearing/habitat trees). • Pre-clearance surveys to include surveys for Hairy-joint Grass <i>Arthraxon hispidus</i> during flowering period (between summer and autumn) within final impact areas. • Pre-clearance surveys to be undertaken for the Three-toed Snake-tooth Skink, in suitable areas that have not yet surveyed (i.e. ancillary sites, especially in North Grafton where houses are to be demolished) prior to demolition and construction works during late spring, early summer in accordance with relevant guidelines (DSEWPaC, 2011; DEC, 2004 and TSSC, 2008). • Construction traffic will be restricted to defined access tracks and construction works zone areas. • The location of exclusion zones will be identified, with temporary fencing or flagging tape to indicate the limits of clearing (in accordance with the Roads and Maritime Biodiversity Guidelines (RTA, 2011). • All relevant staff will be inducted and informed of the limits of vegetation clearing and the areas of vegetation to be retained.	Contractor	Pre-construction

Impact	Environmental safeguards	Responsibility	Timing
Weed management	- Weeds to be controlled in accordance with RTA (2011a) – <i>Biodiversity Guidelines Guide 6: Weed Management</i>. - Declared noxious weeds will be managed according to the requirements of the NW Act. - Weed infested topsoil will be appropriated stockpiled with sediment fencing and as soon as practical, disposed of or treated appropriately to limit potential impacts onto adjacent areas of native vegetation.	Contractor	Pre-construction and operation
Revegetation management and landscaping	- A Revegetation Management Sub-Plan as part of the FFMP will be developed to provide specific details for the re-establishment of native vegetation on areas disturbed by the project construction. This plan will: - Be developed in line with <i>Roads and Maritime Biodiversity Guidelines</i> (RTA, 2011), the design principles identified in the EIS Working paper. - Include details for the regeneration and rehabilitation of areas with a focus on riparian areas within the project area with reference to Guide 3, Guide 6 and Guide 10. - Includes objectives to incorporate local native species across all revegetation and landscaping efforts along the Clarence River and in the adjoining project area. This will include species consistent with FWCF and SCFF TEC species composition, and which could potentially provide foraging resources and roosting to threatened fauna species, and increase corridors and connectivity throughout the landscape.	Roads and Maritime	Detailed Design
Pests and Pathogens	- FFMP to outline a strategy for the implementation of site hygiene protocols and management measures according to Biodiversity Guide 7 – Pathogen Management from Roads and Maritime (2011) to reduce the risk of localised or regional introduction of Myrtle Rust, <i>Phytophthora cinnamomi</i> and the amphibian chytrid fungus as result of the project. - Measures for preventing the introduction and/or spread of disease causing agents such as bacteria and fungi will be implemented, as detailed in RTA (2011a) – <i>Biodiversity Guidelines Guide 7: Pathogen management</i>.	Contractor	Pre-construction Construction

Impact	Environmental safeguards	Responsibility	Timing
Threatened flora impacts	The FFMP to develop a threatened species guideline to be developed for Hairy-joint Grass <i>Arthraxon hispidus</i> in order to show and educate construction workers of its appearance and outline what to do if the species is found during construction.	Contractor	Pre-construction Construction
<u>Loss of fauna habitat</u>			
Impacts to fauna	- Where practicable, vegetation (especially of the two hollow-bearing and five habitat trees identified) removal will occur outside the main fauna breeding season (August to February) to avoid potential breeding disturbance to fauna, particularly to avifauna (i.e. birds and bats). - Pruning or lopping of limbs will be conducted in preference to tree removal wherever possible. - Appropriate tree removal procedure requiring the presence of a qualified ecologist or wildlife expert experienced in the rescue of fauna should be adopted as detailed in <i>RMS Biodiversity Guidelines -Guide 4: Clearing of vegetation and removal of bush rock including the staged removal process (2011)</i>. - Woody debris and habitat trees removed for the project will be managed in accordance with <i>RMS Biodiversity Guidelines - Guide 5: Re-use of woody debris and bush rock (2011)</i>. - Fauna handling during vegetation removal will be undertaken by a licensed fauna ecologist or wildlife carer, as detailed in <i>RMS Biodiversity Guidelines Guide 9: Fauna handling (2011)</i>.	Contractor	Pre-Construction Construction
Threatened fauna	- Threatened species guidelines to be developed for threatened fauna likely to occur directly within the project area, and potentially may be impacted during construction, in order to show and educate construction workers of its appearance and outline what to do if the species is found during construction. Species include: - Three-toed snake-tooth skink - Grey-headed Flying-fox - Microbats (general)		

Impact	Environmental safeguards	Responsibility	Timing
Unexpected finds	If unexpected threatened fauna or flora species are discovered, works will stop immediately and the <i>Unexpected Threatened Species Find Procedure</i> RTA (2011a) as well as the <i>Biodiversity Guidelines Guide 1: Pre-clearing process</i> is to be followed. This Procedure will be included in the FFMP developed for the project.	Contractor	Construction
Nest Box and Microbat management	- Nest boxes and bat roost structures will be installed in accordance with the principles outlined in the <i>RMS Guide 8 Nest Boxes</i> (2011). Details of the number of type of nest boxes will be included in the FFMP prepared for the project, and will include the following details: - The number and type of nest boxes required based on the number, quality and size of the hollows that will be removed. - Specifications for nest box dimensions, installation requirements, locations of nest boxes and ongoing monitoring and maintenance. - Installation timeframes, including the installation of 70 % of nest boxes prior to the removal of any vegetation. - Staged habitat removal including removal of secondary or less preferential roosting habitat prior to removal of primary habitat, such as hollow bearing trees and houses. - Pre demolition inspection and exclusion measures to prevent the continuing use of roosts. These will be prepared to address the subject species(s), specific habitat, roosting habits at each location and capture and handling procedures if required.	Contractor	Pre-construction
<u>Aquatic</u>			
Aquatic Fauna	Minimise direct disturbance of aquatic fauna and riparian zones in accordance with <i>RMS Biodiversity Guidelines – Guide 10 Aquatic Habitat and riparian zones</i> (2011).	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Bank Stability Sedimentation/ Erosion	- Erosion and sediment control measures are to be implemented and maintained to: - Prevent sediment moving off-site and sediment laden water entering any water course, drainage lines, or drain inlets. - Reduce water velocity and capture sediment on site. - Minimise the amount of material transported from site to surrounding pavement surfaces. - Divert clean water around the site in accordance with, Managing Urban Stormwater: Soils and Construction Guidelines (the Blue Book) (Landcom, 2004). - Erosion and sedimentation controls are to be checked and maintained on a regular basis (including clearing of sediment from behind barriers) and records kept and provided on request. - Erosion and sediment control measures are not to be removed until the works are complete and areas are stabilised. - Work areas are to be stabilised progressively during the works. - A progressive erosion and sediment control plan is to be prepared for the works. - The <i>Guidelines for in stream works on waterfront land</i> (NSW DPI 2012) will be implemented when constructing and installing piers, bridge footings and undertaking river front landscape works.	Contractor	Construction
Aquatic Habitat	Where reasonable and feasible relocate any large woody debris that may have been encountered during construction.	Contractor	Construction
Protection of Fish Habitat	During detailed design, the project design team will comply with the Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) in relation to requirements for maintaining fish passage via the design and construction of instream structures.	Roads and Maritime	Detailed Design

7. Assessments of Significance

In conjunction with proposed management measures, assessments to determine the significance of impacts for a range of TSC Act, FM Act and EPBC Act listed threatened biota have been prepared and are provided in Appendices 3 and 4. The results of such assessments which are summarised below in Table 20 and Table 21 below.

Table 20: Potential for impacts to threatened biota pursuant to the TSC Act/FM Act

TSC Act / FM Act listed threatened biota	Significance assessment question ^{1*}							Likely significant impact?
	a	b	c	d	e	f	g	
Threatened Ecological Communities								
Freshwater Wetlands on Coastal Floodplains	X	X	N	N	N	N	Y	No
Subtropical Coastal Floodplain Forest	X	X	N	N	N	N	Y	No
Flora								
Hairy-joint Grass	N	X	X	N	N	N	Y	No
Fauna								
Wetland Birds - Magpie goose, Black-necked Stork, Brolga, and Comb-crested Jacana	N	X	X	N	N	N	Y	No
Flightless birds - Emu	X	N	X	N	N	N	Y	No
Birds of Prey - Osprey, and Square-tailed Kite	N	X	X	N	N	N	Y	No
Forest Owls - Masked Owl	N	X	X	N	N	N	Y	No
Flying foxes – Grey-headed Flying-fox	N	X	X	N	N	N	Y	No
Reptiles – Three-toed Snake-tooth Skink	Y	X	X	Y	X	N	Y	Yes
Cave-dependent microbats - Little bentwing-bat, Eastern bentwing-bat, and Eastern cave bat	Y	X	X	N	N	N	Y	No

TSC Act / FM Act listed threatened biota	Significance assessment question ^{1*}							Likely significant impact?
	a	b	c	d	e	f	g	
Hollow-dependent microbats - Yellow-bellied sheath-tail-bat, Greater broad-nosed bat, Hoary wattled-bat, Southern myotis, Eastern long-eared bat, Eastern freetail-bat	Y	X	X	Y	N	N	Y	No
Fish - Silver perch and Purple-spotted gudgeon.	N	X	X	N	N	N	Y	No

Notes: Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ? = unknown impact

*This table has been adapted from the *Threatened Species Assessment Guidelines – The Assessment of Significance* (DECC, 2007) and the Environmental Impact Assessment Practice Note – Biodiversity Assessment (RMS, 2011)

Table 21: Potential for impacts to threatened biota pursuant to the EPBC Act

EPBC Act listed threatened biota	Important population ² in the project area	Likely significant impact?
Flora		
Hairy-joint Grass	No	No
Fauna		
Grey-headed flying-fox	No (in study area yes – Susan Island)	No
Three-toed snake-tooth skink	Yes	No
Silver Perch	No	No
Migratory Fauna		
Common Tern	No	No
Glossy Ibis	No	No
Rainbow Bee-eater	No	No
Caspian Tern	No	No
White-bellied Sea-Eagle	No	No
Latham's Snipe	No	No
Eastern Great Egret	No	No
Cattle Egret	No	No

EPBC Act listed threatened biota	Important population ² in the project area	Likely significant impact?
Clamorous Reed Warbler	No	No

Notes: Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ?= unknown impact.

- Significance Assessment Questions as set out in the *Threatened Species Conservation Act 1995/ Environmental Planning and Assessment Act 1979*.
 - in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,
 - in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,
 - in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
 - is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
 - is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
 - in relation to the habitat of a threatened species, population or ecological community:
 - the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
 - whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and
 - the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
 - whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
 - whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,
 - whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.
- Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:
 - is likely to be key source populations either for breeding or dispersal
 - is likely to be necessary for maintaining genetic diversity
 - is at, or near the limit of the species range.

7.1 Potential impacts on threatened ecological communities

Two TEC listed under the TSC Act were recorded in the project area. Freshwater Wetlands on Coastal Floodplains (FWCF) occurring as stands of Common Reed and Broadleaf Cumbungi was recorded on the northern and southern banks of the Clarence River, immediately downstream of the existing bridge alignment. The condition of the FWCF is typically poor owing to fragmentation, weed invasion and/or livestock grazing. Approximately 0.10 ha of FWCF were mapped as occurring within the project area, split across the northern and southern bank. The level of direct impact to the community is thought to be less than this given the setback of the bridge piers, minimising the impact to riparian vegetation.

The second TEC, Subtropical Coastal Floodplain Forest (SCFF) is present as small patches of remnant eucalypts with exotic shrubs and groundstorey species. The majority of the SCFF previously identified by Biosis is located to the south of the Clarence River, downstream of the existing and proposed bridge alignment, and would not be impacted by the project. Within the project area, approximately 0.31 ha of SCFF was recorded, the largest patch of which is located along the northern levee, upstream of the existing bridge. The fragmented and isolated nature of this community and prolific recruitment of exotic species have contributed to the poor condition of this TEC within the project area.

On the basis of the current project, AoS under Section 5A of the EP&A Act (Appendix 4) concluded that there is unlikely to be a significant impact on either of the two TECs as:

- The areas likely to be impacted are in poor condition and therefore not of high conservation significance.

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- The project would not result in a significant further fragmentation or isolation of any patches of these communities.
 - The direct impacts, including clearing, would only affect a small area of the TEC. With other more representative examples within the locality, it is considered unlikely the project would cause local extinction.

7.2 Potential impacts on threatened flora species

No threatened plant species were recorded in the project area. However one threatened plant species listed under the TSC and EPBC Acts, Hairy-joint Grass, is considered to have a medium likelihood of occurrence within the project area as assessed according to the criteria outlined in Appendix 1.

Appendix 2 assesses the likelihood of occurrence for all threatened flora species recorded or predicted to occur within the locality and determines a list of subject species for the preparation of AoS. One TSC Act threatened flora species, Hairy-joint Grass, has been assessed according to the provisions of the AoS as having a medium likelihood of occurrence within the project area.

The impact assessments concluded that the project would have a minimal impact on Hairy-joint Grass or its potential habitat in the locality based on the following:

- No individuals were recorded in the project area despite targeted surveys of potential habitat.
- Potential habitat for the species is limited to the FWCF TEC which is considered marginal for the species based on the edge effected and isolated nature of the habitat.
- The project would not result in further isolation or fragmentation of potential habitat for Hairy-joint Grass.
- The project is unlikely to interfere with important lifecycle functions of Hairy-joint Grass.

The AoS determined that a Species Impact Statement (SIS) is not necessary for Hairy-joint Grass.

7.2.1 EPBC Act threatened flora

Hairy-joint Grass has been assessed according to the provisions of the EPBC Act SIC assessment. In summary it was considered that the project is unlikely to significantly impact upon an important population of the species and a Referral under the provisions of the EPBC Act is not considered necessary.

7.3 Potential impacts on threatened fauna

Where there is potential habitat (foraging or breeding resources) for threatened species in the project area, further consideration must be given to the potential impact of the project on these species. The project may impact on threatened species by causing any of the following:

- Death or injury of individuals.
- Loss or disturbance of limiting foraging resources.
- Loss or disturbance of limiting breeding resources.

Limiting factors is a term used to describe the specialised habitat resources that certain species are directly dependent on for their ongoing survival. Limiting factors may be associated with specialised habitat resources required for breeding, for example tree hollows or maternity cave roost sites required by some microbat species. Such habitat resources are considered to be limiting, as there is not considered to be an endless supply of these habitat resources, and they occur at low densities across the landscape. However, for some species, limiting resources include specialised foraging habitats that have a restricted distribution (e.g. Koalas *Phascolarctos cinereus* feeding only on specific tree species).

7.3.1 TSC Act threatened fauna assessments of significance

Nine threatened fauna species listed on the TSC Act were recorded during the field surveys: Masked owl, Hoary wattled-bat, Little bent-wing bat, Eastern bent-wing bat, Eastern freetail-bat, Southern myotis, Grey-headed flying-fox, Greater-broad nosed bat, Eastern cave bat.

Appendix 2; Table 26 outlines the likelihood of occurrence for all fauna species recorded or predicted to occur within the locality, and summarises the possible predicted impacts from the project on all 22 TSC Act-listed threatened fauna species with known and/or potential habitat in the project area, and determines the need for AoS (TSC Act).

Seven part tests (i.e. AoS) have been prepared for 19 species: Magpie goose, Black-necked Stork, Brolga, Comb-crested Jacana, Emu, Osprey, Square-tailed Kite, Masked Owl, Grey-headed Flying-fox, Three-toed Snake-tooth Skink, Little Bentwing-bat, Eastern bentwing-bat, Eastern cave bat, Yellow-bellied Sheath-tail-bat, Greater broad-nosed bat, Hoary Wattled-bat, Southern Myotis, Eastern Long-eared Bat and Eastern Freetail-bat (Appendix 3). The assessments concluded that the project is unlikely to have a significant effect on any of these species. Accordingly, an SIS is not considered necessary.

7.3.2 FM Act threatened aquatic fauna assessments of significance

Two fish species (Olive Perchlet, and Freshwater Catfish) were captured during aquatic surveys completed by Biosis, 2010. As outlined in Section 4.12 Olive Perchlet and Freshwater Catfish are listed as endangered populations of western New South Wales and the Murray-Darling Basin respectively, however given the location at Grafton, the individuals within the project area are not representative of these endangered populations. Two threatened fish species listed under the FM Act were considered to have a moderate likelihood of occurrence within the project area based on previous records within the Clarence Valley Local Government Area and correspondence with DPI Fisheries (NSW DPI, 2013, Butler pers. comm.). AoS were completed for Purple-spotted Gudgeon and Silver Perch which concluded that the project would have a minimal impact upon these fish species or their potential habitat based on the following:

- Disturbance caused by the development is thought to be temporary and confined to the construction phase.

- The project would not result in a permanent blockage to fish passage that may further isolate or fragment potential habitat for these fish.
- The project is unlikely to interfere with important lifecycle functions of these fish.

The AoS determined that an SIS is not necessary for these fish species.

7.3.3 EPBC Act threatened fauna assessments of significance

Appendix 2; Table 26 outlines the likelihood of occurrence for all fauna species recorded or predicted to occur within the locality and determines the need for EPBC Act SIC assessments.

EPBC Act SIC assessments have been prepared for three species: Grey-headed flying-fox, Three-toed snake-tooth skink and Silver Perch. EPBC Act significant impact criteria assessments have been provided for all species using DEWHA (2009a). The assessments concluded that the project is unlikely to have a significant impact on any of these species. A referral to the Federal Environment Minister is not considered necessary for any EPBC Act-listed threatened fauna species.

7.3.4 Potential impacts on migratory fauna

The list of migratory species under the EPBC Act is a compilation of species listed under four international conventions: China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). A total of 32 migratory species listed under the EPBC Act that known/predicted to occur within a 10 km radius of the project area (Appendix 2; Table 26). Of these 32 migratory species, five are considered to have a high potential to utilise habitats within the project area based on the availability of suitable habitat in the locality, namely the Cattle Egret *Ardea ibis*, Clamorous reed-warbler *Acrocephalus stentoreus*, Common tern *Sterna hirundo*, Rainbow bee-eater *Merops ornatus*, and White-bellied sea-eagle *Haliaeetus leucogaster*.

Migratory shorebirds and waders are the most common migratory species recorded within the locality. This is likely due to the proximity of the project area to both the Clarence River, being the largest river on the eastern seaboard, and the coast. The riparian areas within the project area may be used on occasion or regularly by these migratory species for foraging and associated activities, however no breeding habitat has been identified for any of these species within the project area. Although, it is noted that there are various permanent Cattle Egret breeding colonies around Grafton (with the closest one to the project area being on the corner of Kitchner and Price Street), it is not perceived that there would be any direct, or significant indirect, impacts to this species as a result of the project due to the proximity of this colony to the project area.

These species have been further considered in accordance with the Commonwealth MNES significant impact criteria (DEWHA, 2009a), and an assessment for migratory species has been undertaken in Appendix 4.

8. Conclusion

This report assesses the terrestrial and aquatic flora and fauna values as well as the threatened biota likely to be impacted upon by the Grafton Bridge Project, in accordance with the EP&A Act, TSC Act, FM Act and the EPBC Act.

Overall the project is likely to have some impact on the biodiversity values of the locality. Given the landscape, land usage, condition of flora and fauna habitats and the Roads and Maritime commitment to follow due diligence in accordance with relevant policies and relevant State and Commonwealth legislation, the project is unlikely to have a significant impact on the biodiversity values of the project area and locality. The project would result in the following impacts to biodiversity:

- The removal of approximately 0.41 ha of remnant vegetation constituting two threatened ecological communities (TECs), listed under the TSC Act to accommodate bridge footings and levee construction associated with the bridge upgrade including:
 - 0.10 ha of *Freshwater Wetlands on Coastal Floodplains*
 - 0.31 ha of *Subtropical Coastal Floodplain Forest*
- Disturbance to 0.10 ha of FWCF and other native and exotic plantings lining the northern and southern bank of the Clarence River, areas which may provide potential habitat for threatened fish species.
- Disturbance to drainage soaks and wetlands providing potential foraging habitat for threatened and migratory species.
- The removal of hollow bearing and habitat trees within the project area, including; a Eucalyptus, a River She-oak, and five large Moreton Bay Fig habitat trees, trees considered likely to provide potential roosting and foraging resources for threatened avifauna (i.e. bird and bat) species.
- The demolition of residential dwellings within the indicative ancillary sites providing potential roosting resources for threatened microbats.
- Excavation and demolition for the compound, roads and related infrastructure within the project area, in areas that may provide potential subterranean burrowing habitat for the Three-toed snake-tooth skink.

Key management measures to minimise and avoid biodiversity impacts include, but are not limited to (refer to Section 6):

- Development of a Flora Fauna Management Plan as part of the overall Project Construction Environmental Management Plan.
- Undertaking works in accordance with RMS Biodiversity Guidelines 2011
- Avoidance and minimisation of the 0.41 ha of remnant vegetation (TECs) removal where possible.
- Pre-clearing surveys for the Three-toed snake-tooth skink during excavation and demolition of housing infrastructure, roads and related infrastructure, in areas immediately north and south of the Clarence River.
- Staged clearing of habitat trees, and the application of the precautionary principle to reduce the risk of fauna mortality associated with their removal.
- Management of erosion and sedimentation in and around riverbank areas

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- To address loss to biodiversity values such as hollow bearing and habitat trees, 0.41 ha of TEC vegetation and foraging resources, Roads and Maritime would develop the FFMP inclusive of a Revegetation Management Sub-Plan and Microbat Management Sub-Plan to compensate for impacts in consultation with NSW Office of Environment and Heritage.

Provided the management measures detailed in Section 6 are adequately implemented, the project is considered unlikely to have a significant impact on any threatened species, populations or ecological communities listed pursuant to the TSC Act, FM Act and/or the EPBC Act, therefore a Species Impact Statement and/or EPBC Act Referral is not required.

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Appendix 1: Flora

A1.1 Flora species recorded from the project area

Notes to tables:

EPBC Act: CR – Critically Endangered EN – Endangered VU – Vulnerable	TSC Act: E1 – endangered species (Part 1, Schedule 1) E2 – endangered population (Part 2, Schedule 1) E4 – presumed extinct (Part 4, Schedule 1) E4A – critically endangered V1 – vulnerable (Part 1, Schedule 2) <i>Codes identify the Legal Status of threatened biota within NSW under the TSC Act and the OEH Sensitive Species Data Policy (SSDP).</i>
FM Act: E1 – endangered E2 – endangered E4 – presumed extinct E4A – critically endangered V1 – vulnerable <i>Codes identify the Legal Status of threatened biota within NSW under the FM Act and the OEH Sensitive Species Data Policy (SSDP).</i>	Ecological communities: FW – Freshwater Wetlands SCFF – Subtropical Coastal Floodplain Forest
Non-indigenous species # – Native species outside natural range * – noxious weed species declared under the Noxious Weeds Act	Noxious weed status: State prohibited species (Class 1) Regionally prohibited species (Class 2) Regionally controlled species (Class 3) Regionally restricted species (Class 4) Restricted plant (Class 5)

Table 22: Flora species recorded from the project area

Status	Family	Scientific name	Common name
Native Species			
	<i>Amaryllidaceae</i>	<i>Crinum pedunculatum</i>	Swamp Lily
	<i>Apiaceae</i>	<i>Centella asiatica</i>	Pennywort
	<i>Apiaceae</i>	<i>Hydrocotyle peduncularis</i>	
	<i>Apocynaceae</i>	<i>Parsonsia straminea</i>	Common silkpod
	<i>Arecaceae</i>	<i>Archontophoenix cunninghamiana</i>	Bangalow palm
	<i>Arecaceae</i>	<i>Livistona australis</i>	Cabbage palm
	<i>Asteliaceae</i>	<i>Cordyline stricta</i>	Narrow-leaved palm lily
	<i>Asteraceae</i>	<i>Calotis</i> sp.	

Status	Family	Scientific name	Common name
	Casuarinaceae	<i>Allocasuarina torulosa</i>	Forest oak
	Casuarinaceae	<i>Casuarina cunninghamiana</i>	River oak
	Casuarinaceae	<i>Casuarina glauca</i>	Swamp oak
	Chenopodiaceae	<i>Einadia hastata</i>	Berry saltbush
	Chenopodiaceae	<i>Einadia trigonos</i>	Fishweed
	Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew
	Convolvulaceae	<i>Dichondra repens</i>	Kidney weed
	Cyperaceae	<i>Bolboschoenus fluviatilis</i>	Marsh club rush
	Cyperaceae	<i>Carex appressa</i>	Tall Sedge
	Cyperaceae	<i>Cyperus exaltatus</i>	
	Cyperaceae	<i>Eleocharis sphacelata</i>	Tall spike rush
	Cyperaceae	<i>Schoenoplectus mucronatus</i>	Triangular club rush
	Cyperaceae	<i>Schoenoplectus validus</i>	
	Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken
	Elaeocarpaceae	<i>Elaeocarpus grandis</i>	Blue quandong
	Elaeocarpaceae	<i>Elaeocarpus obovatus</i>	Hard quandong
	Fabaceae - Caesalpinioideae	<i>Cassia brewsteri</i>	Native laburnum
	Fabaceae (Faboideae)	<i>Castanospermum australe</i>	Black bean
	Fabaceae (Faboideae)	<i>Desmodium rhytidophyllum</i>	
	Fabaceae (Mimosoideae)	<i>Acacia floribunda</i>	White sally
	Fabaceae (Mimosoideae)	<i>Acacia irrorata</i>	Green wattle
	Geraniaceae	<i>Geranium solanderi</i>	Native geranium
	Juncaceae	<i>Juncus kraussii</i>	
	Juncaceae	<i>Juncus usitatus</i>	
	Juncaginaceae	<i>Triglochin multifructa</i>	
	Lemnaceae	<i>Lemna trisulca</i>	Duckweed
	Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed mat-rush
	Loranthaceae	<i>Amyema congener</i>	
	Meliaceae	<i>Melia azedarach</i>	White cedar
	Menyanthaceae	<i>Nymphoides indica</i>	Water snowflake
	Moraceae	<i>Ficus macrophylla</i>	Moreton Bay fig

Status	Family	Scientific name	Common name
	<i>Moraceae</i>	<i>Ficus obliqua</i>	Deciduous fig
	<i>Moraceae</i>	<i>Ficus rubiginosa</i>	Port Jackson fig, rusty fig
	<i>Myrtaceae</i>	<i>Acmena smithii</i>	Lilly pilly
	<i>Myrtaceae</i>	<i>Angophora costata</i>	Sydney Red Gum
	<i>Myrtaceae</i>	<i>Angophora floribunda</i>	Rough-barked apple
	<i>Myrtaceae</i>	<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush
	<i>Myrtaceae</i>	<i>Callistemon viminalis</i>	Weeping bottlebrush
	<i>Myrtaceae</i>	<i>Corymbia maculata</i>	Spotted gum
	<i>Myrtaceae</i>	<i>Eucalyptus grandis</i>	Flooded gum
	<i>Myrtaceae</i>	<i>Eucalyptus saligna</i>	Sydney blue gum
	<i>Myrtaceae</i>	<i>Eucalyptus scoparia</i>	Wallangarra white gum
	<i>Myrtaceae</i>	<i>Eucalyptus sp.</i>	
	<i>Myrtaceae</i>	<i>Eucalyptus tereticornis</i>	Forest red gum
*	<i>Myrtaceae</i>	<i>Leptospermum petersonii</i>	Lemon-scented tea tree
	<i>Myrtaceae</i>	<i>Lophostemon confertus</i>	Brush box
	<i>Myrtaceae</i>	<i>Lophostemon suaveolens</i>	Black tea tree
	<i>Myrtaceae</i>	<i>Melaleuca alternifolia</i>	Tea tree
	<i>Myrtaceae</i>	<i>Melaleuca bracteata</i>	
	<i>Myrtaceae</i>	<i>Melaleuca leucadendra</i>	Weeping paperbark
	<i>Myrtaceae</i>	<i>Melaleuca quinquenervia</i>	Broad leaved paperbark
	<i>Myrtaceae</i>	<i>Melaleuca styphelioides</i>	Prickly-leaved tea tree
	<i>Myrtaceae</i>	<i>Syzygium australe</i>	Brush cherry
	<i>Myrtaceae</i>	<i>Syzygium luehmannii</i>	Riberry
	<i>Myrtaceae</i>	<i>Waterhousea floribunda</i>	Weeping lilly pilly
	<i>Pittosporaceae</i>	<i>Pittosporum undulatum</i>	Sweet pittosporum
	<i>Poaceae</i>	<i>Bothriochloa macra</i>	Red Grass
	<i>Poaceae</i>	<i>Chloris truncata</i>	Windmill Grass
	<i>Poaceae</i>	<i>Cynodon dactylon</i>	Common couch
	<i>Poaceae</i>	<i>Leersia hexandra</i>	Swamp ricegrass
	<i>Poaceae</i>	<i>Microlaena stipoides</i>	Weeping grass
	<i>Poaceae</i>	<i>Oplismenus aemulus</i>	

Status	Family	Scientific name	Common name
	Poaceae	<i>Paspalum distichum</i>	Water couch
	Poaceae	<i>Phragmites australis</i>	Common reed
	Polygonaceae	<i>Persicaria decipiens</i>	Slender knotweed
	Polygonaceae	<i>Persicaria hydropiper</i>	Water pepper
	Polygonaceae	<i>Persicaria sp.</i>	
	Polygonaceae	<i>Rumex brownii</i>	Swamp dock
	Proteaceae	<i>Banksia integrifolia</i>	Coast banksia
	Proteaceae	<i>Banksia robur</i>	Swamp banksia
	Proteaceae	<i>Grevillea baileyana</i>	White oak
	Proteaceae	<i>Grevillea robusta</i>	Silky oak
	Proteaceae	<i>Stenocarpus sinuatus</i>	Firewheel tree
	Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup
	Rutaceae	<i>Flindersia schottiana</i>	Cudgerie
	Sapindaceae	<i>Cupaniopsis anacardioides</i>	Tuckeroo
	Sapindaceae	<i>Harpullia pendula</i>	Tulipwood
	Sapindaceae	<i>Jagera pseudorhus</i>	Foam bark
	Sapindaceae	<i>Mischocarpus australis</i>	Red pear fruit
	Sterculiaceae	<i>Brachychiton acerifolius</i>	Illawarra flame tree
	Typhaceae	<i>Typha orientalis</i>	Broad-leaved cumbungi
	Violaceae	<i>Viola caleyana</i>	Swamp violet
Exotic Species			
	Alliaceae	<i>Agapanthus praecox</i>	Agapanthus
	Altingiaceae	<i>Liquidambar styraciflua</i>	Liquid amber
*	Amaranthaceae	<i>Alternanthera philoxeroides</i>	Alligator weed
	Amaranthaceae	<i>Alternanthera sp.</i>	
	Amygdalaceae	<i>Prunus sp.</i>	Flowering cherry
	Anacardiaceae	<i>Mangifera indica</i>	Mango
	Anacardiaceae	<i>Pistacia chinensis</i>	
	Anacardiaceae	<i>Toxicodendron succedaneum</i>	Rhus Tree
	Apiaceae	<i>Foeniculum vulgare</i>	Fennel
*	Apocynaceae	<i>Cryptostegia grandiflora</i>	Rubber vine

Status	Family	Scientific name	Common name
	<i>Apocynaceae</i>	<i>Nerium oleander</i>	Oleander
	<i>Apocynaceae</i>	<i>Plumeria sp</i>	White Frangipani
	<i>Aquifoliaceae</i>	<i>Ilex aquifolium</i>	Holly
	<i>Araliaceae</i>	<i>Schefflera actinophylla</i>	Umbrella tree
	<i>Araucariaceae</i>	<i>Agathis robusta</i>	Queensland kauri pine
	<i>Araucariaceae</i>	<i>Araucaria heterophylla</i>	Norfolk Island pine
	<i>Arecaceae</i>	<i>Archontophoenix alexandrae</i>	Alexandra palm
	<i>Arecaceae</i>	<i>Syagrus romanzoffiana</i>	Cocos palm
	<i>Asclepiadaceae</i>	<i>Araujia sericifera</i>	Moth vine
	<i>Asclepiadaceae</i>	<i>Gomphocarpus physocarpus</i>	Balloon cotton bush
	<i>Asparagaceae</i>	<i>Asparagus aethiopicus</i>	Asparagus fern
*	<i>Asteraceae</i>	<i>Ageratina adenophora</i>	Crofton weed
	<i>Asteraceae</i>	<i>Ageratum houstonianum</i>	Blue billy goat weed
	<i>Asteraceae</i>	<i>Bidens pilosa</i>	Cobbler's pegs
	<i>Asteraceae</i>	<i>Cirsium vulgare</i>	Spear thistle
	<i>Asteraceae</i>	<i>Conyza bonariensis</i>	Fleabane
	<i>Asteraceae</i>	<i>Conyza sp.</i>	Fleabane
	<i>Asteraceae</i>	<i>Gazania rigens</i>	
	<i>Asteraceae</i>	<i>Hypochaeris radicata</i>	Catsear
	<i>Asteraceae</i>	<i>Onopordum acanthium</i>	
	<i>Asteraceae</i>	<i>Senecio madagascariensis</i>	Fireweed
	<i>Asteraceae</i>	<i>Sonchus asper</i>	Prickly Sowthistle
	<i>Asteraceae</i>	<i>Sonchus oleraceus</i>	Common sowthistle
	<i>Asteraceae</i>	<i>Tagetes minuta</i>	Stinking Roger
	<i>Asteraceae</i>	<i>Taraxacum officinale</i>	Dandelion
	<i>Azollaceae</i>	<i>Azolla sp.</i>	
	<i>Basellaceae</i>	<i>Anredera cordifolia</i>	Madeira vine
	<i>Bignoniaceae</i>	<i>Jacaranda mimosifolia</i>	Jacaranda
	<i>Bignoniaceae</i>	<i>Macfadyena unguis-cati</i>	Cat's claw creeper
	<i>Brassicaceae</i>	<i>Brassica napus</i>	Rape
	<i>Brassicaceae</i>	<i>Lepidium bonariense</i>	Argentine Peppergrass

Status	Family	Scientific name	Common name
*	Cactaceae	<i>Opuntia stricta</i>	Prickly pear
	Cannaceae	<i>Canna indica</i>	Indian shot
	Caprifoliaceae	<i>Lonicera japonica</i>	Japanese Honeysuckle
	Commelinaceae	<i>Tradescantia fluminensis</i>	Wandering jew
	Convolvulaceae	<i>Ipomoea cairica</i>	Coastal morning glory
	Convolvulaceae	<i>Ipomoea indica</i>	Morning Glory
	Cupressaceae	<i>Cupressus leylandii</i>	
	Cyperaceae	<i>Cyperus brevifolius</i>	Mullumbimby couch
	Cyperaceae	<i>Cyperus eragrostis</i>	Umbrella sedge
	Cyperaceae	<i>Cyperus papyrus</i>	Papyrus
	Cyperaceae	<i>Cyperus sesquiflorus</i>	
	Euphorbiaceae	<i>Ricinus communis</i>	Castor oil plant
	Fabaceae - Caesalpinioideae	<i>Caesalpinia ferrea</i>	Leopard tree
	Fabaceae - Caesalpinioideae	<i>Delonix regia</i>	Royal poinciana
	Fabaceae (Faboideae)	<i>Erythrina crista-galli</i>	Cockspur coral tree
	Fabaceae (Faboideae)	<i>Medicago sp.</i>	
	Fabaceae (Faboideae)	<i>Trifolium repens</i>	White clover
	Fabaceae (Faboideae)	<i>Vicia sativa</i>	
	Fumariaceae	<i>Fumaria bastardii</i>	Bastards fumitory
	Haloragaceae	<i>Myriophyllum aquaticum</i>	Parrots feathers
*	Lauraceae	<i>Cinnamomum camphora</i>	Camphor laurel
	Malvaceae	<i>Hibiscus sp.</i>	
	Malvaceae	<i>Modiola caroliniana</i>	Red-flowered mallow
	Malvaceae	<i>Sida rhombifolia</i>	Paddy's lucerne
	Moraceae	<i>Ficus benjamina</i>	Weeping fig
	Moraceae	<i>Ficus microcarpa</i>	Small-fruited fig
	Moraceae	<i>Morus alba</i>	White mulberry
	Myrsinaceae	<i>Anagallis arvensis</i>	Scarlet Pimpernel
	Myrtaceae	<i>Corymbia citriodora</i>	Lemon-scented gum
	Myrtaceae	<i>Corymbia torelliana</i>	Cadaghi
	Nyctaginaceae	<i>Bougainvillea glabra</i>	

Status	Family	Scientific name	Common name
	<i>Oleaceae</i>	<i>Fraxinus excelsior</i>	European Ash
*	<i>Oleaceae</i>	<i>Ligustrum lucidum</i>	Large-leaved privet
*	<i>Oleaceae</i>	<i>Ligustrum sinense</i>	Small-leaved privet
	<i>Oleaceae</i>	<i>Olea europaea ssp. cuspidata</i>	African olive
	<i>Oxalidaceae</i>	<i>Oxalis sp.</i>	
	<i>Papaveraceae</i>	<i>Argemone ochroleuca</i>	Mexican poppy
	<i>Passifloraceae</i>	<i>Passiflora suberosa</i>	Cork passionfruit
	<i>Phytolaccaceae</i>	<i>Phytolacca octandra</i>	Inkweed
	<i>Plantaginaceae</i>	<i>Plantago lanceolata</i>	Lamb's tongues
	<i>Platanaceae</i>	<i>Platanus x acerifolia</i>	Plane tree
	<i>Poaceae</i>	<i>Arundo donax</i>	Giant reed
	<i>Poaceae</i>	<i>Avena fatua</i>	Wild Oats
	<i>Poaceae</i>	<i>Axonopus compressus</i>	Broad-leaved carpet grass
	<i>Poaceae</i>	<i>Axonopus fissifolius</i>	Narrow-leaved carpet grass
	<i>Poaceae</i>	<i>Bambusa sp</i>	Unidentified bamboo
	<i>Poaceae</i>	<i>Bromus catharticus</i>	Prairie grass
	<i>Poaceae</i>	<i>Chloris gayana</i>	Rhodes grass
	<i>Poaceae</i>	<i>Chloris gayana</i>	Rhodes Grass
	<i>Poaceae</i>	<i>Digitaria ciliaris</i>	
	<i>Poaceae</i>	<i>Eragrostis curvula</i>	African Lovegrass
	<i>Poaceae</i>	<i>Eragrostis pilosa</i>	Soft Lovegrass
	<i>Poaceae</i>	<i>Holcus lanatus</i>	Yorkshire fog
	<i>Poaceae</i>	<i>Lolium perenne</i>	Perennial Ryegrass
	<i>Poaceae</i>	<i>Megathyrsus maximus</i>	Guinea grass
	<i>Poaceae</i>	<i>Melinis repens</i>	Red Natal Grass
	<i>Poaceae</i>	<i>Panicum maximum</i>	Guinea grass
	<i>Poaceae</i>	<i>Paspalum dilatatum</i>	Paspalum
	<i>Poaceae</i>	<i>Paspalum urvillei</i>	Vasey grass
	<i>Poaceae</i>	<i>Pennisetum clandestinum</i>	Kikuyu grass
	<i>Poaceae</i>	<i>Pennisetum purpureum</i>	Elephant grass
	<i>Poaceae</i>	<i>Phalaris aquatica</i>	Phalaris

Status	Family	Scientific name	Common name
	Poaceae	<i>Setaria gracilis</i>	Slender pigeon grass
	Poaceae	<i>Setaria sphacelata</i>	South African Pigeon Grass
	Poaceae	<i>Sporobolus africanus</i>	Parramatta grass
*	Poaceae	<i>Sporobolus fertilis</i>	Giant Parramatta grass
	Polygonaceae	<i>Rumex crispus</i>	Curled Dock
	Polygonaceae	<i>Rumex sp.</i>	
*	Pontederiaceae	<i>Eichhornia crassipes</i>	Water hyacinth
	Proteaceae	<i>Macadamia integrifolia</i>	Macadamia nut
	Rutaceae	<i>Citrus limonia</i>	Rough lemon
	Salicaceae	<i>Populus sp.</i>	Poplar
*	Salicaceae	<i>Salix fragilis</i>	Crack willow
	Salicaceae	<i>Salix sp.</i>	Willow
	Sapindaceae	<i>Cardiospermum grandiflorum</i>	Balloon vine
	Sapindaceae	<i>Koelreuteria paniculata</i>	Golden rain tree
*	Solanaceae	<i>Cestrum parqui</i>	Green cestrum
	Solanaceae	<i>Lycopersicon esculentum</i>	Tomato
	Solanaceae	<i>Solanum mauritianum</i>	Wild tobacco bush
	Solanaceae	<i>Solanum nigrum</i>	Black-berry Nightshade
	Solanaceae	<i>Solanum seaforthianum</i>	Climbing nightshade
	Solanaceae	<i>Solanum sp.</i>	
	Tropaeolaceae	<i>Tropaeolum majus</i>	Nasturtium
*	Verbenaceae	<i>Lantana camara</i>	Lantana
	Verbenaceae	<i>Verbena bonariensis</i>	Purpletop
	Verbenaceae	<i>Verbena sp.</i>	

A1.2 Threatened flora species and Ecological communities

The following table includes a list of the threatened flora species and ecological communities that have potential to occur within the project area. The list of species is sourced from the NSW BioNet Wildlife Atlas and the Protected Matters Search Tool (DoE; accessed on 14 October 2013).

Notes to table:

#	species predicted to occur by the DoE database (not recorded on other databases)
##	species predicted to occur based on natural distributional range and suitable habitat despite lack of records in the databases searched
Year	recorded on databases listed above
Biosis	recorded during Biosis surveys

Likelihood of occurrence	Potential criteria
High	- Species recorded in project area during current or previous assessment/s. - Aquatic species recorded from connected waterbodies in close proximity to the project area during current or previous assessment/s. - Sufficient good quality habitat is present in project area or in connected waterbodies in close proximity to the project area (aquatic species). - Project area is within species natural distributional range (if known). - Species has been recorded within 10 km or from the relevant catchment/basin.
Medium	- Records of terrestrial species within 10 km of the project area or of aquatic species in the relevant basin/neighbouring basin. - Habitat limited in its capacity to support the species due to extent, quality, or isolation.
Low	- No records within 10 km of the project area or for aquatic species, the relevant basin/neighbouring basin. - Marginal habitat present (low quality & extent). - Substantial loss of habitat since any previous record(s).
Negligible	- Habitat not present in project area - Habitat for aquatic species not present in connected waterbodies in close proximity to the project area. - Habitat present but sufficient targeted survey has been conducted at an optimal time of year and species wasn't recorded.

Table 23: Threatened flora species and ecological communities potentially occurring within 10 km of the project area

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
Flora Species							
<i>Acacia ruppii</i>	Rupp's Wattle	EN	E1	#	Low	No potential habitat or associated species identified within the project area. No previous records within the project area.	Occurs at altitudes of 50 - 150 meters in the Banyabba - Coaldale area to the north-west of Grafton. Although plentiful in some locations it is restricted to a small area. Occurs in dry open forest and shrubland in sandstone areas, often near creeks and on roadsides. Grows in the understorey below Needlebark Stringybark (<i>Eucalyptus planchoniana</i>), Red Bloodwood (<i>Corymbia gummifera</i>) and Smudgy Apple (<i>Angophora woodsiana</i>).
<i>Allocasuarina defungens</i>	Dwarf Heath Casuarina	EN	E1	#	Low	No previous records within the project area.	<i>Allocasuarina defungens</i> is found only in the Hunter/Central Rivers, and Northern Rivers Catchments, ranging from the Napiac area, north-west of Forster, to Byron Bay on the NSW north coast. <i>Allocasuarina defungens</i> grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains. Vegetation communities associated with the species, includes: Dry Sclerophyll Forests, Forested Wetlands, Grassy Woodlands, and Heathlands.

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Angophora robur</i>	Sandstone Rough-barked Apple	VU	V	2011/#	Low	Soil preferences not present within the project area although there are six records within the 10 km search area, of which the closest is located approximately one kilometer away.	Occurs in a band from around Glenreagh, north-west of Coffs Harbour, to the Coaldale area north-west of Grafton, with an isolated occurrence farther west near Nymboida. It can be locally common. Dry open forest in sandy or skeletal soils on sandstone, or occasionally granite, with frequent outcrops of rock.
<i>Arthraxon hispidus</i>	Hairy Jointgrass	VU	V	#	Medium	Potential habitat within the project area however no previous records.	Occurs over a wide area in south-east Queensland, and on the northern tablelands and north coast of NSW, but is never common. Also found from Japan to central Eurasia. Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.
<i>Centranthera cochinchinensis</i>	Swamp Foxglove		E1	2012	Low	No associated communities are located within the project area and the nearest previous record is approximately six km away. What little remnant vegetation is present is highly disturbed.	Occurs in northern Australia and south-east Asia and known from NSW north from Wooli. Recorded in swampy areas and other moist sites. Predicted to occur within Swamp Oak swamp forest of the coastal lowlands of the North Coast and Forest Red Gum - Swamp Box of the Clarence Valley lowlands of the North Coast.

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	VU	V	#	Low	No potential habitat and no previous records within the project area.	This species typically grows in swamp-heath on sandy soils chiefly in coastal districts but has also been recorded on steep bare hillsides. Within the Central Coast bioregion, this species has been recorded within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland. This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by <i>Eucalyptus sclerophylla</i>, <i>E. sieberi</i>, <i>Corymbia gummifera</i> and <i>Allocasuarina littoralis</i>; appears to prefer open areas in the understorey of this community and is often found in association with the <i>Cryptostylus subulata</i>. It occurs in the following Catchment Management Regions Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers and Southern Rivers. Inconsistent flowering times December to February; January to February (in Victoria)

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Cynanchum elegans</i>	White-flowered Wax Plant	EN	E1	#	Low	No potential habitat or previous records within the project area.	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan. <i>Cynanchum elegans</i> usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; <i>Leptospermum laevigatum</i> , <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> ; <i>Eucalyptus tereticornis</i> open forest and woodland; <i>Eucalyptus maculata</i> open forest and woodland; and <i>Melaleuca armillaris</i> scrub to open scrub. Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific.
<i>Eucalyptus tetrapleura</i>	Square-fruited Ironbark	VU	V	2006/#	Low	Potential habitat is highly restricted due to vegetation clearance and the species has not been recorded during previous assessments.	Restricted to the coastal lowlands and foothills of northern NSW around Casino and Grafton. Dry or moist eucalypt forest on moderately fertile soil, often in low areas with poor drainage.
<i>Geodorum densiflorum</i>	Pink Nodding Orchid		E1	2010	Low	Closest previous record approximately 10 km from the project area, no suitable habitat.	There are thought to be less than 20 populations of Pink Nodding Orchid in NSW, all north of Bundjalung National Park, and including Tweed Shire. The species also occurs in Queensland. Occurs in dry eucalypt forest and coastal swamp forest at lower altitude.

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Hydrocharis dubia</i>	Frogbit (Delisted)	N/A		2008	Medium	Recent record within the locality and potential habitat within the project area.	Aquatic perennial with emergent and floating leaves; stolons rooted in shallow water, floating across deeper water. Grows in small shallow freshwater bodies or swamps. It is known from north of Kempsey, in New South Wales, to Fletcher River, near Charters
<i>Macrozamia johnsonii</i>	Johnson's Cycad		E1	1911	Low	No potential habitat within the project area and no recent records within the 10 km locality.	Found only in north-east NSW. Locally common in restricted areas west of Grafton, in the Dalmorton and Chaelundi districts. The trunk may be up to 1.5 meters in height and 80 cm in diameter. The stiff, bright green, glossy fronds are up to 3 m long, with 150 – 250 leaf-segment.
<i>Marsdenia longiloba</i>	Slender Marsdenia	VU	E1	#	Low	No potential habitat within the project area and no records within the 10 km locality.	Scattered sites on the north coast of NSW north from Barrington Tops. Also occurs in south-east Queensland. Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops.
<i>Maundia triglochinos</i>			V	1987	Low	No recent records within the 10 km locality.	<i>Maundia triglochinos</i> is restricted to Coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct. Catchment Regions include Hunter/Central Rivers, Northern Rivers and Sydney Metropolitan. Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. It is associated with wetland species e.g. <i>Triglochin procerum</i> and vegetation communities such as Dry Sclerophyll Forests, Forested wetlands, and Freshwater wetlands.

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Melaleuca irbyana</i>	Weeping Paperbark		E1	2006	Low	No potential habitat within the project area although there are three records within the 10 km locality, the most recent of which from 2006.	Found in only a few places in north-east NSW, including near Coraki, Casino and Coutts Crossing south of Grafton. Also occurs in near Ipswich south-east Queensland. Open eucalypt forest in poorly drained, usually clay, soils.
<i>Niemeyera whitei</i>	Rusty Plum, Plum Boxwood		V	1918	Low	No potential habitat within the project area and no records within the 10 km locality.	Found in littoral and warm-temperate rainforest and the adjacent understorey of moist eucalypt forest. Rusty Plum occurs in the coast and adjacent ranges of northern NSW from the Macleay River into southern Queensland.
<i>Phaius australis</i>	Southern Swamp Orchid	EN	E1	#	Low	No potential habitat within the project area and no records within the 10 km locality.	Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie. Found in swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.
<i>Phyllanthus microcladus</i>	Brush Sauropus		E1	2006	Low	The distribution of this species is well documented with a known population approximately two km from the project area. No rainforest communities occur within the project area.	In NSW confined to a few locations in the Tweed, Brunswick, Richmond and Wilson River Valleys with an outlying population near Grafton. Also occurs in south-east Queensland. Usually found on banks of creeks and rivers, in streamside rainforest.

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Prostanthera spinosa</i>	Spiny Mint-bush		V	2011	Low	Recent records 130 meters away from the project area however they are from 1948 and accurate to 10 km. Habitat preferences are rocky hill tops and skeletal soils which were not present within the project area.	<i>Prostanthera spinosa</i> is an aromatic, scrambling, and prostrate shrub, to 0.5 m high growing in skeletal sandy soils in rocky areas. The NSW populations of <i>Prostanthera spinosa</i> are located within a small area to the north of Grafton on the NSW North Coast. All known populations are within a linear range of 16-20 km.
<i>Streblus pendulinus</i>	Whalebone Tree	EN		#	Low	No potential habitat within the project area and no records within the 10 km locality.	The species is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 meters above sea level. The species grows in well developed rainforest, gallery forest and drier, more seasonal rainforest.
<i>Taeniophyllum muelleri</i>		VU		#	Low	No potential habitat within the project area and no records within the 10 km locality.	Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges, from sea level to 250 meters alt., north from the Bellinger R.
<i>Triplarina imbricata</i>	Creek Triplarina	EN	E1	#	Low	No potential habitat within the project area and no records within the 10 km locality.	Found only in a few locations in the ranges south-west of Glenreagh and near Tabulam in north-east NSW. Also dubiously recorded from Parramatta (before 1810). Habitat is along watercourses in low open forest with Water Gum.
<i>Tylophora woollsii</i>	Cryptic Forest Twiner	EN	E1	#	Low	No potential habitat within the project area and no records within the 10 km locality.	Found in wet sclerophyll forest and rainforest. Co-occurring species include <i>Acacia melanoxylon</i> , <i>A. binervata</i> , <i>Caldcluvia paniculata</i> , <i>Ehretica acuminata</i> , <i>Eucalyptus microcorys</i> , <i>E. saligna</i> , <i>Schizomeria ovata</i> and <i>Syncarpia</i> spp.

Scientific Name	Common Name	EPBC Act	TSC Act	Most recent record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Zieria obcordata</i>		EN	E1	#	Low	No potential habitat within the project area and no records within the 10 km locality.	Grows in eucalypt woodland or shrubland dominated by species of Acacia on rocky hillsides. Also occurs in Eucalyptus and Callitris dominated woodland with an open, low shrub understorey, on moderately steep, west to north-facing slopes in sandy loam amongst granite boulders. The altitude range of sites is 500 to 830 m. Soil types include shallow sandy loam and shallow brown gravelly loam on granite substrates. In wild populations, plants tend to grow in crevices between granite boulders.
Name		EPBC Act	TSC Act	Most recent record	Likelihood of occurrence	Rationale for likelihood	Habitat description
Threatened Ecological Communities							
Coastal Cypress Pine Forest in the New South Wales North Coast Bioregion			E3	-	Negligible	No coastal sand plain habitat or associated species within the project area.	Coastal Cypress Pine Forest in the NSW North Coast Bioregion is typically characterized by Coastal Cypress Pine, <i>Callitris columellaris</i> and is found typically on coastal sand plains, north from the Angourie area on the far north coast of NSW. The community is characterised a closed to open canopy of <i>C. columellaris</i> , which may be mixed with eucalypts, wattles, banksias and/or rainforest trees, and an open to sparse understorey of shrubs, sedges and herbs.

Name	EPBC Act	TSC Act	Most recent record	Likelihood of occurrence	Rationale for likelihood	Habitat description
<i>Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>	CE	E3	-	Negligible	No suitably brackish/saline conditions preferred by this community within the project area.	The community typically occurs in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast. Species composition within Coastal Saltmarsh varies with elevation. <i>Sarcocornia quinqueflora</i> dominates at lower, and hence more frequently flooded, levels than <i>Sporobolus virginicus</i> which dominates the mid saltmarsh, while <i>Juncus kraussii</i> and <i>Baumea juncea</i> are upper saltmarsh species. There is also geographic variation, with much more extensive stands of <i>Sporobolus virginicus</i> being found in northern NSW, and conversely more extensive <i>Sarcocornia quinqueflora</i> stands in the south.
<i>Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>		E3	-	High	Present within project area.	Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains. Within the study area these were present as monocultures of Common Reed and Broad-leaved Cumbungi.

Name	EPBC Act	TSC Act	Most recent record	Likelihood of occurrence	Rationale for likelihood	Habitat description
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	CE	E3	-	Low	The degraded floodplain within the project area does not provide potential habitat for rainforest communities.	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions is generally a closed forest, the structure and composition of which is strongly influenced by proximity to the ocean. The plant species in this ecological community are predominantly rainforest species with evergreen mesic or coriaceous leaves. Several species have compound leaves, and vines may be a major component of the canopy. These features differentiate littoral rainforest from sclerophyll forest or scrub, but while the canopy is dominated by rainforest species, scattered emergent individuals of sclerophyll species, such as <i>Angophora costata</i> , <i>Banksia integrifolia</i> , <i>Eucalyptus botryoides</i> and <i>E. tereticornis</i> occur in many stands.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	CE	E3	-	Low	The degraded floodplain within the project area does not provide potential habitat for rainforest communities.	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions is the name given to the ecological community of subtropical rainforest and some related, structurally complex forms of dry rainforest, excluding Littoral and Lowland Rainforest on Floodplain in the NSW North Coast Bioregion. In a relatively undisturbed state, the community has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes, give the canopy an irregular appearance. A range of plant growth forms are present in Lowland Rainforest, including palms, vines and vascular epiphytes. Scattered eucalypt emergents may occasionally be present.

Name	EPBC Act	TSC Act	Most recent record	Likelihood of occurrence	Rationale for likelihood	Habitat description
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	CE	E3	-	Low	The degraded floodplain within the project area does not provide potential habitat for rainforest communities.	Lowland Rainforest on Floodplain is a rainforest community which now occurs only as small remnants in scattered localities on the NSW north coast, with less than 1000ha in total thought to remain. Larger stands of the community typically have a dense canopy, which blocks most light from reaching the ground, creating cool, moist conditions within. Lowland Rainforest on Floodplain supports a rich diversity of plants and animals. Typical tree species in the community include figs <i>Ficus macrophylla</i> , <i>F. obliqua</i> and <i>F. watkinsiana</i> , palms <i>Archontophoenix cunninghamiana</i> and <i>Livistona australis</i> , Silky Oak <i>Grevillea robusta</i> , Black Bean <i>Castanospermum australe</i> and Brush Cherry <i>Syzygium australe</i> .
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion		E3	-	High	Present within project area.	Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion is the name given to the ecological community associated with clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. The structure of the community may vary from tall open forests to woodlands, although partial clearing may have reduced the canopy to scattered trees. The most widespread and abundant dominant trees include Forest Red Gum <i>Eucalyptus tereticornis</i> , Grey Ironbark <i>E. siderophloia</i> , Pink Bloodwood <i>Corymbia intermedia</i> and Swamp Turpentine <i>Lophostemon suaveolens</i> . Within the Study area this community was present as isolated remnant Forest Red gum paddock trees.

Name	EPBC Act	TSC Act	Most recent record	Likelihood of occurrence	Rationale for likelihood	Habitat description
<i>Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>		E3	-	Low	Present in the surrounding landscape, not present within the project area.	The most widespread and abundant dominant trees include Swamp Mahogany <i>Eucalyptus robusta</i> and <i>Melaleuca quinquenervia</i> . Other trees may be scattered throughout at low abundance or may be locally common at few sites, including Sweet Willow Bottlebrush <i>Callistemon salignus</i> , Swamp Oak <i>Casuarina glauca</i> and Red Mahogany <i>Eucalyptus resinifera</i> subsp. <i>hemilampra</i> , Cabbage Palm <i>Livistona australis</i> and Swamp turpentine.
<i>Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions</i>		E3	-	Low	No exposed seacliff habitat was present within the project area.	<i>Themeda australis</i> is the dominant species in the Themeda Grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregion ecological community. <i>Themeda australis</i> is an extremely widespread species, but in this community it may have a distinctive appearance, being prostrate and having glaucous leaves. These features are retained in cultivation and the form is believed to be genetically distinct. <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> , <i>Westringia fruticosa</i> and <i>Acacia sophorae</i> occurs as an emergent shrub or as a dense cover where they have recruited over grasslands.

* - habitat descriptions have been adapted by qualified ecologists from the DoE Species Profile and Threats (SPRAT) Database, OEH Threatened Species online profiles and the NSW Scientific Committee final determinations for listed species, references within the above table are provided within the report reference list.

Appendix 2: Fauna

Fauna species in these tables are listed in alphabetical order within their taxonomic group.

A2.1 Fauna species recorded from the project area

Below is a combined list of fauna species recorded from the project area during the 2010, 2012 and 2013 assessment, and a list of significant fauna species recorded or predicted to occur within 10 km of the project area.

Notes to table:

EPBC Act:

EX - Extinct

CR - Critically Endangered

EN - Endangered

VU - Vulnerable

CD - Conservation dependent

TSC Act:

C1 – critically endangered

E1 – endangered species (Part 1, Schedule 1)

E2 – endangered population (Part 2, Schedule 1)

E4 – presumed extinct (Part 4, Schedule 1)

V1 – vulnerable (Part 1, Schedule 2)

FM Act:

C1 – critically endangered

E1 – endangered

E2 – endangered

E4 – presumed extinct

V1 – vulnerable

* - introduced species

Table 24: Fauna species recorded from the project area

Status	Scientific name	Common name	TSC Act	EPBC Act
	Amphibians			
	<i>Limnodynastes peronii</i>	Striped marsh frog		
	<i>Litoria fallax</i>	Eastern dwarf tree frog		
	Birds			
	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped thornbill		
	<i>Acanthiza lineata</i>	Striated thornbill		
	<i>Acanthiza pusilla</i>	Brown thornbill		
	<i>Accipiter cirrhocephalus</i>	Collared sparrowhawk		
	<i>Accipiter fasciatus</i>	Brown goshawk		
*	<i>Acridotheres tristis</i>	Indian myna		
	<i>Acrocephalus stenoreus</i>	Clamorous reed-warbler		M
	<i>Alcedo azurea</i>	Azure kingfisher		
	<i>Anas superciliosa</i>	Pacific black duck		

Status	Scientific name	Common name	TSC Act	EPBC Act
	<i>Anhinga novaehollandiae</i>	Australasian darter		
	<i>Anthus novaeseelandiae</i>	Richard's pipit		
	<i>Aquila audax</i>	Wedge-tailed Eagle		
	<i>Ardea ibis</i>	Cattle egret		M
	<i>Ardea intermedia</i>	Intermediate egret		
	<i>Ardea pacifica</i>	White-necked heron		
	<i>Artamus leucorhynchus</i>	White-breasted woodswallow		
	<i>Aviceda subcristata</i>	Pacific baza		
	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo		
	<i>Cacatua roseicapilla</i>	Galah		
	<i>Cacatua sanguinea</i>	Little Corella		
	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo		
	<i>Chenonetta jubata</i>	Australian wood duck		
	<i>Cisticola exilis</i>	Golden-headed Cisticola		
	<i>Columba leucomela</i>	White-headed Pigeon		
*	<i>Columba livia</i>	Rock dove		
	<i>Coracina novaehollandiae</i>	Black-faced cuckoo-shrike		
	<i>Corvus coronoides</i>	Australian Raven		
	<i>Corvus orru</i>	Torresian crow		
	<i>Cracticus nigrogularis</i>	Pied butcherbird		
	<i>Cracticus torquatus</i>	Grey butcherbird		
	<i>Cygnus atratus</i>	Black swan		
	<i>Dacelo novaeguineae</i>	Laughing kookaburra		
	<i>Dicaeum hirundinaceum</i>	Mistletoebird		
	<i>Egretta novaehollandiae</i>	White-faced heron		
	<i>Elanus axillaris</i>	Black-shouldered kite		
	<i>Entomyzon cyanotis</i>	Blue-faced honeyeater		
	<i>Eudnamys orientalis</i>	Eastern Koel		
	<i>Eurystomus orientalis</i>	Dollarbird		
	<i>Falco berigora</i>	Brown falcon		
	<i>Falco cenchroides</i>	Nankeen kestrel		
	<i>Gallinula tenebrosa</i>	Dusky moorhen		

Status	Scientific name	Common name	TSC Act	EPBC Act
	<i>Geopelia humeralis</i>	Bar-shouldered Dove		
	<i>Grallina cyanoleuca</i>	Magpie-lark		
	<i>Gymnorhina tibicen</i>	Australian magpie		
	<i>Haliaeetus leucogaster</i>	White-bellied sea-eagle		M
	<i>Haliastur indus</i>	Brahminy kite		
	<i>Haliastur spheonurus</i>	Whistling Kite		
	<i>Hirundo neoxena</i>	Welcome swallow		
	<i>Hirundo nigricans</i>	Tree Martin		
	<i>Larus novaehollandiae</i>	Silver gull		
	<i>Lichmera indistincta</i>	Brown honeyeater		
	<i>Malurus cyaneus</i>	Superb fairy-wren		
	<i>Manorina melanocephala</i>	Noisy miner		
	<i>Merops ornatus</i>	Rainbow bee-eater		M
	<i>Myzomela sanguinolenta</i>	Scarlet honeyeater		
	<i>Neochmia temporalis</i>	Red-browed finch		
	<i>Ocyphaps lophotes</i>	Crested pigeon		
*	<i>Passer domesticus</i>	European house sparrow		
	<i>Pelecanus conspicillatus</i>	Australian pelican		
	<i>Phalacrocorax varius</i>	Pied cormorant		
	<i>Phalacrocorax varius</i>	Little black cormorant		
	<i>Phaps chalcoptera</i>	Common bronzewing		
	<i>Philemon citreogularis</i>	Little friarbird		
	<i>Platalea regia</i>	Royal Spoonbil		
	<i>Platycercus eximius</i>	Eastern rosella		
	<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe		
	<i>Porphyrio porphyrio</i>	Purple swamphen		
	<i>Rhipidura albiscapa</i>	Grey Fantail		
	<i>Rhipidura leucophrys</i>	Willie wagtail		
	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo		
	<i>Sphecotheres viridis</i>	Figbird		
	<i>Sterna hirundo</i>	Common tern		M
	<i>Strepera graculina</i>	Pied Currawong		

Status	Scientific name	Common name	TSC Act	EPBC Act
*	<i>Streptopelia chinensis</i>	Spotted turtle-dove		
	<i>Taeniopygia bichenovii</i>	Double-barred finch		
	<i>Threskiornis molucca</i>	Australian white ibis		
	<i>Threskiornis spinicollis</i>	Straw-necked ibis		
	<i>Todiramphus sanctus</i>	Sacred Kingfisher		
	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet		
	<i>Trichoglossus haematodus</i>	Rainbow lorikeet		
	<i>Tyto novaehollandiae</i>	Masked owl	V	
	<i>Vanellus miles</i>	Masked lapwing		
	<i>Zosterops lateralis</i>	Silvereye		
	Mammals			
	<i>Austronomus australis</i>	White-striped Freetail-bat		
*	<i>Bos primigenius</i>	Cattle		
	<i>Chalinolobus gouldii</i>	Gould's wattled bat		
	<i>Chalinolobus nigrogriseus</i>	Hoary wattled-bat	V	
	<i>Isodon macrourus</i>	Northern brown bandicoot		
	<i>Macropus giganteus</i>	Eastern grey kangaroo		
	<i>Miniopterus australis</i>	Little bent-wing bat	V	
	<i>Miniopterus schreibersii oceanensis</i>	Eastern bentwing-bat	V	
	<i>Mormopterus norfolkensis</i>	Eastern freetail-bat	V	
	<i>Mormopterus ridei</i>	Eastern Freetail-bat		
	<i>Myotis macropus</i>	Southern myotis	V	
	<i>Nyctophilus sp.</i>	Long-eared bat		
	<i>Pteropus alecto</i>	Black flying-fox		
	<i>Pteropus poliocephalus</i>	Grey-headed flying-fox	V	V
	<i>Scoteanax rueppellii</i>	Greater broad-nosed bat	V	
	<i>Scotorepens sp.</i>	Broad-nosed bat		
	<i>Scotorepens sp. (undescribed)</i>	Central-eastern broad-nosed bat (undescribed)		
	<i>Trichosurus sp.</i>	Brushtail possum		
	<i>Vespadelus regulus</i>	Southern forest-bat		
	<i>Vespadelus troungtoni</i>	Eastern cave-bat	V	

Status	Scientific name	Common name	TSC Act	EPBC Act
	<i>Vespadelus vulturnus</i>	Little forest bat		
*	<i>Vulpes vulpes</i>	Fox		
	Reptiles			
	<i>Cryptoblepharus virgatus</i>	Wall lizard		
	<i>Eulamprus quoyii</i>	Eastern water skink		
*	<i>Hemidactylus frenatus</i>	Common asian house gecko		
	<i>Lampropholis delicate</i>	Garden sun-skink		
	<i>Lampropholis guichenoti</i>	Grass sun skink		
	<i>Physignathus lesueurii</i>	Eastern water dragon		
	<i>Pseudechis porphyriacus</i>	Red-bellied black snake		
	<i>Saiphos equalis</i>	Three-toed skink		
	<i>Saproscincus sp.</i>	Shade skink		

A2.2 Aquatic fauna species

Aquatic fauna species recorded within and in the vicinity of the project area.

Notes to table:

- e euryhaline species – species which are capable of occurring in marine and freshwater environments (i.e. typically estuarine species and marine vagrants).
- d diadromous species – species which migrate between fresh and salt water at specific parts of their lifecycle (includes anadromous, catadromous and amphidromous species).
- n declared noxious species under the Fisheries Management Act, 1994.
- ✓ denotes presence only (no count)

Table 25: Aquatic fauna survey results

		Waterbody					
		Carrs Creek		Alipou Creek		Cowan Creek	
Native Fish Species		Gear Type					
		Bait Traps	Fyke Nets	Bait Traps	Fyke Nets	Bait Traps	Fyke Nets
Pacific blue eye	<i>Pseudomugil signifer</i>	8	36	0	0	0	0
Flathead gudgeon	<i>Philypnodon grandiceps</i> (Adult)	17	50	0	0	2	10
Flathead gudgeon	<i>Philypnodon grandiceps</i> (Juvenile/Dwarf)	3	2	3	20	0	0
Olive perchlet	<i>Ambassis agassizii</i>	7	89	0	2	1	0
Striped gudgeon	<i>Gobiomorphus australis</i>	22	43	10	55	5	5
Empire/Firetail gudgeon	<i>Hypseleotris compressa/galii</i> (Adult)	11	0	11	323	0	0
Empire gudgeon	<i>Hypseleotris compressa</i> (Adult)	0	0	0	0	10	60
Firetail gudgeon	<i>Hypseleotris galii</i> (Adult)	0	0	0	0	5	50
Empire/Firetail gudgeon	<i>Hypseleotris compressa/galii</i> (Juvenile)	0	0	0	1	10	50
Freshwater catfish	<i>Tandanus tandanus</i>	0	0	0	0	0	1
Introduced Fish Species							
Plague minnow	<i>Gambusia holbrooki</i>	3	0	0	0	5	0
Rainbow mish	<i>Perca fluviatilis</i>	0	0	0	1	0	0
Other Native Vertebrate Species							
Marbled eel	<i>Anguilla reinhardtii</i>	0	3	0	0	1	4
Clarence River turtle	<i>Emydura macquarii binjing</i>	0	0	0	0	0	2
Native Invertebrate Species							
Prawn	Family: Palaemonidae	5	30	0	0	2	10

A2.3 Threatened fauna species

The following table includes a list of the significant fauna species that have potential to occur within the project area. The list of species is sourced from the BioNet Wildlife Atlas, BirdLife Australia data search and the Protected Matters Search Tool (DoE; accessed on 14 October 2013).

Notes to table:

#	species predicted to occur by the DoE database (not recorded on other databases)
##	species predicted to occur based on natural distributional range and suitable habitat despite lack of records in the databases searched
Year	recorded on databases listed above
Biosis	recorded during Biosis surveys

Likelihood of occurrence	Potential criteria
High	- Species recorded in project area during current or previous assessment/s. - Aquatic species recorded from connected waterbodies in close proximity to the project area during current or previous assessment/s. - Sufficient good quality habitat is present in project area or in connected waterbodies in close proximity to the project area (aquatic species). - Project area is within species natural distributional range (if known). - Species has been recorded within 10 km or from the relevant catchment/basin.
Medium	- Records of terrestrial species within 10 km of the project area or of aquatic species in the relevant basin/neighbouring basin. - Habitat limited in its capacity to support the species due to extent, quality, or isolation.
Low	- No records within 10 km of the project area or for aquatic species, the relevant basin/neighbouring basin. - Marginal habitat present (low quality & extent). - Substantial loss of habitat since any previous record(s).
Negligible	- Habitat not present in project area - Habitat for aquatic species not present in connected waterbodies in close proximity to the project area. - Habitat present but sufficient targeted survey has been conducted at an optimal time of year and species wasn't recorded.

Table 26: Threatened fauna species potentially occurring within 10 km of the project area

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
Amphibians							
<i>Mixophyes balbus</i>	Stuttering Frog	VU	E1	#	Low	No preferred habitat occurs within the project area.	This species is usually associated with mountain streams, wet mountain forests and rainforests. It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains.
<i>Mixophyes iteratus</i>	Giant Barred Frog	EN	E1	#	Low	No preferred habitat occurs within the project area.	Occurs along coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. Found in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 meters, often hiding in leaf litter near permanent fast-flowing streams. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. When not breeding the frogs disperse hundreds of meters away from streams.
Birds							

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Anseranas semipalmata</i>	Magpie Goose		V	2013/#	Medium	80 records of this species occur within 10 km of the project area. The Magpie Goose may utilise ephemeral freshwater wetlands within the project area and permanent habitats along the Clarence River.	Mainly found in shallow wetlands (less than 1 meter deep) with dense growth of rushes or sedges. They are often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes. Breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level. Nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW. Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation.
<i>Anthochaera phrygia</i>	Regent Honeyeater	EN	E4A	#	Low	No known breeding habitat. No preferred foraging resources and no historical records occur within the project area.	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: <i>E. microcarpa</i> , <i>E. punctata</i> , <i>E. polyanthemus</i> , <i>E. mollucana</i> , <i>Corymbia robusta</i> , <i>E. crebra</i> , <i>E. caleyi</i> , <i>C. maculata</i> , <i>E. mckieana</i> , <i>E. macrorhyncha</i> , <i>E. laevopinea</i> and <i>Angophora floribunda</i> . Nectar and fruit from the mistletoes <i>A. miquelii</i> , <i>A. pendula</i> , <i>A. cambagei</i> are also eaten during the breeding season. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and she-oaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	E1	#	Low	No records of this species occur within 10 km of the project area. Potential habitat occurs within the degraded riparian vegetation along the Clarence River however this habitat is marginal.	The Australasian Bittern is distributed across south-eastern Australia. Often found in terrestrial and estuarine wetlands, generally where there is permanent water with tall, dense vegetation including <i>Typha spp.</i> and <i>Eleocharis spp.</i> . Typically this bird forages at night on frogs, fish and invertebrates, and remains inconspicuous during the day. The breeding season extends from October to January with nests being built amongst dense vegetation on a flattened platform of reeds.
<i>Burhinus grallarius</i>	Bush Stone-curlew		E1	2007	Low	Habitat is of poor quality, sparse fallen woody branches, debris and largely urbanized. Five records of this species occur within 10 km of the study, the closest occurring 145m away.	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present.
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo		V	2008	Low	No suitable tree hollows occur within the project area for this species. No preferred foraging resources present within the project area. 16 records the closest 2265 meters from the project area.	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Chthonicola sagittata</i>	Speckled Warbler		V	2006	Low	26 records occur within 10 km of the project area however the project area does not support large intact areas of eucalyptus forest required to support this species.	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understory, often on ridges or gullies. The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understory for arthropods and seeds. Home ranges vary from 6-12 ha.
<i>Circus assimilis</i>	Spotted Harrier		V	2006	Low	Three records occur within 10 km of the project area. The closest being 2565 meters away. The Spotted Harrier may forage throughout the agricultural farmland habitats within the project area within South Grafton, however no trees suitable for nesting are present.	The Spotted Harrier is found throughout Australia but rarely in densely forested and wooded habitat of the escarpment and coast. Preferred habitat consists of open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, acacia and mallee remnants, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation. The Spotted Harrier is more common in drier inland areas, nomadic part migratory and dispersive, with movements linked to the abundance of prey species. Nesting occurs in open or remnant woodland and unlike other harriers, the Spotted Harrier nests in trees.
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)		V	2012	Low	81 records occur within 10 km of the project area. The closest being 80m away. The project area does not support woodland habitat required to support this species.	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Daphoenositta chrysoptera</i>	Varied Sittella		V	1996	Low	60 records of this species occurs within 10 km of the project area including within the project area. Preferred habitat for this species is absent from the project area.	The Varied Sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts. The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	EN	E1	#	Low	No preferred habitat occurs within the project area.	Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands.
<i>Diomedea antipodensis</i>	Antipodean Albatross	VU	V	#	Low	No preferred habitat occurs within the project area.	A marine pelagic species rarely visiting Australia.
<i>Diomedea dabbenena</i>	Tristan albatross	EN		#	Low	No preferred habitat occurs within the project area.	<i>Diomedea exulans exulans</i> is a newly defined species and its 'at sea' range is yet to be defined. Currently, only one definitive record of this species exists; on Gough Island and was recaptured 4 years later off Wollongong.
<i>Diomedea epomophora epomophora</i>	Southern Royal Albatross - see Royal Albatross	VU		#	Low	No preferred habitat occurs within the project area.	A marine pelagic species rarely visiting the mainland.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Diomedea epomophora sanfordi</i>	Northern Royal Albatross	EN		#	Low	No preferred habitat occurs within the project area.	A marine pelagic species rarely visiting the mainland.
<i>Diomedea exulans (sensu lato)</i>	Wandering Albatross	VU	E1	#	Low	No preferred habitat occurs within the project area.	A marine, pelagic and aerial species. Versatile feeders in pelagic and shelf waters. Breed on sub-antarctic and antarctic islands.
<i>Diomedea exulans antipodensis</i>	Antipodean Albatross	VU	V	#	Low	No preferred habitat occurs within the project area.	A marine pelagic species rarely visiting Australia.
<i>Diomedea exulans exulans</i>	Tristan albatross	EN		#	Low	No preferred habitat occurs within the project area.	<i>Diomedea exulans exulans</i> is a newly defined species and its 'at sea' range is yet to be defined. Currently, only one definitive record of this species exists; on Gough Island and was recaptured 4 years later off Wollongong.
<i>Diomedea gibsoni</i>	Gibson's Albatross	VU	V	#	Low	No preferred habitat occurs within the project area.	A marine pelagic species which breeds on the Auckland islands, New Zealand.
<i>Dromaius novaehollandiae</i>	Emu	EX	E2	2012	Medium	Four records of this endangered population occur within 10 km of the project area. The closest record occurs 988m from the project area. Individuals may cross open farmland within the project area.	Emu population in the NSW North Coast Bioregion and Port Stephens Local Government Area occurs in open forest, woodland, coastal heath, coastal dunes, wetland areas, tea tree plantations and open farmland, and occasionally in littoral rainforest.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork		E1	2013	Medium	709 records occur within 10 km of the project area including within the project area. This species may forage within the freshwater wetlands and agricultural floodplains of the Clarence River.	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water.
<i>Erythrotriorchis radiatus</i>	Red Goshawk	VU	E4A	1980/#	Low	Two records of this species occur within 10 km of the project area. The closest record occurs 140 meters from the project area. No woodland habitat occurs within the project area.	Occur in forest and woodland habitat near permanent water. In NSW prefer Melaleuca swamp forest and open eucalypt woodland. Require greater than 20 meters tall trees for nesting.
<i>Glossopsitta pusilla</i>	Little Lorikeet		V	2013	Low	49 records of Little Lorikeet within 10 km of the project area including records occurring within the project area. No intact woodlands occur within the project area, limiting the availability of foraging resources. No suitable tree hollows for breeding occur within the project area.	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 meters and 15 meters, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Grus rubicunda</i>	Brolga		V	2006	Medium	Five records of this species occur within 10 km of the project area the closest being 1495 meters from the project area. This species may forage within agricultural farmland habitats within the project area within South Grafton including the degraded freshwater wetlands.	The Brolga has been recorded on open wetlands, shallow swamps, floodplains, paddocks, farmland and salt flats. This species nest in shallow wetlands where there is shelter such as canegrass, lignum or sedge swamp. They feed in or near water and have often been observed foraging in grassland, dry wetlands and cultivated areas.
<i>Gygis alba</i>	White Tern		V	1951	Low	No preferred habitat occurs within the project area.	The extreme west of this species range touches the mid-east coast of Australia, where it may be occasionally observed during the breeding season foraging over reefs. Otherwise this pelagic species only comes to land to breed which occurs exclusively on Lord Howe and Norfolk Islands.
<i>Haematopus longirostris</i>	Pied Oystercatcher		E1	1988	Low	Five records of this species have been historically recorded within 10 km of the project area however the most recent record dates from 1988. Habitat for this species occurs along the banks of the Clarence River however	An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Its food supply (beach macroinvertebrates) have been negatively affected by human impacts. The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. A pair will re-nest in the same spot each year, rarely shifting their territory. Occasionally the Pied Oystercatcher is found in paddocks near the coast.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Hieraaetus morphnoides</i>	Little Eagle		V	2010	Low	24 records of this species occur within 10 km of the project area including within the project area. The Little Eagle may forage throughout the agricultural farmland habitats within the project area within South Grafton, however no trees suitable for nesting are present.	The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species. It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests.
<i>Irediparra gallinacea</i>	Comb-crested Jacana		V	2008	Medium	162 records of this species occur within 10 km of the project area including within the project area. The Clarence river does not support abundant floating aquatic vegetation. One ornamental pond occurs in South Grafton which this species may frequent on occasion.	Occurs in freshwater wetlands, lagoons, Billabongs, swamps, lakes, rivers and reservoirs, generally with abundant floating aquatic vegetation.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Lathamus discolor</i>	Swift Parrot	EN	E1	#	Low	No preferred foraging resources occur within the project area.	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. Favoured feed trees include winter flowering species such as Swamp Mahogany <i>Eucalyptus robusta</i> , Spotted Gum <i>Corymbia maculata</i> , Red Bloodwood <i>C. gummifera</i> , Mugga Ironbark <i>E. sideroxylon</i> , and White Box <i>E. albens</i> . Commonly used lerp infested trees include Grey Box <i>E. microcarpa</i> , Grey Box <i>E. moluccana</i> and Blackbutt <i>E. pilularis</i> . This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.
<i>Lophoictinia isura</i>	Square-tailed Kite		V	2012	Medium	This species has been recorded on 104 occasions within 10 km of the project area including within the project area. Suitable foraging habitat occurs within South Grafton throughout agricultural areas, however no trees suitable for nesting are present.	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by <i>Eucalyptus longifolia</i> , <i>Corymbia maculata</i> , <i>E. elata</i> , or <i>E. smithii</i> . Individuals appear to occupy large hunting ranges of more than 100 km ² . They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN	E1	#	Low	No preferred habitat occurs within the project area.	The Southern Giant-Petrel is a marine species found throughout the Antarctic to subtropical waters occasionally venturing to inshore waters.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Macronectes halli</i>	Northern Giant-Petrel	VU	V	#	Low	No preferred habitat occurs within the project area.	Marine, pelagic species found mainly in sub-antarctic waters.
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)		V	2001	Low	This species has been recorded on 75 occasions within 10 km of the project area including within the project area, however the project area does not support woodland habitat required by this species.	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts. It is rarely recorded east of the Great Dividing Range.
<i>Ninox connivens</i>	Barking Owl		V	2010	Low	The Barking Owl has been recorded on seven occasions within 10 km of the project area with the closest record being 2078 meters away. No tree hollows suitable for nesting or possums (prey) occur within the project area. The project area may compose part of the larger foraging territory for this species but are sparsely vegetated.	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country. Territories are typically 2000 ha in NSW habitats.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Ninox strenua</i>	Powerful Owl		V	2001	Low	The Powerful Owl has been recorded on nine occasions within 10 km of the project area with the closest record being 7172 meters away. No tree hollows suitable for nesting or possums (prey) occur within the project area. The project area may compose part of the larger foraging territory for this species but are sparsely vegetated.	The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. Large mature trees with hollows at least 0.5 meters deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm. It has a large home range of between 450 and 1450 ha.
<i>Onychoprion fuscata</i>	Sooty Tern		V	1982	Low	No preferred habitat occurs within the project area.	The Sooty Tern is a pelagic species found over tropical waters where it feeds offshore far away from land. It breeds off the coast of WA and QLD rarely venturing to the south-east of Australia.
<i>Pandion cristatus</i>	Osprey		V	2010	Medium	The Osprey has been recorded on 61 occasions within 10 km of the project area including within the project area. No nesting sites occur within the project area. This species is likely to hunt along the Clarence River.	Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers. It is water-dependent, hunting for fish in clear, open water. The Osprey occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Petroica boodang</i>	Scarlet Robin		V	1988	Low	The Scarlet Robin has been recorded on 10 occasions previously within 10 km of the project area including within the project area. This species may move through open and urban landscapes during winter however is unlikely to regularly frequent the project area.	During the breeding season the Scarlet Robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet Robin forages amongst logs and woody debris for insects which make up the majority of its diet. The nest is an open cup of plant fibers and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 meters above the ground. It is conspicuous in open and suburban habitats.
<i>Petroica phoenicea</i>	Flame Robin		V	1991	Low	The Flame Robin has been recorded on three occasions previously within 10 km of the project area including within the project area. This species may move through open and urban landscapes during winter however are unlikely to regularly frequent the project area.	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. The preferred habitat in summer includes moist eucalyptus forests and open woodlands, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)		V	2012	Low	The Grey-crowned Babbler has been recorded on 204 occasions within 10 km of the project area with records occurring within the project area. No conspicuous nests were observed during surveys and no woodland habitats occur within the project area to support this species.	The Grey-crowned Babbler is found in dry, open forests, scrubby woodlands, trees bordering roads and farmland with isolated trees.
<i>Rostratula australis</i>	Australian Painted Snipe	EN	E1	#	Low	No records of this species occur within 10 km of the project area. Potential habitat occurs within ephemeral wetlands within South Grafton agricultural lands however this habitat is marginal.	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters.
<i>Stagonopleura guttata</i>	Diamond Firetail		V	1987	Low	The Diamond Firetail was recorded on nine occasions within 10 km of the project area with the closest record occurring 849 meters from the project area. Potential habitat for this species is restricted to the degraded riparian vegetation along the banks of the Clarence River.	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs. Often occur in vegetation along watercourses.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Stictonetta naevosa</i>	Freckled Duck		V	1981	Low	The Freckled Duck has been recorded on nine occasions previously within 10 km of the project area with the closest record being 849 meters from the project area. The project area does not support preferred or known habitat for this species.	The Freckled Duck breeds in permanent swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits.
<i>Thalassarche cauta cauta</i>	Shy Albatross	VU	V	#	Low	No preferred habitat occurs within the project area.	The Shy Albatross is a marine pelagic species inhabiting sub-antarctic and subtropical waters, spending the majority of their time at sea. Occasionally it is observed in continental shelf waters in bays and harbours.
<i>Thalassarche eremita</i>	Chatham Albatross	EN		#	Low	No preferred habitat occurs within the project area.	The Chatham Albatross is a medium sized albatross, with a wing-span less than 2.1 meters. The bright yellow bill has a distinctive black spot near the tip of the lower mandible, allowing discrimination from the similar Shy Albatross. Breeding for the Chatham Albatross is restricted to Pyramid Rock, Chatham Islands, off the coast of New Zealand. The principal foraging range for this species is in coastal waters off eastern and southern New Zealand, and Tasmania.
<i>Thalassarche impavida</i>	Campbell albatross	VU		#	Low	No preferred habitat occurs within the project area.	Inhabits Antarctic, sub-antarctic and subtropical waters.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Thalassarche melanophris</i>	Black-browed Albatross	VU	V	#	Low	No preferred habitat occurs within the project area.	Inhabits Antarctic, subantarctic and subtropical waters. Although generally pelagic the species also occurs on the continental shelf and can be seen from land.
<i>Thalassarche melanophris impavida</i>	Campbell albatross	VU		#	Low	No preferred habitat occurs within the project area.	Inhabits Antarctic, subantarctic and subtropical waters.
<i>Thalassarche salvini</i>	Salvin's Albatross	VU		#	Low	No preferred habitat occurs within the project area.	A marine pelagic species.
<i>Thalassarche steadyi</i>	White-capped Albatross	VU		#	Low	No preferred habitat occurs within the project area.	A marine pelagic species.
<i>Turnix melanogaster</i>	Black-breasted Button-quail	VU	E4A	#	Low	No previous records occur within 10 km of the project area. Poor quality habitat may occur within the levee area.	Within NSW, the species inhabits areas with an elevation of 200 to 700m, in dry or subtropical rainforests which contain brigalow, belah, bottle trees, hoop pine, lantana, ironbark, wattle, spotted gum, wallaby grass or rhodes grass.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Tyto novaehollandiae</i>	Masked Owl		V	2013/ Biosis	High	Pellets were collected from a potential nest tree in proximity to the project area during 2010. The project area is likely to form part of the hunting territory for the Masked Owl.	The Masked Owl may be found across a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. It has mostly been recorded in open forests and woodlands adjacent to cleared lands. They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. The nest hollows are usually located within dense forests or woodlands. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. It has a large home range of between 500 to 1000 ha.
Fish							
<i>Bidyanus bidyanus</i>	Silver Perch	CE	V	2009 (Nymboi da River)	Moderate	Suitable habitat is available within the project area. Due to previous occurrence in a connected water body and the potential of long-distance movements, there is moderate potential for the species to occur here.	They prefer flowing, open waters, particularly those containing races. However, they also inhabit warm, sluggish water with cover provided by large woody debris and reeds. Whilst spawning can occur during non-flood conditions, spawning activity can significantly increase during floods and/or environmental water releases.
<i>Epinephelus daemeli</i>	Black Rock-cod	VU	V	N/A	Low	Pelagic species with no potential habitat within project area.	Black Rock-cod are a large, reef-dwelling, carnivorous grouper species. They are found in warm temperate and subtropical parts of the south-western Pacific, and naturally occur along the entire NSW coast including Lord Howe Island.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Maccullochella ikei</i>	Clarence River Cod	EN	EN	2009 (Mann and Nymboid a Rivers)	Low	Due to previous occurrence in a connected water body and the potential of long-distance movements, there is some potential for the species to occur here, although it is considered to be low.	Eastern freshwater cod are often found in clear, flowing streams with rocky beds and deep holes. They are generally found in areas that have plenty of boulders or large woody debris (snags). Riparian vegetation, large boulders and snags provide a complex array of habitats for each stage of the cod life cycle and influence the quality and quantity of food and shelter.
<i>Mogurnda adspersa</i>	Purple-spotted Gudgeon	-	EN	Recent (G. Butler, DPI, pers. comm.)/Biosis	High	Suitable habitat is available and individuals were captured during recent surveys by DPI (G. Butler, DPI, pers. comm.). NOTE: The species was included based on the results of previous surveys within the project area. No records were found during the DPI Fisheries database searches.	Inhabits slow-flowing or still waters, among weed. Occurs in rivers, creeks and billabongs, usually over rocks or among vegetation. Two populations occur in NSW. The eastern population of the Purple-spotted Gudgeon occurs north of the Clarence River catchment in the coastal drainage of NSW. Targeted sampling at sites where this species has previously been found has not produced any new records, although there are unconfirmed records from student research projects in the Tweed and Brunswick river catchments.
<i>Nannoperca oxleyana</i>	Oxleyan pygmy perch	EN	EN	2004 (Minnie Water)	Low	Endemic to the coastal region of eastern Australia, from northern NSW to south-eastern Queensland (DPI 2010). There is also only limited habitat available within project area.	Oxleyan pygmy perch occur mostly in swamps, creeks and lakes of coastal 'wallum' (Banksia-dominated coastal heath). These waters are usually acidic, with low salinity and low conductivity, and are often darkly stained. They seem to prefer slow-moving or still waters with plenty of shelter in the form of dense aquatic vegetation (e.g. sedges) or undercut, root-filled banks. Populations are most common on the coastal floodplains of NSW where they disperse between water bodies during localised flood events.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
Mammals							
<i>Aepyprymnus rufescens</i>	Rufous Bettong		V	2012	Low	35 records occur within 10 km of the project area. The closest record occurring 884 meters. No woodland or forest habitats occur within the project area to support this species.	Occurs in a variety of habitats for coastal eucalypt forest, through tall, wet sclerophyll, to low, dry open woodland. Only occurs in areas with a sparse or grassy understorey, adjacent to areas of dense undergrowth.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	VU	V	#	Low	No roosting habitat occurs within the project area for this species. No woodland is present within the project area to provide preferred foraging grounds for this species.	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands. Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months. The only known existing maternity roost is in a sandstone cave near Coonabarabran.
<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat		V	2007/ Biosis	High	This species was recorded during anabat surveys (Biosis, 2013) and hollow bearing trees within the project area provide suitable roosting habitat for the species.	Predominantly a northern species, but occurs in north-eastern NSW to the lower Clarence and Richmond River areas in dry open eucalypt forests, particularly those dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common. Prefers open habitat types and roosts mainly in tree hollows, but sometimes in rock crevices or buildings.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	EN	V	2012	Low	16 records occur within 10 km of the project area, with records occurring within the project area. No dens sites, caves or rocky outcrops occur within the project area. No wooded habitat present within the project area in which to forage. This species may traverse the agricultural areas when moving between foraging habitats outside of the project area.	Occurs along the east coast of Australia and the Great Dividing Range. Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests. Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas. Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage. Seventy per cent of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage. The home range of a female is between 180 and 1000 ha, while males have larger home ranges of between 2000 and 5000 ha. Breeding occurs from May to August.
<i>Miniopterus australis</i>	Little Bentwing-bat		V	2010/ Biosis	High	This species was recorded during surveys conducted within the project area during 2010. This species was also recorded during anabat surveys (Biosis, 2013), and buildings within the project area may provide suitable roosting habitat for the species.	Occurs from Northern Queensland to the Hawkesbury River near Sydney. Roost sites encompass a range of structures including caves, tunnels and stormwater drains. Young are raised by the females in large maternity colonies in caves in summer. Shows a preference for well timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. The Little Bentwing bat forages for small insects (such as moths, wasps and ants) beneath the canopy of densely vegetated habitats.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat		V	2010/ Biosis	High	This species was recorded during surveys conducted within the project area during 2010. This species was also recorded during anabat surveys (Biosis, 2013). No potential roosts sites occur within the subject site.	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred km to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways.
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat		V	2008	High	This species was recorded during anabat surveys (Biosis, 2013). This species may roost beneath exfoliating bark in Eucalyptus trees within habitat in South Grafton.	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few km of roosting sites.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Myotis macropus</i>	Southern Myotis		V	2010/ Biosis	High	This species was recorded during current surveys via anabat (Biosis, 2013). This species is likely to forage along the riparian vegetation of the Clarence River and Alipou Creek within the project area. This species was also recorded during anabat surveys (Biosis, 2013), and buildings within the project area may provide suitable roosting habitat for the species.	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects.
<i>Nyctophilus bifax</i>	Eastern Long-eared Bat		V	2008	Medium	This species has been recorded once previously approximately 9500m from the project area. A <i>Nyctophilus</i> sp. call was recorded during anabat surveys conducted. Habitat for this species within the project area is restricted to a small stand of vegetation within South Grafton in proximity to the Clarence River.	Occurs across northern Australia in habitats ranging from rainforests to riparian woodlands. It frequently roosts communally in foliage and tree hollows and under exfoliated bark. They change roosts seasonally, from rainforest edges in winter to the centre of rainforest patches in summer.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Petaurus australis</i>	Yellow-bellied Glider		V	2009	Low	Five records of this species occur within 10 km of the project area the closest being recorded 6525 meters from the project area. No woodland habitats suitable to support this species occur within the project area.	Restricted to tall native forests in regions of high rainfall along the coast of NSW. Bago Plateau: Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types. Live in family groups of 2-6 individuals which commonly share a number of tree hollows. Family groups are territorial with exclusive home ranges of 30-60 ha. Very large expanses of forest (>15,000 ha) are required to conserve viable populations.
<i>Petaurus norfolcensis</i>	Squirrel Glider		V	2011	Low	Nine records of this species occur within 10 km of the project area the closest being recorded 2308 meters from the project area. No woodland habitats suitable to support this species occur within the project area.	Wagga Wagga and Barrenjoey peninsula (north syd): Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran in the northern part of the state and as far west as Tocomwal along the southern border of the state. Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow-bearing trees and a mix of eucalypts, banksias and acacias. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. They live in family groups of 2-10 individuals and maintain home ranges of 0.65 and 10.5 ha, varying according to habitat quality and food resource availability. Family groups occupy multiple hollows over time.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	VU	E1	#	Low	No preferred habitat occurs within the project area.	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2-30 ha.
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale		V	2010	Low	The Brush-tailed Phascogale has been recorded on 18 occasions previously within 10 km of the project area with the closest record being only 159 meters from the project area. Despite this the project area does not support woodland habitat to support this species.	The Brush-tailed Phascogale had a scattered distribution centered around the Great Dividing Range. It prefers open forests with a sparse ground cover, but also inhabits mallee and rainforests. It feeds on insects and nectar, particularly in rough-barked trees. The Brush-tailed Phascogale will Nests and shelter in tree hollows, tree stumps and occasionally bird nests, and can use more than 40 nests in a year. Suitable tree hollows have entrances 25-40 mm wide. Females have exclusive territories of approximately 20 - 60 ha, while males have overlapping territories of up to 100 ha. Breeding occurs from May to July, after which all the males die.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Phascolarctos cinereus</i>	Koala	VU	V	2012	Low	The Koala has been recorded on 158 occasions within 10 km of the project area with the closest record occurring 243 meters from the project area. One preferred feed tree occurs within the project area however based on the scarce number of potential feed trees and habitat the Koala is unlikely to traverse or occupy the project area.	Pittwater LGA and Hawks nest: In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region. Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally. Primary feed trees include Eucalyptus robusta, E. tereticornis, E. punctata, E. haemostoma and E. signata. They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100 ha.
<i>Planigale maculata</i>	Common Planigale		V	2009	Low	The Common Planigale has been recorded twice previously within 10 km of the project area, the closest record being 692 meters from the project area. The project area supports marginal potential habitat within agricultural paddocks along the boundary of the Pacific Highway within South Grafton. This habitat is unlikely to support the Common Planigale given the sparse ground cover available.	Occurs from the Queensland border and south to the Upper Hunter River. The southernmost record is from Gosford. The Common Planigale is known to occur in a variety of habitats from weed-infested urban reserves to cool mountain forests (Burnett 2008), from sea level up to 400 meters. Habitat selection is considered to be dependent on an adequate surface cover of grasses, hollow logs, rocks and leaf litter. It feeds on insects, spiders and small lizards. This species shelters under rocks, timber, rubbish (e.g. sheet iron) and in termite mounds. There is nothing known of its home range. Breeding occurs during spring and summer.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo	VU	V	#	Low	No preferred habitat occurs within the project area.	Cobaki Lakes and Tweed Heads West population: Occurs from Queensland to Victoria, normally within 50 km of the coast. Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue. It is solitary and sedentary, but tends to aggregate in small groups. It has two breeding seasons, one in late winter-early spring and the other in late summer. This species appears to benefit from a lack of recent disturbance.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	VU		#	Low	No preferred habitat occurs within the project area.	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understory, and vegetated sand dunes. The home range of the New Holland Mouse can range from 0.44 ha to 1.4 ha. The New Holland Mouse is a social animal, living predominantly in burrows shared with other individuals. The species is nocturnal and omnivorous, feeding on seeds, insects, leaves, flowers and fungi, and is therefore likely to play an important role in seed dispersal and fungal spore dispersal. It is likely that the species spends considerable time foraging above-ground for food, predisposing it to predation by native predators and introduced species. Breeding typically occurs between August and January, but can extend into autumn.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	VU	V	2010/##/ Biosis	High	Resident colony on Susan Island. Individuals are likely to forage within Moreton bay figs within the project area.	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat		V	2007	Medium	This species has been recorded on seven occasions previously within 10 km of the project area, with some records occurring within the project area. Roosting habitat for this species is restricted to five potential hollow bearing Ficus sp. and a Eucalyptus sp. within the project area.	Found throughout NSW. They have been reported from southern Australia between January and June. Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat		V	1998/ Biosis	High	This species was recorded during current surveys via anabat (Biosis, 2013). Roosting habitat for this species is restricted to five potential hollow bearing Ficus sp. and a Eucalyptus sp. within the project area.	Occurs along the Great Dividing Range, generally at 500 meters but up to 1200 meters, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 meters or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Vespadelus trougtoni</i>	Eastern Cave Bat		V	2007/ Biosis	High	Foraging habitat present only. This species was recorded during current surveys via anabat (Biosis, 2013).	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. It roosts in small groups, often in well-lit overhangs and caves, mine tunnels, road culverts, and occasionally in buildings.
Reptiles							
<i>Cacophis harriettae</i>	White-crowned Snake		V	2012	Low	Three records the closest only 590m from the project area. However no suitable habitat occurs within the project area. Leaf litter is absent or sparse and the project area is highly disturbed with no woodland or forest vegetation present.	Distributed from coastal and near-coastal areas from central eastern Queensland south to the vicinity of Coffs Harbour in north-east NSW. The White-crowned snake favours low to mid-elevation dry eucalypt forest and woodland, particularly areas with a varied and well-developed litter layer, where their prey of small lizards may be more abundant. It is also occasionally found in moist eucalypt forest and coastal heathland.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Caretta caretta</i>	Loggerhead Turtle	EN	E1	#	Low	This is a marine species. There is no suitable habitat in the project area.	In Australia, the Loggerhead Turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia. While nesting is concentrated in southern Queensland and from Shark Bay to the North West Cape in Western Australia, foraging areas are more widely distributed. Small Loggerhead Turtles live at or near the surface of the ocean and move with the ocean currents. In eastern Australia, there is evidence that they spend around 15 years or more in the open ocean, with much of their feeding in the top 5 meters of water, before recruiting to their chosen inshore or neritic feeding area. Loggerhead Turtles choose a wide variety of tidal and sub-tidal habitat as feeding areas and show fidelity to both their foraging and breeding areas.
<i>Chelonia mydas</i>	Green Turtle	VU	V	#	Low	This is a marine species. There is no suitable habitat in the project area.	Marine species with a pan-tropical distribution throughout the world. More abundant along the tropical coasts of Australia and the Great Barrier Reef. Green Turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with driftlines and rafts of Sargassum (a floating marine plant that is also carried by currents). Once Green Turtles reach 30 to 40 cm curved carapace length, they settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds. The shallow foraging habitat of adults contains seagrass beds or algae mats on which Green Turtles mainly feed.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-tooth Skink	VU	V	1992/#	High	Four records of this species occur within 10 km with records occurring within the project area.	The Three-toed Snake-tooth Skink occurs in the coast and ranges from the Macleay valley in NSW to south-eastern Queensland. It is very uncommon south of Grafton. Its habitat includes rainforest and occasionally moist eucalypt forest, on loamy or sandy soils. The Three-toed Snake-tooth Skink lives in loose soil, leaf litter and rotting logs, and feeds on earthworms and beetle grubs.
<i>Dermochelys coriacea</i>	Leathery Turtle	EN	V	#	Low	This is a marine species. There is no suitable habitat in the project area.	Marine species usually sighted along the eastern seaboard often in bays, estuaries and rivers. No major nesting has been recorded in Australia, although scattered isolated nesting (one to three nests per annum) occurs in southern Queensland and the Northern Territory. Some nesting has occurred in northern NSW near Ballina. However, no nesting has occurred in Queensland or NSW since 1996. Diet is dominated by gelatinous organisms such as jellyfish, salps, squid and siphonophores.
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	VU		#	Low	This is a marine species. There is no suitable habitat in the project area.	Hawksbill Turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with rafts of Sargassum (a floating marine plant that is also carried by currents). Once Hawksbill Turtles reach 30 to 40 cm curved carapace length, they settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat. They primarily feed on sponges and algae. They have also been found, though less frequently, within seagrass habitats of coastal waters, as well as the deeper habitats of trawl fisheries. Major nesting of Hawksbill Turtles in Australia occurs at Varanus Island and Rosemary Island in Western Australia, and in the northern Great Barrier Reef and Torres Strait.

Scientific Name	Common Name	EPBC Act	TSC /FM Act	Most Recent Record	Likelihood of Occurrence	Rationale for Likelihood	Habitat Description
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake		V	2003	Low	One record occurs 3398 meters from the project area. No woodland or forested habitats suitable for this species occur within the project area.	Found in a variety of habitats from wet sclerophyll forest to dry eucalypt forest on the western slopes of NSW. Feeds largely on frogs and lizards.
<i>Natator depressus</i>	Flatback Turtle	VU		#	Low	This is a marine species. There is no suitable habitat in the project area.	The flatback turtle is endemic to Australia with all known breeding sites occurring only in Australia. They feed in the northern coastal regions of Australia, extending as far South as the Tropic of Capricorn. Their feeding grounds also extend to the Indonesian archipelago and the Papua New Guinea coast. Flatback turtles have a preference for shallow, soft-bottomed sea bed habitats away from reefs. The flatback turtle is carnivorous, feeding mostly on soft bodied prey such as sea cucumbers, soft corals and jellyfish. They feed mainly in subtidal, soft-bottomed habitats.

* - habitat descriptions have been adapted by qualified ecologists from the DoE Species Profile and Threats (SPRAT) Database, OEH Threatened Species online profiles and the NSW Scientific Committee final determinations for listed species, references within the above table are provided within the report reference list.

A2.4 Migratory species (EPBC Act listed)

Includes records from the following sources:

- Atlas of NSW Wildlife (refer to Section 3.1)
- DoE database (accessed on 14/10/2013)
- BirdLife Australia data search
- Current survey

Bold denotes species recorded in the project area during the current assessment.

Table 27: Migratory fauna species potentially occurring within 10 km of the project area

Scientific Name	Common Name	Most Recent Record	Likelihood of Occurrence	Habitat Description
<i>Apus pacificus</i>	Fork-tailed Swift	1996/#	Low	Almost exclusively aerial (foraging). The Fork-tailed Swift breeds in Asia but migrates to Australia from September to April. Individuals or flocks can be observed hawking for insects at varying heights from only a three m from the ground and up to 300 m high.
<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler	Biosis	High – Confirmed	Reed beds; other dense vegetation near water. Flies low over water.
<i>Ardea alba</i>	Eastern Great Egret	#	#	(SEE <i>Ardea modesta</i>)
<i>Ardea ibis</i>	Cattle Egret	2010/#/ Biosis	High – Confirmed	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands.
<i>Ardea modesta</i>	Eastern Great Egret	2013	Medium	Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers.
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	1986	Low	Inland waters, coastal.
<i>Chalcophaps indica</i>	Emerald Dove	2009	Low	

Scientific Name	Common Name	Most Recent Record	Likelihood of Occurrence	Habitat Description
<i>Chlidonias leucopterus</i>	White-winged Black Tern	1986	Low	Irregular summer visitor from northern Eurasia to coastal and subcoastal grassy swamps and fresh or saline wetlands of western, northern and eastern mainland Australia. Rarely recorded inland or at sea except during migration.
<i>Cuculus saturatus</i>	Himalayan Cuckoo	1987	Low	Canopy or shrub layer of monsoon rainforest, vine thickets, wet sclerophyll forest, or open casuarina, Acacia or Eucalyptus woodland.
<i>Gallinago hardwickii</i>	Latham's Snipe	2007/#	Medium	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	2013/#/ Biosis	High – Confirmed	A migratory species that is generally sedentary in Australia, although immature individuals and some adults are dispersive. Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees.
<i>Hirundapus caudacutus</i>	White-throated Needletail	2006/#	Low	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breeds in Asia.
<i>Hydroprogne caspia</i>	Caspian Tern	1994	Medium	Usually coastal, with a preference for sheltered estuaries, inlets, bays, harbours, lagoons with muddy or sandy shores. Keeps close inshore, not out beyond reef line. Also extends well inland on fresh or salt lakes, temporary floodwaters, large rivers, reservoirs, sewage ponds.
<i>Merops ornatus</i>	Rainbow Bee-eater	2010/#	High	Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movement in Australia. NSW populations migrate north for winter.
<i>Monarcha melanopsis</i>	Black-faced Monarch	2010/#	Low	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland.

Scientific Name	Common Name	Most Recent Record	Likelihood of Occurrence	Habitat Description
<i>Monarcha trivirgatus</i> (SEE <i>Symposiachrus trivirgatus</i>)	Spectacled Monarch	#	Low	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	#	Low	Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies.
<i>Plegadis falcinellus</i>	Glossy Ibis	2007	High	Terrestrial wetlands, and occasionally wet grasslands and sheltered marine habitats. Forage in shallow water over soft substrate or on grassy or muddy verges of wetlands, preferring those providing variety of water depths; avoid dry ground.
<i>Rhipidura rufifrons</i>	Rufous Fantail	2007/#	Low	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas.
<i>Rostratula benghalensis</i> (sensu lato)	Australian Painted Snipe	#	#	(SEE <i>Rostratula australis</i>) in Table 26
<i>Sterna hirundo</i>	Common Tern	Biosis	High – Confirmed	Common Terns are marine, pelagic and coastal. In Australia, they are recorded in all marine zones, but are commonly observed in near-coastal waters, both on ocean beaches, platforms and headlands and in sheltered waters, such as bays, harbours and estuaries with muddy, sandy or rocky shores. However, off Wollongong, NSW, Common Terns were recorded in all marine zones but generally recorded in offshore and pelagic waters, 11–55 km from shore. Occasionally they are recorded in coastal and near-coastal wetlands, either saline or freshwater, including lagoons, rivers, lakes, swamps and saltworks. Sometimes they occur in mangroves or saltmarsh and, in bad weather, in coastal sand-dunes or coastal embayments.
<i>Symposiachrus trivirgatus</i>	Spectacled Monarch	2009	Low	Found in darker parts of mountain and lowland rainforest, adjacent to thickly wooded gullies.

Scientific Name	Common Name	Most Recent Record	Likelihood of Occurrence	Habitat Description
<i>Tringa stagnatilis</i>	Marsh Sandpiper	1992	Low	Inhabits permanent or ephemeral wetlands, including swamps, billabongs, lagoons, saltmarshes and estuaries. Forages at the edge of wetlands in shallow water.
<i>Xanthomyza Phrygia</i>	Regent Honeyeater	#	#	(SEE <i>Anthochaera Phrygia</i>) in Table 26

* - habitat descriptions have been adapted by qualified ecologists from the DoE Species Profile for listed migratory species, references within the above table are provided within the report reference list.

Appendix 3: Assessments of Significance

The following section provides for Assessments of Significance according to the seven factors outlined in Section 5A of the EP&A Act for all species listed as a medium likelihood or greater in Appendix 1 and Appendix 2.

Plants: Hairy-joint Grass (*Arthraxon hispidus*)

Hairy-joint Grass is listed as Vulnerable under Part 1 of Schedule 2 of the NSW TSC Act. It is a creeping grass with branching, erect to semi-erect purplish stems (OEH, 2013). Leaf-blades are 2–6 centimeters long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. The grass was once thought of as an annual however it is now thought to be a perennial that tends to die down in winter. Habitat for Hairy-joint Grass is thought to include the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.

Within the project area, habitat for Hairy-joint Grass was limited to wet areas, predominantly along the banks of the Clarence River and within wet depressions and ephemeral drainage lines. Areas of potential habitat include the FWCF TEC mapped to the east of the existing bridge alignment, on both the northern and southern river banks. No Hairy-joint Grass was recorded within the project area however the wet soaks and ephemeral drainage lines may be considered marginal potential habitat for the species.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The OEH profile (OEH, 2013) lists grazing, slashing and inappropriate fire regimes as three of the threats to the species, all of which would have an adverse effect on the life-cycle of the species. Little information on the pollination and seed dispersal mechanisms of the species is available however given the scabrid nature of the glume and length of the awn it is anticipated that it is likely to be distributed by wind, water and potentially animals. The project is unlikely to significantly reduce the dispersal mechanisms or the lifecycle of the species.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

No Hairy-joint Grass was recorded within the project area, however the wet soaks and areas mapped as Freshwater Wetlands on Coastal Floodplains threatened ecological community (FWCF TEC) do provide marginal potential habitat for the species. The area of marginal potential habitat within the project area is approximately 0.10 ha, however this is considered to be conservative and the actual extent of direct impacts is likely to be far less. Within the likely area of direct impacts (project area), the habitat with greatest potential was identified as the banks of the Clarence River immediately under the project area. The set back of the piers and ramps for the proposed bridge are anticipated to minimise the direct impacts of the action on habitat for Hairy-joint Grass such as vegetation removal and piling. Indirect impacts of the project will include increased shading (expected to be limited to under the bridge) and potential increased recruitment of exotic grasses. Given the species is shade tolerant, and provided hygiene protocols are adhered to, it is unlikely that the extent of potential habitat for the species would be significantly reduced.

Historical disturbance regimes including residential and urban development, grazing and the construction of the levee have contributed to the increase in fragmentation and isolation of habitat for Hairy-joint Grass. Potential habitat within the project area is considered marginal based on the rainforest edge or wet eucalypt forest habitat preferences and it is restricted to the FWCF TEC mapped to the east of the existing bridge alignment. The project is therefore considered unlikely to significantly isolate or fragment habitat for the species.

The habitat for Hairy-joint Grass is considered to be marginal given the lack of rainforest edge or wet eucalypt forest habitat. Based on this, the potential habitat identified within the project area is considered to be of low regional importance for the species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a register of critical habitat. To date, no critical habitat has been declared for Hairy-joint Grass.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date there is no recovery plan for Hairy-joint Grass. The OEH lists 10 priority actions and five activities to assist this species, including:

- Protect habitat from frequent fire.
- Avoid slashing or mowing around rainforest edges.
- Fence habitat remnants to protect from stock.
- Control introduced grasses in areas with known populations.
- Protect areas of rainforest, wet eucalypt forest and swamp from clearing and development.

The proposed development is not in conflict with these activities.

Whether the action proposed constitutes or is part of a key threatening process (KTPs) or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project has the potential to trigger the following KTPs relevant to Hairy Joint Grass:

- Clearing of native vegetation
- Invasion and establishment of exotic vines and scramblers
- Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*
- Invasion, establishment and spread of Lantana camara
- Invasion of native plant communities by exotic perennial grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Conclusion

Based on no Hairy-joint Grass being identified within the project area, the marginal nature of the potential habitat and the proposed setback minimising the impacts on habitat it is considered unlikely that the project would have a significant impact on Hairy-joint Grass and therefore a Species Impact Statement is not recommended.

Threatened Ecological Communities: Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Freshwater Wetlands on Coastal Floodplains (FWCF) is an Endangered Ecological Community listed under Part 3 of Schedule 1 of the TSC Act. It is associated with coastal areas subject to periodic flooding (greater than 1 in 100 years) and in which standing fresh water persists for at least part of the year in most years (OEH, 2012). The TEC is often dominated by herbaceous plants and has very few woody species. Instances lacking regular standing water are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 m tall and dominated by amphibious plants including *Paspalum distichum* (water couch), *Leersia hexandra* (swamp rice-grass), *Pseudoraphis spinescens* (mud grass) and *Carex appressa* (tussock sedge). Where they are subject to regular inundation and drying the vegetation may include large emergent sedges over 1 m tall, such as *Baumea articulata*, *Eleocharis equisetina* and *Lepironia articulata*, as well as emergent or floating herbs such as *Hydrocharis dubia* (frogbit), *Philydrum lanuginosum* (frogsmouth), *Ludwigia peploides subsp. montevidensis* (water primrose), *Marsilea mutica* (nardoo) and *Myriophyllum spp.* (milfoils). As standing water becomes deeper or more permanent, amphibious and emergent plants become less abundant, while floating and submerged aquatic herbs become more abundant.

Within the project area, FWCF was present as scattered patches occurring within wet depressions and ephemeral drainage lines, often associated with the flood gate channels through the levee.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not Applicable to Endangered Ecological Communities.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not Applicable to Endangered Ecological Communities.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

The direct impacts of the project would be limited to the FWCF mapped immediately under the proposed bridge alignment on the northern and southern banks of the Clarence River. Numerous small patches of FWCF, totalling approximately 0.10 ha, are located within the project area and would be potentially impacted by the proposed activity, however this is considered to be a conservative estimate based on the buffer size for the levee assessment. The true extent of the FWCF TEC to be removed is considered to be far smaller than this, and given its occurrence is limited to the banks of the River, the setback of the piers is considered sufficient to avoid direct impacts to the majority of the mapped community. Furthermore, due to the presence of the TEC at various locations along the banks of the Clarence River, it is considered unlikely that the extent of the community would be reduced such that it is placed at risk of extinction.

The FWCF TEC was found to meet the OEH identification guidelines based on the inclusion of a number of degraded variants of the community. In all cases within the project area, the reedlands and drainage soaks are in a poor condition owing to fragmentation, weed invasion and/or livestock grazing. It is considered unlikely that any impacts from the proposed activity would substantially modify the composition of what is already a degraded representation of the community.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Habitat for FWCF TEC is limited to sections of the banks of the Clarence River in addition to wet depressions and ephemeral creeklines often associated with the flood channels through the levee. On the southern bank, the TEC is represented by a stand of *Phragmites australis* immediately to the west of the existing bridge alignment. This is within the project area however it is located to the east of the proposed alignment and direct impacts during the construction for the bridge are anticipated to be minimal. The first bridge pier on the southern side is to be located in stream limiting the requirement for clearance of bank vegetation. Given the raised nature of the levee, little habitat was identified along its alignment however drainage lines either side of the flood gates were found to contain the FWCF TEC. The extent of the FWCF TEC and its habitat did not encroach into the assigned 20m buffer for the levee so it is anticipated that it would not be impacted by the proposed activity.

The FWCF TEC and its habitat has been fragmented by historical impacts including clearing of native vegetation, livestock grazing and introduction of exotic species. Within the section of Clarence River valley assessed, the TEC is present as small isolated patches with limited connectivity to other areas of the TEC.

The identification guidelines for FWCF TEC (DECC, 2008) lists a number of variations to its composition that are considered consistent with the final determination. Included in this are monocultures of reeds and water bodies invaded by floating weeds. The largest patch of mapped FWCF within the project area was dominated by *Phragmites australis*, along the northern and southern bank, immediately adjacent to the existing bridge alignment. Given the lack of diversity recorded within the FWCF TEC to be impacted by the project, it is considered to be in moderate condition and given its size, it is of relatively low regional importance.

Considering the size, species composition and level of fragmentation of the patches of FWCF TEC to be impacted by the project, it is considered unlikely that it would have a significant impact on the habitat for the TEC.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a register of critical habitat. To date, no critical habitat has been declared for FWC.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date there is no recovery plan for FWCF. The OEH lists a number of priority actions that would assist in the recovery of the TEC. The proposed development is not in conflict with any of these.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project has the potential to trigger the following KTP's relevant to FWCF TEC:

- Clearing of native vegetation
- Invasion and establishment of exotic vines and scramblers
- Invasion of native plant communities by African Olive *Olea europaea L. subsp. cuspidata*
- Invasion, establishment and spread of Lantana camara
- Invasion of native plant communities by exotic perennial grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Conclusion

The project is not considered likely to have a significant impact on the FWCF TEC recorded within the project area based on;

- The restricted extent of the community at 0.10 ha.
- The marginal nature of the community with it being present as a *Phragmites australis* and *Typha orientalis* monoculture with substantial recruitment of exotic species.
- The setback of the piers from the banks of the River which is likely to minimise the direct impacts of the community.

References

NSW Scientific Committee, 2011, Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community listing. Accessed October 2013.

OEH, 2012, Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - Profile. Accessed October 2013.

DECC, 2008, Freshwater wetlands on coastal floodplains (Freshwater Wetlands) – Identification Guidelines for Endangered Ecological Communities.

Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion

Subtropical Coastal Floodplain Forest (SCFF) is listed as a TEC on Part 3 of Schedule 1 of the TSC Act, occurring on the coastal floodplains of the North Coast of NSW. It is comprised of a tall open tree layer of Eucalypts, Angophoras, Melaleucas and Bloodwoods of varying height, the most abundant species of which being *Eucalyptus tereticornis* (forest red gum), *E. siderophloia* (grey ironbark), *Corymbia intermedia* (pink bloodwood) and, north of the Macleay floodplain, *Lophostemon suaveolens* (swamp turpentine) (OEH, 2012).

Scattered shrubs within the TEC include *Breynia oblongifolia*, *Acacia concurrens*, *Commersonia* spp., and *Hibiscus* spp. Occasional vines include *Eustrephus latifolius*, *Parsonsia straminea* and *Geitonoplesium cymosum*. The groundcover is composed of abundant forbs, scramblers and grasses including *Imperata cylindrica*, *Themeda australis*, *Vernonia cinerea*, *Dianella caerulea*, *Pratia purpurascens*, *Cheilanthes sieberi* and *Dichondra repens*.

Within the project area, SCFF was present as small scattered patches of remnant indicative canopy species with limited shrub and understory diversity. Across the project area, the community was recorded as being in poor condition owing to its degraded and fragmented state.

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not Applicable to Endangered Ecological Communities.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not Applicable to Endangered Ecological Communities.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Approximately 0.31 ha of SCFF has been mapped by Biosis as occurring within the current project area and has the potential to be impacted by the proposed activity. The SCFF previously recorded by Biosis, both within and surrounding the project area was found to be in a degraded state, predominantly due to increased edge effects including recruitment of exotic species. The patches likely to be impacted are located within the levee alignment on the northern bank of the Clarence River and had a high proportion of exotic species with the ground and shrub strata. Due to the small size of the patches to be impacted and currently degraded nature of those patches, it is considered unlikely that the proposed activity would substantially reduce the extent or modify the composition of the TEC.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Habitat for SCFF would have historically occurred throughout the Clarence River floodplain, however clearing for grazing and urban and residential development have significantly reduces its regional extent to approximately 30 per cent of its original occurrence. The high level of recruitment of exotic species, both within the identified SCFF and surrounding communities, mean that little of the vegetation to be impacted by the proposed activity would be considered suitable habitat for the community based on the considerable intervention required to rehabilitate back to SCFF.

The historic disturbance regimes within the region have left much of the remnant SCFF TEC as isolated degraded patches. This is the case for those likely to be impacted by the proposed activity and with larger patches recorded outside of the project area and retaining improved connectivity, the removal of the patches within the levee alignment is not considered likely to significantly increase fragmentation of habitat for the TEC.

Larger and relatively better quality patches of the TEC were identified to the east of the proposed ridge alignment, both along the river bank and within grazed paddocks, and to the west of the alignment on Susan Island. Given the small size and isolated nature of the patches likely to be impacted compared to other patches previously mapped outside of the project area, they are considered to be of low local and regional significance.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a register of critical habitat. To date, no critical habitat has been declared for FWC.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

To date there is no recovery plan for FSCFF. The OEH lists a number of priority actions that would assist in the recovery of the TEC. The proposed development is not in conflict with any of these.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

- Clearing of native vegetation
- Invasion and establishment of exotic vines and scramblers
- Invasion of native plant communities by *African Olive Olea europaea L. subsp. cuspidata*
- Invasion, establishment and spread of *Lantana camara*
- Invasion of native plant communities by exotic perennial grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Conclusion

Given the impacts that are expected to result from the proposed activity are limited to a small area of the TEC which is currently in a highly degraded state, a significant impact is considered unlikely. A Species Impact Statement is not required.

References

OEH, 2012, Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion - profile. Accessed October 2013.

NSW Scientific Committee, 2011, Subtropical coastal floodplain forest of the NSW North Coast bioregion - endangered ecological community listing. Accessed October 2013.

Wetland birds: Magpie Goose (*Anseranas semipalmata*); Black-necked Stork (*Ephippiorhynchus asiaticus*), Brolga (*Grus rubicunda*), and Comb-crested Jacana (*Irediparra gallinacea*).

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The **Magpie Goose** (Vulnerable, TSC Act) is mainly found in shallow wetlands (less than 1m deep) within dense growth of rushes and sedges. They are equally at home in aquatic or terrestrial habitats, and often seen walking and grazing on land. They feed on grasses, bulbs and rhizomes. Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off. Breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level. Most breeding now occurs in monsoonal areas and is unlikely to occur in south-eastern NSW. Nests are formed in trees over deep water. Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains, and roosts in tall vegetation (NSW OEH, 2013). The Magpie Goose has been recorded on 80 occasions within 10 km of the project area. The Magpie Goose may utilise ephemeral freshwater wetlands within the project area and permanent habitats along the Clarence River.

The **Black-necked Stork** (Endangered, TSC Act) is found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation. In NSW, Black-necked Storks breed in late spring and summer (NSW OEH, 2013). The Black-necked Stork has been recorded on 709 occasions within 10 km of the project area including within the project area. The Black-necked Stork may forage within the freshwater wetlands and agricultural floodplains of the Clarence River.

The **Brolga** (Vulnerable, TSC Act) often feeds in dry grassland or ploughed paddocks or even desert claypans, but are also dependent on wetlands too, especially shallow swamps, where they would forage with their head entirely submerged (NSW OEH, 2013). The Brolga has been recorded on five occasions within 10 km of the project area, with the closest being 1495 meters from the project area. The Brolga may forage within agricultural farmland habitats within the project area within South Grafton including the degraded freshwater wetlands.

The **Comb-crested Jacana** (Vulnerable, TSC Act) inhabits permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation. They forage on floating vegetation, walking with a characteristic bob and flick. They feed primarily on insects and other invertebrates, as well as some seeds and other vegetation (NSW OEH, 2013). The Comb-crested Jacana has been recorded on 162 occasions within 10 km of the project area including within the project area. The Clarence River does not support abundant floating aquatic vegetation. One ornamental pond occurs outside of the project area, in South Grafton which the Comb-crested Jacana may frequent on occasion.

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and

reserves in Grafton and South Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

Given the scale and nature of the project, it is considered unlikely that the availability of potential habitat within the region would be impacted by the project. Furthermore, it is considered unlikely that the project would result in the life cycle of the species being altered such that a viable local population of the species is likely to be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation types which provide habitat for Wetland birds within the project area are considered to be continuous and of similar quality in the Locality. The project would remove approximately 0.41ha of potential foraging habitat, such as reedlands, drainage soaks and riparian vegetation along the banks of the Clarence River (i.e. 0.31ha of *Sub-coastal Floodplain Forest* TEC and 0.10 ha of *Freshwater Wetlands on Coastal Floodplains* TEC). Whilst this project has the potential to degrade riparian habitat and lowland grasslands, it is considered unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

The potential habitat to be removed by the project is not considered to be important habitat for the long-term survival of these Wetland birds within the Locality as it does not provide suitable breeding resources for the species.

The areas of riparian vegetation to be removed does provide potential foraging resources for these species, however as the diet of these wetland birds consist primarily of aquatic invertebrates (NSW OEH, 2013), it is considered unlikely to rely solely on potential foraging habitat within the project area. As such, given the nature and scale of the project, the presence of suitable habitat elsewhere within the locality, and provided the mitigation measures are adopted, the loss of some small areas of potential suitable foraging

habitat within the locality is considered unlikely to have long-term negative consequences for the species' local occurrences.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH or DPI within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery or threat abatement plans for the Magpie Goose, however OEH have identified 15 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Restore natural hydrological regimes to freshwater wetlands, and maintain existing hydrological regimes. Do not fill or drain wetlands. Retain and protect native vegetation in and around wetlands, and restore degraded wetlands.
- Improve the protection of Magpie Goose habitat by excluding stock, reducing grazing pressure and controlling weeds in wetlands. Avoid placing powerlines over or near wetlands/ nest sites.
- Reduce nutrient runoff into wetlands, and avoid the use of herbicides and pesticides near or in wetlands.
- Promote and support weed control programs within wetlands.
- Control feral animals near nest sites.
- Retain native vegetation with wetlands.

There is currently no recovery or threat abatement plans for the Black-necked Stork, however OEH have identified 14 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Restore natural hydrological regimes to freshwater wetlands. Maintain existing hydrological regimes. Do not fill or drain wetlands. Retain and protect native vegetation in and around wetlands. Restore degraded wetlands.
- Improve the protection of Black-necked Stork habitat by excluding stock, reducing grazing pressure and controlling weed species at important sites. Avoid construction activities near wetlands and/or nest sites.
- Reduce nutrient runoff into wetlands known to be used by Black-necked Storks. Avoid the use of herbicides and pesticides near or in wetlands.
- Control feral animals near nesting sites.

There is currently no recovery or threat abatement plans for the Brolga, however OEH have identified 9 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Retain or reintroduce water flows to wetlands, soaks, swamps, etc.

There is currently no recovery or threat abatement plans for the Comb-crested Jacana, however OEH have identified eight priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Fence off wetland areas from stock.
- Maintain natural hydrological flows in wetland areas.
- Restore or maintain natural vegetation buffer to wetlands of 200m or greater.
- Protect wetlands from flood mitigation works or clearing.
- Ensure the species is considered in Plans of Management and Fire Management strategies.

Whilst the project is not expected to result in the substantial achievement of many of the above listed priority actions, the project is not considered to be inconsistent with the broader achievement of these priority actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to all species included within this assessment:

- Clearing of native vegetation.
- Entanglement or ingestion of anthropogenic debris in marine and estuarine environments.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Invasion of plant communities by exotic perennial grasses.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Removal of dead wood and dead trees.

Conclusion

The project has the potential to have an adverse impact on the above-listed Wetland birds, although due to the scope and nature of the project, the degree of such impact is likely to be minor and insignificant. However, a number of measures have been recommended in Section 6 of this Report, which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

References

Biosis (2011) Main Road 83 Summerland Way- Additional Crossing of the Clarence River at Grafton: Preliminary Route Options Report. Technical Paper: Ecology. Report to Arup on behalf of the Roads and Maritime Services – Northern Regional Office

Biosis (2013) Field surveys conducted as part of the Grafton Highway Upgrade Flora and Fauna Assessment. October, 2013. Biosis Pty Ltd

NSW OEH (2013a) Threatened species profiles. NSW Office of Environment and Heritage. Accessed online 5/11/2013 - <http://www.environment.nsw.gov.au/threatenedspecies/index.htm>

NSW OEH (2013b) List of key threatening processes. NSW Office of Environment and Heritage. Accessed online 5/11/2013 - <http://www.environment.nsw.gov.au/threatenedspecies/KeyThreateningProcessesByDoctype.htm>

Flightless birds: Emu (*Dromaius novaehollandiae*) population in the New South Wales North Coast Bioregion and Port Stephens LGA

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable. This refers to vulnerable species listed in Part 1 of Schedule 2 of the TSC Act, endangered species listed in Part 1 of Schedule 1 of the TSC Act, critically endangered species listed in Part 1 of Schedule 1A of the TSC Act, vulnerable species listed in Part 1 of Schedule 5 of the FM Act, endangered species listed in Part 1 of Schedule 4 of the FM Act and critically endangered species listed in Part 1 of Schedule 4A of the FM Act.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

On the NSW north coast, the Emu occurs in a range of predominantly open lowland habitats, including grasslands, heathland, shrubland, open and shrubby woodlands, forest, and swamp and sedgeland communities, as well as the ecotones between these habitats. They also occur in plantations of tea-tree and open farmland, and occasionally in littoral rainforest (NSW OEH, 2013). The Emu has been recorded on 4 occasions within 10 km of the project area. The closest record occurs 988m from the project area. Emus may cross open farmland within the project area.

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

Given the scale and nature of the project, it is considered unlikely that the availability of potential habitat within the region would be impacted by the project. Furthermore, it is considered unlikely that the project would result in the life cycle of the species being altered such that a viable local population of the species is likely to be placed at risk of extinction. However, to minimise potential impacts to this species, a number of mitigation measures have been recommended in Section 6.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation types which provide potential habitat for the Emu within the project area are considered to be continuous and of similar quality in the Locality. The project would remove potential foraging habitat for the species, such as open grasslands (totalling a maximum of 4.41 ha). Whilst this project has the potential to degrade areas of open grasslands, it is considered unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

The potential habitat to be removed by the project is not considered to be important habitat for the long-term survival of the endangered Emu population within the Locality as it does not provide suitable breeding resources for the species.

The areas of grassland vegetation to be removed do provide potential foraging resources for this species, however due to the lack of records of this species in the project area, it is considered unlikely to rely heavily on foraging habitat within the project area. As such, given the nature and scale of the project, the presence of suitable habitat elsewhere within the locality, and provided the mitigation measures are adopted, the loss of some small areas of potential suitable foraging habitat within the Locality is considered unlikely to have long-term negative consequences for the species' local occurrences.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery or threat abatement plans for the Emu, however OEH have identified 20 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Protect areas of known habitat from clearing or development.
- Increase road signage and reduce speed limits in areas where emus routinely cross roads.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Emu population is threatened by further loss and fragmentation of habitat for suburban and rural development, inappropriate fire regimes, deliberate killing, predation of eggs and young by pigs, dogs and foxes, road kill and altered population dynamics (OEH, 2013). The project may result in an increase to the following key threatening processes, which are considered relevant to this species included within the assessment:

- Clearing of native vegetation.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.

-
- Invasion of plant communities by exotic perennial grasses.
 - Predation by the European red fox (*Vulpes vulpes*).
 - Removal of dead wood and dead trees.

Conclusion

The project is considered unlikely to have an adverse impact on the Emu population in the New South Wales North Coast Bioregion and Port Stephens LGA , due to the scope and nature of the project and sporadic records of this species from the project area.

Birds of prey: Osprey (*Pandion haliaetus*), Square-tailed Kite (*Lophoictinia isura*)

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The **Osprey** (Vulnerable, TSC Act) favours coastal areas, especially the mouths of large rivers, lagoons and lakes. The species feeds on fish over clear, open water. They breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea (NSW OEH, 2013). The Osprey has been recorded on 61 occasions within 10 km of the project area including within the project area. No nesting sites occur within the project area. This species is likely to hunt along the Clarence River.

The **Square-tailed Kite** (Vulnerable, TSC Act) is found in a variety of timbered habitats including dry woodlands and open forests. They show a particular preference for timbered watercourses. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs. The Square-tailed Kite has been recorded on 104 occasions within 10 km of the project area including within the project area. No nesting sites occur within the project area. This species is considered likely to hunt along the Clarence River.

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

Given the scale and nature of the project, it is considered unlikely that the availability of potential habitat within the region would be impacted by the project. Furthermore, it is considered unlikely that the project would result in the life cycle of the species being altered such that a viable local population of the species is likely to be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation types which provide habitat for Birds of Prey within the project area are continuous and of similar quality in the Locality. The project would remove potential roosting habitat in the form of roadside vegetation and paddock trees, and foraging habitat in the form of open paddocks and grasslands. Whilst this project would increase the distance between patches of vegetation lying north and south of the existing bridge crossing, it is unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

The potential habitat to be removed by the project is not considered to be important habitat for the long-term survival of the Osprey, or Square-tailed kite within the Locality as it does not provide suitable breeding resources for these species.

The vegetation to be removed does provide potential foraging resources for this species, however as the Osprey mostly eats fish (Debus, 2012), it is considered unlikely to rely solely on potential foraging habitat within the project area. The Square-tailed Kite hunts in the tree canopy, however is unlikely to rely largely on foraging habitat within the project area due to the highly urbanised nature of this area and general lack of tree canopy. As such, given the nature and scale of the project, the presence of suitable habitat elsewhere within the locality, and provided the mitigation measures are adopted, the loss of some small areas of potential suitable foraging habitat within the locality is considered unlikely to have long-term negative consequences for the species' local occurrences.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH or DPI within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery or threat abatement plans for the Osprey, however OEH have identified 9 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Protect nest sites (usually large dead trees) and surrounding vegetation using appropriate buffer zones (suggest 100 m). Preservation of the existing nest and structure is a priority and relocation should only be considered a last resort.
- Identify and protect regular feeding areas, perch (feeding) trees and nest material collection sites, particularly vegetation surrounding nest tree.

- Consider direct and indirect impacts on the species and its habitat in planning processes including adequate field survey to identify nest tree, buffer protection zone, perch trees and feeding areas. Nesting season is from June to October.

There is currently no recovery or threat abatement plans for the Square-tailed Kite, however OEH is currently developing a targeted approach for managing this species. In the interim, the following management actions have been identified for this species, which are considered relevant to the project, including:

- Ensure implementation of management strategies that reduce disturbance of riparian areas.
- Identify and protect nest trees, and monitor reproduction.

The project is not considered to be inconsistent with the achievement of the above listed priority actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to all species included within this assessment:

- Clearing of native vegetation.
- Entanglement or ingestion of anthropogenic debris in marine and estuarine environments.
- Removal of dead wood and dead trees.

Conclusion

The project has the potential to have an adverse impact on the Osprey and Square-tailed Kite, although due to the scope and nature of the project it is considered unlikely. However, a number of measures have been recommended in Section 6 of this Report, which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

References

- Biosis (2011) Main Road 83 Summerland Way- Additional Crossing of the Clarence River at Grafton: Preliminary Route Options Report. Technical Paper: Ecology. Report to Arup on behalf of the Roads and Maritime Services – Northern Regional Office
- Biosis (2013) Field surveys conducted as part of the Grafton Highway Upgrade Flora and Fauna Assessment. October, 2013. Biosis Pty Ltd
- Debus, S (2012) Birds of Prey of Australia: A field guide – Second Edition. CSIRO Publishing
- NSW OEH (2013a) Threatened species profiles. NSW Office of Environment and Heritage. Accessed online 5/11/2013 - <http://www.environment.nsw.gov.au/threatenedspecies/index.htm>
- NSW OEH (2013b) List of key threatening processes. NSW Office of Environment and Heritage. Accessed online 5/11/2013 - <http://www.environment.nsw.gov.au/threatenedspecies/KeyThreateningProcessesByDoctype.htm>

Forest Owls: Masked Owl (*Tyto novaehollandiae*)

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Masked Owl (Vulnerable, TSC Act) may be found across a diverse range of wooded habitats that provide tall or dense mature trees with hollows suitable for nesting and roosting. It has mostly been recorded in open forests and woodlands adjacent to cleared lands. They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. The nest hollows are usually located within dense forests or woodlands. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. It has a large home range of between 500 - 1000 ha (OEH, 2013). Pellets were collected from a potential nest tree in close proximity to the project area (Biosis, 2010). As such, the project area is considered likely to form part of the hunting territory for the Masked Owl.

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

Given the scale and nature of the project, it is considered unlikely that the availability of potential habitat within the region would be impacted by the project. Furthermore, it is considered unlikely that the project would result in the life cycle of the Masked Owl being altered such that a viable local population of the species is likely to be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation types which provide habitat for large Forest Owls within the project area are continuous and of similar quality in the Locality. The project would remove potential roosting habitat in the form of roadside vegetation and paddock trees, and foraging habitat in the form of open paddocks and grasslands. Whilst the project would increase the distance between patches of vegetation occurring north and south of the existing bridge crossing, it is unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

Resident pairs of Masked Owls can have several roosting sites, used regularly for months at a time (Debus, 2009). Although a nest tree was found in close proximity to the project area (Biosis, 2012), the potential habitat to be removed by the project does not include this nest tree or other hollow-bearing trees likely to be used by large Forest Owls. As such, the land to be disturbed by the project is not considered to be important habitat for the long-term survival of the Masked Owl within the Locality as it does not provide suitable breeding resources for the species.

The vegetation to be removed does provide potential foraging resources for this species, however as the species has a large home range, which is in the magnitude of several hundred ha (Gibbons and Lindenmayer, 1997), it is considered unlikely to rely solely on potential foraging habitat within the project area. As such, given the nature and scale of the project, the presence of suitable habitat elsewhere within the locality, and provided the mitigation measures are adopted, the loss of some small areas of potential suitable foraging habitat within the Locality is considered unlikely to have long-term negative consequences for the species' local occurrences.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

A formal approved NSW Recovery Plan exists for the Large Forest Owls (NSW DEC, 2006) which identifies a number of actions that need to be undertaken in order to ensure their long-term conservation. These are summarised by OEH, which have identified 24 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Prepare environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess impacts of developments on the Masked Owl.
- Prepare environmental impact assessment guidelines to assist consent and determining authorities and environmental consultants to assess impacts of developments on the large forest owls.

Whilst the project would not result in the achievement of either of the above listed priority actions, the project is not considered to be inconsistent with the broader achievement of these priority actions.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to the Masked Owl:

- Bush rock removal.
- Clearing of native vegetation.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Loss of hollow-bearing trees.
- Removal of dead wood and dead trees.

Conclusion

The project has the potential to have an adverse impact on the Masked Owl, although due to the scope and nature of the project it is considered unlikely. However, a number of measures have been recommended in Section 6 of this Report, which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

References

- Biosis (2011) Main Road 83 Summerland Way- Additional Crossing of the Clarence River at Grafton: Preliminary Route Options Report. Technical Paper: Ecology. Report to Arup on behalf of the Roads and Maritime Services – Northern Regional Office
- Debus, S (2009) The Owls of Australia: A field guide to Australian Night Birds. Envirobook, Australia.
- Gibbons, P. and Lindenmayer, D. B. (1997) Conserving Hollow-dependent Fauna in Timber-production Forests, Environmental Series Monograph Series No. 3, NSW National Parks and Wildlife Service, Sydney.
- NSW DEC (2006) NSW Recovery Plan for the Large Forest Owls. NSW Department of Environment and Conservation. Accessed online 5/11/2013 - <http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&cad=rja&ved=0CC8QFjAB&url=http%3A%2F%2Fwww.environment.nsw.gov.au%2Fresources%2Fnature%2FTRSRecoveryPlanForestOwls.pdf&ei=TzJ4UoeNAYeZiQe-rICgDA&usg=AFQjCNGHVzRuKIU07Zjzu00-mqGafymTwQ>
- NSW OEH (2013a) Threatened species profiles. NSW Office of Environment and Heritage. Accessed online 5/11/2013 - <http://www.environment.nsw.gov.au/threatenedspecies/index.htm>
- NSW OEH (2013b) List of key threatening processes. NSW Office of Environment and Heritage. Accessed online 5/11/2013 - <http://www.environment.nsw.gov.au/threatenedspecies/KeyThreateningProcessesByDoctype.htm>

Flying foxes: Grey-headed Flying-fox (*Pteropus poliocephalus*)

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Grey-headed Flying-fox (Vulnerable, TSC Act; Vulnerable, EPBC Act) is found in a variety of habitats, including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas (Churchill, 1998). The species is a canopy-feeding frugivore and nectarivore. Their major food source is Myrtaceae blossom (mostly eucalypt) and fruits such as native figs (*Ficus* spp.) and cultivated fruit orchards (Churchill 1998). Bats commute daily to foraging areas, usually within 15 km of the day roost (Strahan, 1995), although some individuals may travel up to 70 km. The species was recorded during field surveys foraging within and surrounding the project area (Biosis 2010; 2013). A resident camp site (breeding habitat) is known to occur on Susan Island only 1 km west of the project area. This large camp has records of between 80-7000 individuals (BioNet 2013). Depending on the season, there may be many tens of thousands of flying-foxes on the island, with numbers in summer sometimes exceeding 100 000 (NSW NPWS, 2009). Given the distribution of records of the species within 10 km, individuals from the Susan Island camp site are considered highly likely to utilise resources within the project area, particularly for foraging on fleshy fruited food trees including *Ficus* sp.

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

The project would result in the removal of five significant habitat trees (*Ficus* sp), and therefore it is considered that the availability of potential foraging habitat within the region would be reduced considerably for this species. However, given the high mobility of the Grey-headed Flying-fox (able to travel up to 70 km from a camp site) and the availability of known and potential habitat in the locality (including alternative significant *Ficus* sp trees occurring throughout the city of Grafton), the loss of up these trees are considered unlikely to the disrupt the feeding behaviour and life cycle of a viable local population of the Grey-headed Flying-fox to place it at risk of extinction within the project area or locality.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation types which provide habitat for the Grey-headed flying-fox within the project area are continuous and of similar quality in the Locality. The project would remove foraging resources in the form of the removal of five mature *Ficus sp* habitat trees. Whilst this project would increase the distance between patches of vegetation lying north and south of the existing bridge crossing, it is unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

However, given the availability of known and potential habitat within the locality, including protected habitat within significant *Ficus sp.* trees throughout the city of Grafton, that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that the proposed bridge crossing would have major negative impacts on the Grey-headed Flying-fox habitat within the locality.

The majority of the project area is covered by urban residential areas and grazed paddocks that contain little native vegetation. Wildlife corridors in the project area, therefore, are limited. The Grey-headed Flying-fox is highly mobile and capable of negotiating disturbed habitats including the existing Clarence River bridge crossing and surrounding farmland. These small areas of proposed vegetation removal are therefore not considered to further fragment or isolate areas of habitat within the project area. The proposed location of the second bridge crossing is approximately parallel to the existing bridge and observations of dusk departure from Susan Island did not observe Flying-foxes moving uniformly across the proposed bridge location area suggesting it is not within a flight corridor for this species. As such, it is considered that the construction of a second Clarence River bridge crossing, and associated road infrastructure upgrades is considered unlikely to be important to the long-term survival of the species in the locality.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

NSW Government have developed a *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009). The plan was developed in 2009 and was proposed for a five year duration (to be revised in 2014). It considers the conservation requirements of the species throughout its range, sets objectives for recovery and identifies actions to be undertaken to reverse decline and ensure long-term viability.

The overall objectives of recovery of Grey-headed Flying-foxes are:

- to reduce the impact of threatening processes; to arrest decline throughout their range;

- to conserve their functional roles in seed dispersal and pollination of native plants; and,
- to improve the comprehensiveness and reliability of information available to guide recovery.

Specific objectives relevant to the five-year duration of the recovery plan aim to identify, protect and enhance key foraging and roosting habitat; to substantially reduce deliberate destruction associated with commercial fruit crops; to reduce negative public attitudes and conflict with humans; and to involve the community in recovery actions where appropriate. Further objectives aim to address the impact on the species of artificial structures such as powerlines, loose netting and barbed wire fences; and to improve knowledge of demographics and population structure (DECCW 2009).

No known roost sites would be removed or disturbed as a result of the project, although five high-value habitat trees consisting potential foraging habitat would be removed. Some fleshy fruit trees are located within the project area, however the habitat to be removed is not considered to be limiting for the species in the locality. Therefore the project remains consistent with the objectives outlined by the recovery plans for these species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to the Grey-headed flying-fox:

- Anthropogenic climate change.
- Bush rock removal.
- Clearing of native vegetation
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Predation by the European red fox (*Vulpes vulpes*)
- Removal of dead wood and dead trees.

Conclusion

The project has the potential to have an adverse impact on the Grey-headed flying-fox due to the removal of five significant feed trees, however due to the scope and nature of the project, and availability of additional foraging resources in the surrounding area, it is considered unlikely. Albeit, a number of measures have been recommended in Chapter 6 of this Report, which aim to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

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Reptiles: Three-toed snake-tooth skink (*Coeranoscincus reticulatus*)

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Three-toed snake-tooth skink (Vulnerable, TSC Act; Vulnerable, EPBC Act) has been found in loose, well mulched friable soil, in and under rotting logs, in forest litter, under fallen hoop pine bark and under decomposing cane mulch. In NSW, the species has been recorded in dry rainforest, northern warm temperate rainforest, subtropical rainforest, grassy wet sclerophyll forest and shrubby sclerophyll forest. Records have been made in logged and unlogged forest. More recent records have shown that this species persists in fragmented habitats, and restored riparian vegetation indicating that the species has some adaptability to modified environments as a result of clearing (DoE SPRAT, 2013).

The species was not recorded during field surveys conducted within the project area (Biosis 2010; 2012), nor in targeted surveys undertaken for this species in early summer (Biosis, 2013b). However, this species has been historically recorded in a number of residential areas in Grafton, with some records from within the proposed project area (BioNet, 2013). Given its cryptic habit, there are no population estimates for the Three-toed snake-tooth skink (DoE SPRAT, 2013).

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

Given the scale and nature of the project, and excavation requirements associated with the proposed works, it is considered that there is some possibility that the availability of potential habitat for the species within the region would be impacted by the project. Furthermore, there is considered to be potential that the project would result in the life cycle of the Three-toed snake-tooth skink being altered such that a viable local population of the species, should it be present, is likely to be placed at risk of extinction. Further follow-up surveys prior to construction in areas not yet surveyed (namely the indicative ancillary site locations where suitable habitat and known historical records of the species exist) will be required to provide further evidence for presence/absence of the species, and therefore, enable the determination of where there is a potential for a significant impacts from the project on the species.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation types which provide habitat for the Three-toed snake-tooth skink within the project area occur on the urban fringe, and are considered to be highly disturbed and degraded. The project would remove potential suitable habitat for this species in the form of the removal of 0.31 ha of Subtropical Coastal Floodplain Forest TEC, in addition to some areas of disturbed pasture and residential areas (houses in which the indicative ancillary sites are to be located) in Grafton where this species has been previously recorded (BioNet, 2013). Furthermore, the project is considered likely to increase the distance between patches of vegetation and potential habitat resources lying north and south of the existing bridge crossing, and if the species was to persist in the project area, it is considered likely that the project would result in the removal, modification, fragmentation or isolation of habitat that would be important to the long-term survival of the species in the locality.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no formal recovery or threat abatement plans for the Three-toed snake-tooth skink, however OEH have identified 11 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Prevent the collection of dead fallen timber for firewood in areas where the species is known to occur.
- Prevent clearing of woodland and forest habitats where the species is known to occur.
- Identify locations supporting key populations and investigate and prioritise site-specific threatening processes.
- Determine site-specific management strategies to protect and enhance key populations.
- Identify sites in key habitats and corridors for vegetation rehabilitation and undertake revegetation to provide links between key populations.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to the Three-toed snake-tooth skink:

- Bush rock removal.
- Clearing of native vegetation.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Removal of dead wood and dead trees.

Conclusion

It has been determined that the project has some likelihood of resulting in a significant impact on the Grafton population of the Three-toed snake-tooth skink. For this reason, targeted surveys were undertaken for this cryptic species at a number of sites in North Grafton and South Grafton, however no individuals were recorded (Biosis, 2013b).

Further targeted survey work for this species is recommended to be undertaken in late Spring/early Summer, in suitable areas, not yet surveyed (ancillary sites, especially in North Grafton where houses are to be demolished) prior to construction works, once residencies within the construction compound have been purchased and land in this area is accessible.

A number of measures have been recommended in Chapter 6 of this Report, which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

Depending on targeted survey outcomes a Species Impact Statement may be required.

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Cave-dependent microbats: Little bentwing-bat (*Miniopterus australis*), Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), Eastern cave bat (*Vespadelus troughtoni*)

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The **Little bentwing-bat** (Vulnerable, TSC Act) occurs from Northern Queensland to the Hawkesbury River near Sydney. Roost sites encompass a range of structures including caves, tunnels and stormwater drains. Young are raised by the females in large maternity colonies in caves in summer. It shows a preference for well timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests. The Little bentwing-bat forages for small insects (such as moths, wasps and ants) beneath the canopy of densely vegetated habitats (NSW OEH, 2013). This species was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The **Eastern bentwing-bat** (Vulnerable, TSC Act) occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred km to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways. This species was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The **Eastern cave bat** (Vulnerable, TSC Act) is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. It roosts in small groups, often in well-lit overhangs and caves, mine tunnels, road culverts, and occasionally in buildings. Foraging habitat is considered to be present within the project area. This species was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

Although, no potential roost sites were originally considered to occur within the project area for any of these species (Biosis, 2010), the finalised proposed strategic design does require a large area of residential housing to be removed and thus there is some potential for these buildings to support cave-dwelling bat roosts. For this reason, the project is considered to have some potential to result in the life cycle of any of these species being altered such that a viable local population of the species is likely to be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation to be removed does provide some degree of potential suitable foraging resources for these species, however it is considered unlikely that any of the cave-dependent microbats listed here would rely solely on potential foraging habitat within the project area. Furthermore, the original Grafton Bridge would not be removed as part of this project, and thus, potential roosting habitat in these structures would be preserved. As such, given the nature and scale of the project, the presence of suitable habitat elsewhere within the locality, and provided the mitigation measures are adopted, the loss of some small areas of potential foraging habitat within the Locality is considered unlikely to have long-term negative consequences for the species' local occurrences.

The vegetation types which provides habitat for Cave-dependent microbats within the project area is considered to be continuous, and of similar quality in the Locality. The project would remove potential foraging habitat in the form of roadside vegetation and paddock trees, and open grasslands for some species. Whilst this project would increase the distance between patches of vegetation lying north and south of the existing bridge crossing, it is unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

These Cave-dependent microbats are known to roost predominately in caves, but have occasionally been found occupying mine tunnels, road culverts, and occasionally in buildings (NSW OEH, 2013). As potential suitable roosting habitat would not be removed by the project, the extent of habitat to be removed is not considered to be important habitat for the long-term survival of any of these Cave-dependent microbats within the Locality as it does not provide suitable breeding resources for the species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive OEH within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery or threat abatement plans for the Little bent-wing bat, however OEH have identified 25 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).

There is currently no recovery or threat abatement plans for the Eastern bent-wing bat, however OEH have identified 25 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).

There is currently no recovery or threat abatement plans for the Eastern cave bat, however OEH have identified 13 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Identify and protect significant roost habitat in artificial structures (e.g. culverts, old buildings and derelict mines).
- Survey areas of potential habitat.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to Cave-dependent microbats:

- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Loss of hollow-bearing trees.
- Clearing of native vegetation.
- Removal of dead wood and dead trees.

Conclusion

The project has the potential to impact upon cave-dependent microbats, due to the extent of housing to be removed and potential for these buildings to support microbat roosts as well as vegetation/hollow bearing tree clearance. However, a number of measures have been recommended in Chapter 6 of this Report which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved. Furthermore, as part of the proposed mitigation measures, a Microbat Management Sub- plan (as part of the FFMP) would be developed. With the implementation of the recommended management measures and the Microbat Management Sub-plan, the project is considered unlikely to result in a significant impact on cave-dependent microbats.

References

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Hollow-dependent microbats: Yellow-bellied sheath-tail-bat (*Saccolaimus flaviventris*), Greater broad-nosed bat (*Scoteanax rueppellii*), Hoary wattled bat (*Chalinolobus nigrogriseus*), Southern myotis (*Myotis macropus*), Eastern long-eared bat (*Nyctophilus bifax*), Eastern freetail-bat (*Mormopterus norfolkensis*).

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The **Yellow-bellied sheath-tail-bat** (Vulnerable, TSC Act) is found throughout NSW. They have been reported from southern Australia between January and June. Reported in a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (NSW OEH, 2013). This species has been recorded on seven occasions previously within 10 km of the project area, with some records occurring within the project area. Roosting habitat for this species is restricted to 5 potential hollow bearing and habitat trees, the *Ficus* sp. and a *Eucalyptus* sp. within the project area (Biosis, 2013).

The **Greater broad-nosed bat** (Vulnerable, TSC Act) occurs along the Great Dividing Range, generally at 500 meters but up to 1200 meters, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 meters or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches (NSW OEH, 2013). This species was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The **Hoary wattled-bat** (Vulnerable, TSC Act) is predominantly a northern species, but occurs in north-eastern NSW to the lower Clarence and Richmond River areas in dry open eucalypt forests, particularly those dominated by Spotted Gum, boxes and ironbarks, and heathy coastal forests where Red Bloodwood and Scribbly Gum are common. Prefers open habitat types, and roosts mainly in tree hollows, but sometimes in rock crevices or buildings (NSW OEH, 2013). Nine records of this species exist within 10 km of the project area, the closest being 5600m away. No stands of forest or woodland occur within the project area to support this species. Habitat is restricted to marginal foraging resources and two possible hollow bearing trees. Even so, this species was recorded during anabat surveys conducted within the project area (Biosis, 2013).

The **Southern myotis** (Vulnerable, TSC Act) is scattered, mainly coastal distribution extending to South Australia along the Murray River. They roost in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (NSW OEH, 2013). This species is likely to forage along the riparian vegetation of the Clarence River and Alipou Creek within the project area (Biosis, 2013). Furthermore, this species was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The **Eastern long-eared bat** (Vulnerable, TSC Act) occurs across northern Australia in habitats ranging from rainforests to riparian woodlands. It frequently roosts communally in foliage and tree hollows and under exfoliated bark. They change roosts seasonally, from rainforest edges in winter to the centre of rainforest patches in summer (NSW OEH, 2013). This species has been recorded once previously

approximately 9500m from the project area. Habitat for this species within the project area is restricted to a small stand of vegetation within South Grafton in proximity to the Clarence River. A *Nyctophilus* sp call was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The distribution of the **Eastern freetail-bat** (Vulnerable, TSC Act) extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few km of roosting sites. This species has been recorded on six occasions previously including within the project area (NSW OEH, 2013). This species may roost beneath exfoliating bark in *Eucalyptus* trees within habitat in South Grafton (Biosis, 2013). Furthermore, this species was recorded during anabat surveys conducted within the project area (Biosis, 2010; 2013).

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

The project would remove potential roosting resources in the form of the removal of seven hollow bearing trees including five mature *Ficus* trees, one hollow-bearing *Eucalyptus* sp, and one hollow-bearing River She-oak. Although the vegetation to be removed contains potential roosting habitat for these species, given the very limited quantity (i.e. seven trees) of potential habitat to be removed, it is considered that the project is unlikely to result in the life cycle of any of these hollow-dependent microbats being altered such that a viable local population of the species is likely to be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

The vegetation to be removed does provide potential suitable roosting and foraging resources for hollow-dependent microbats, however there is some level of uncertainty regarding the extent to which these species would rely solely on roosting habitat within the project area. Consequently, there is considered to be potential for microbat roosts to be present in the hollows identified for the project area, comprising two hollow bearing trees and five habitat trees, and thus the action proposed would remove potential roosting habitat for these species.

The vegetation types which provide habitat for hollow-dependent microbats within the project area are considered to be continuous, and of similar quality in the Locality. The project would remove potential roosting habitat in the form of seven hollow bearing trees, and foraging habitat in the form of roadside vegetation and paddock trees, and open grasslands for some of these species. Whilst this project would increase the distance between patches of vegetation lying north and south of the existing bridge crossing, it is unlikely that the project would further fragment or isolate areas of potential habitat for these species, given their high mobility and the urban nature of the project area.

Hollow-dependent microbats are known to roost predominately in hollows, but have occasionally been found to form roosts in other structures such as under exfoliating bark, in buildings, metal caps of telegraph poles, under bridges and even in dense foliage (NSW OEH, 2013). Whilst potential suitable roosting habitat would be removed by the project, when considered in the context of the similar habitat present in the wider locality, the extent of habitat to be removed is considered unlikely to have the potential to be significant to the long-term survival of hollow-dependent microbats within the Locality.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery or threat abatement plans for the **Yellow-bellied sheath-tail-bat**, however OEH have identified 21 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Ensure the largest hollow bearing trees (including dead trees and paddock trees) are given highest priority for retention in PVP assessments and or other land assessment tools.
- Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes, such as revegetating and installing bat boxes.

There is currently no recovery or threat abatement plans for the **Greater broad-nosed bat**, however OEH have identified 19 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Ensure largest hollow bearing trees, including dead trees and paddock trees are given highest priority for retention in PVP assessments (offsets should include remnants in high productivity) and/or other land assessment tools.
- Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes, such as revegetating riparian zones.
- Identify important foraging range and key habitat components for this species.

There is currently no recovery or threat abatement plans for the **Hoary wattled-bat**, however OEH have identified 20 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Ensure the largest hollow bearing trees are given highest priority for retention when undertaking PVP assessments (offsets should include remnants in old growth forest) or other land assessment tools.
- Identify important foraging range and key habitat components for this species.

There is currently no recovery or threat abatement plans for the **Southern myotis**, however OEH have identified 15 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Ensure the largest hollow bearing trees in riparian zones are given highest priority for retention in PVP assessments or other land clearing assessment tools.
- Survey large inland waterways for this species to determine distribution in Murray Darling Basin.
- Promote roosting habitat in new artificial structures within the species range.
- Better regulate pollution of waterways e.g. sewage and fertilizer run-off (eutrophication) and pesticide/herbicide leakage (chemical pollution) and thermal pollution.
- Encourage recovery of natural hydrological regimes, including retention and rehabilitation of riparian vegetation.

There is currently no recovery or threat abatement plans for the **Eastern long-eared bat**, however OEH have identified 20 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Ensure the largest hollow bearing trees are given highest priority for retention in PVP assessments (offsets should include remnants in high productivity) and other or other land assessment tools.
- Identify important foraging range and key habitat components for this species.
- Determine the viability of populations and extent of use of remnant vegetation and revegetation in areas abutting coastal developments.

There is currently no recovery or threat abatement plans for the **Eastern freetail-bat**, however OEH have identified 18 priority actions to assist with the recovery of this species in NSW. Actions considered to be relevant to the current project include:

- Ensure the largest hollow bearing trees, including dead trees and paddock trees, are given highest priority for retention in PVP assessments. Offsets should include remnants in high productivity.
- Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP, CAPs, PVPs.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes, which are considered relevant to Hollow-dependent microbats:

- Clearing of native vegetation.
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Loss of hollow-bearing trees.
- Removal of dead wood and dead trees.

Conclusion

The project is considered unlikely to have the potential to have a significant impact on these hollow-dependent microbats, due to the limited quantity of potential habitat (i.e. seven hollow bearing trees) to be removed and unconfirmed potential for these habitat resources to support microbat roosts. Nevertheless, a number of measures have been recommended in Chapter 6 of this Report, which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved. Furthermore, as part of the proposed mitigation measures, a Microbat Management Plan would be developed to accompany the FFA.

References

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Fish: Silver Perch (*Bidyanus bidyanus*)

The Silver Perch *Bidyanus bidyanus* is listed as Vulnerable under Schedule 5 of the *Fisheries Management Act 1994* (FM Act) in NSW.

The Silver Perch is a moderately large freshwater fish that is native to the Murray-Darling river system (McDowall 1996). This species generally prefers flowing waters but has been found in a broad range of aquatic habitats including dams (NSW DPI 2005b).

The Silver Perch was once one of the most common large fish in the Murray, Murrumbidgee and Darling/Paroo Rivers drainages systems in the 1970's. Today, although still recorded in many areas of the Murray Darling Basin, the only significant population of Silver Perch is present in the lower Murray River below Yarrawonga (NSW DPI 2005b). It historically inhabited a wide variety of river types from slow turbid rivers to larger upland streams and rivers.

The Silver Perch migrates upstream to spawn, with breeding triggered by a rise in temperature and water levels. Silver Perch have been severely impacted by barriers to fish passage and flow reduction, as they have reduced its ability to migrate and breed successfully. The species is also affected by the EHN Virus carried by exotic fish such as European Perch *Perca fluviatilis* (Langdon 1989).

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Silver perch are found in lowland, turbid and slow-flowing rivers. They prefer fast-flowing, open waters, particularly those containing rapids and races (Allen et al 2002). However, they also inhabit warm, sluggish water with cover provided by large woody debris and reeds.

Silver perch are omnivorous. The diet contains aquatic plants, molluscs, earthworms and green algae, shrimps and aquatic insect larvae. Adults migrate upstream in spring and summer to spawn. Juveniles also sometimes move upstream in response to rising water temperatures and levels.

Individuals mature at 3 to 5 years - males at 3 years (~25cm length) earlier than females at 5 years (~29 centimeters length). They spawn in spring and summer after an upstream migration, when large schools often form. The Silver Perch is known to undertake upstream migrations in spring/summer, prior to spawning, and juveniles are known to move in response to slightly elevated water levels and rising water temperatures (NSW DPI 2005b). This species does not reproduce until the water temperature reaches 23 degrees Celsius (NSW DPI 2005b). Females shed 300,000 or more semi-buoyant eggs that develop into free-feeding stages that drift downstream (Morris et al. 2001; Astles et al. 2003). Whilst spawning can occur during non-flood conditions, spawning activity can significantly increase during floods and/or environmental water releases.

Five records of this species occur within 10 km of the project area. The Silver Perch may utilise slow-flowing location within the project area with woody habitat and aquatic vegetation including backwaters and creeks.

Given the scale and nature of the project, it is considered unlikely that the availability of potential habitat within the region would be impacted by the Project. Furthermore, it is considered unlikely that the Project would result in the life cycle of Silver Perch being altered such that a viable local population of the species is likely to be placed at risk of extinction. However, to minimise impacts on these species it is recommended to apply the mitigation measures specified in this report.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

A number of suitable habitat features including creeks and off-river habitats containing aquatic vegetation and woody debris are found within the project area. However, the adherence to specific mitigation measures should be expected to ensure that disturbances to these areas and therefore to Silver Perch are minimised.

If the recommended mitigation measures are employed then any unavoidable removal of in stream features, such as aquatic vegetation and woody debris, would be carried out in a way to minimise the potential impact on the provision of shelter and foraging habitat. It is recommended that an aquatic ecologist is present when construction works are to be carried out where disturbance to potential suitable habitat may occur.

Furthermore, given that the footprint of the proposed works is located within the main river channel and Silver Perch have the potential to occupy the suitable habitat in the creeks within the project area including the Carrs Creek, Alipou Creek and Cowan Creek it is expected that Silver Perch would not be directly affected by the proposed works. It is therefore considered unlikely that the proposed works would affect any significant habitat area of the species such that populations of the species become fragmented or isolated.

While there is some potential that there would be some disturbance within the main river channel, this disturbance would be temporary. There is some potential for temporary fragmentation of the suitable habitat but this is not expected to affect Silver Perch on the long-term. This is further likely prevented the migratory nature of the species, which enables the species to naturally spread across large areas of a catchment and utilise suitable habitat as and when available and/or required.

Given the nature and scale of the proposed works, the presence of suitable habitat within the creeks within the project area, and provided the mitigation measures are adopted, the potential changes in the prevalent habitat are expected to be temporary and are therefore considered not to affect the long-term survival of the species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH or DPI within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

The draft recovery plan for Silver Perch has been released (NSW DPI 2005). The proposed development within Clarence River is consistent with the plan and objective of the program. Particularly relevant actions are:

- Ensure that management authorities carry out appropriate planning and impact assessment and make management decisions which minimise impacts on Silver Perch habitats; and,
- Encourage protection and rehabilitation of river reaches known to support important Silver Perch populations

The mitigation measures recommended in this report are designed to protect the aquatic habitats within the project area as well as habitats downstream, including Silver Perch habitat.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes (FM Act), which are considered relevant to Silver Perch:

- Degradation of native riparian vegetation along New South Wales watercourses.
- Installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams.
- Removal of large woody debris from New South Wales rivers and streams.

Conclusion

The project has the potential to have an adverse impact on the Olive Perchlet, which is listed under the FM Act. However, due to the scope and nature of the project it is considered unlikely to facilitate a significant impact on the species. To mitigate potential impacts on the species, a number of measures have been recommended in Section 6 of this report. These aim to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained and/or improved.

Purple-spotted Gudgeon (*Mogurnda adspersa*)

The Purple-spotted Gudgeon *Mogurnda adspersa* is listed as Endangered under Schedule 5 of the *Fisheries Management Act 1994* (FM Act) in NSW.

Purple-spotted Gudgeon are found in slow moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks and snags (NSW DPI 2013). They feed mainly on insect larvae, but also consume worms, tadpoles, small fish and some plant matter (NSW DPI 2013).

Two populations occur in NSW, the eastern and the western population. The eastern population of the Purple-spotted Gudgeon occurs north of the Clarence River catchment in the coastal drainage of NSW (NSW DPI 2013). The western population was once widespread throughout the Murray-Darling system, but its distribution is now very limited and has significantly declined in recent years.

The general causes of the decline in Purple-spotted Gudgeon may include predation by introduced fish species, habitat loss, and rapid fluctuations in water levels (due to water regulation) that have deleterious effects on successful reproduction and recruitment (NSW DPI 2013).

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Purple-spotted gudgeon inhabit slow-flowing or still waters and among weed (Hoeser et al. 1980). They occur in rivers, creeks and billabongs, usually over rocks or among vegetation (Allen et al. 2002). They feed on worms, dragonfly larvae, midge and mosquito larvae, crustaceans and mosquito fishes (Hoeser et al. 1980). With the species being sexually dimorphic, females mature at a body size of approximately 4.9 centimeters and males at about 4.5 centimeters. Spawning takes place in rivers and ponds at 19 to 34°C between December and February, and preferably during the rainy season between November and March. Females produce successive batches of 280 to 1,300 demersal eggs which are deposited on solid surfaces such as rocks, logs, or other solid debris and often close to vegetation (Lake 1978). Males guard and fan the eggs until hatching, which takes about 3 to 9 days depending on temperature (Allen et al. 2002). Purple-spotted Gudgeon are preyed upon by European Perch *Perca fluviatilis* and competes with mosquito fish *Gambusia* sp. (Arthington et al. 1983).

NSW DPI Fisheries have confirmed recent records of this species within 10 km of the project area (G. Butler, pers. comm.). The Purple-spotted Gudgeon may utilise areas with woody habitat, rocks and aquatic vegetation in areas with little or no flow, particularly backwaters along the Clarence River. Suitable habitat is available within the project area (Biosis 2010).

Given the scale and nature of the proposed works, it is considered unlikely that the availability of potential habitat within the project area would be impacted by the Project. Furthermore, it is considered unlikely that the Project would result in the life cycle of the species being altered such that a viable local population of the species is likely to be placed at risk of extinction. However, to minimise impacts on these species it is recommended to apply the mitigation measures specified in this report.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable, this factor refers to endangered populations listed in Part 2 of Schedule 1 of the TSC Act and Part 2 of Schedule 4 of the FM Act.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

Not applicable, this factor relates to endangered ecological communities listed under Part 3 of Schedule 1 of the TSC Act and Part 3 of Schedule 4 of the FM Act and the critically endangered communities listed under Part 2 of Schedule 1A of the TSC Act and Part 2 of Schedule 4A of the FM Act.

In relation to the habitat of a threatened species, population or ecological community:

The extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the project, and

The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

A number of suitable habitat features including creeks and off-river habitats containing aquatic vegetation and woody debris are found within the project area. However, the adherence to specific mitigation measures should be expected to ensure that disturbances to these areas and therefore to Purple-spotted Gudgeon are minimised.

If the recommended mitigation measures are employed then any unavoidable removal of in stream features, such as aquatic vegetation and woody debris, would be carried out in a way to minimise the potential impact on the provision of shelter and foraging habitat. The removal of solid substrates such as woody debris and/or rocks would affect the availability of spawning substrates for the species and should be avoided. It is recommended that an aquatic ecologist is present when construction works are to be carried out where disturbance to potential suitable habitat may occur.

Furthermore, given that the footprint of the proposed works is located within the main river channel and Purple-spotted Gudgeon have the potential to occupy the suitable habitat in the creeks within the project area including the off-river habitats up and downstream of the proposed works, it is expected that the species would not be directly affected by the proposed works. It is therefore considered unlikely that the proposed works would affect any significant habitat area of the species such that populations of the species become fragmented or isolated.

While there is potential that there would be some disturbance within the main river channel, this disturbance would be temporary. There is some potential for temporary fragmentation of the suitable habitat but this is not expected to affect Purple-spotted Gudgeon on the long-term.

Given the nature and scale of the proposed works, the presence of suitable habitat within the creeks within the project area, and provided the mitigation measures are adopted, the potential changes in the prevalent habitat are expected to be temporary and are therefore considered not to affect the long-term survival of the species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH or DPI within the project area.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no recovery plan for the Purple-spotted gudgeon, however, a number of actions have been developed by NSW DPI as part of the Priority Recovery Strategy for this species and these include:

- Conduct intensive surveys in areas identified as supporting or potentially supporting Purple-spotted Gudgeons, and map the species distribution and habitat associations.
- Establish and commence a long-term monitoring program for Purple-spotted Gudgeons to assess their conservation status and the success of recovery actions.
- Investigate the feasibility of implementing a conservation stocking program for Purple-spotted Gudgeons using genetically appropriate broodstock and in compliance with the Hatchery Quality Assurance Program and the NSW Freshwater Fish Stocking Fishery Management Strategy.
- Prepare and implement a recovery plan for Purple-spotted Gudgeons.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The project may result in an increase to the following key threatening processes (FM Act), which are considered relevant to Purple-spotted Gudgeon:

- Degradation of native riparian vegetation along New South Wales watercourses.
- Installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams.
- Removal of large woody debris from New South Wales rivers and streams.

Conclusion

The project has the potential to have an adverse impact on the Purple-spotted Gudgeon, which is listed under the FM Act. However, due to the scope and nature of the project it is considered unlikely to facilitate a significant impact on the species. To mitigate potential impacts on the species, a number of measures have been recommended in Section 6. These aim to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained and/or improved.

Appendix 4: Significant Impact Criteria assessments

Hairy-joint Grass (*Arthraxon hispidus*)

Hairy-joint Grass (Vulnerable, TSC Act; Vulnerable, EPBC Act) is a creeping grass with branching, erect to semi-erect purplish stems (OEH, 2013). Leaf-blades are 2–6 centimeters long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. The grass was once thought of as an annual however it is now thought to be a perennial that tends to die down in winter. Habitat for Hairy-joint Grass is thought to include the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.

Is there a real chance or possibility that the action will lead to a long-term decrease in the size of an important population of a species

Within the project area, habitat for Hairy-joint Grass was limited to wet areas, predominantly along the banks of the Clarence River and within wet depressions and ephemeral drainage lines. Areas of potential habitat include the Freshwater Wetland TEC mapped to the east of the existing bridge alignment, on both the northern and southern river banks. No Hairy-joint Grass was recorded within the project area however the wet soaks and ephemeral drainage lines may be considered marginal potential habitat for the species.

There is no real chance or a possibility that the action would lead to a long-term decrease in the size of an important population of Hairy-joint Grass as the project area is not considered to contain an 'important population' of the species.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?

There is no real chance or a possibility that the project would reduce the area of occupancy of an important population of Hairy-joint Grass as the project area is not considered to contain an 'important population' of the species.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

There is no real chance or a possibility that the action would fragment an existing important population into two or more populations of Hairy-joint Grass as the project area is not considered to contain an 'important population' of the species.

With regard to fragmentation of habitat for the species, historical disturbance regimes including residential and urban development, grazing and the construction of the levee have contributed to the increase in fragmentation and isolation of habitat for Hairy-joint Grass. Potential habitat within the project area is considered marginal based on the rainforest edge or wet eucalypt forest habitat preferences and it is restricted to the FWCF TEC mapped to the east of the existing bridge alignment. The project is therefore considered unlikely to significantly isolate or fragment habitat for the species.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

To date, no habitat for Hairy-joint Grass is listed on the Register of Critical Habitat. Habitat within the project area was limited to FWCF TEC on the northern and southern bank, to the east of the existing bridge alignment, as well as damp depressions. This habitat was found to be marginal based on the patch size and disturbed nature of the FWCF TEC and is not considered critical to the survival of the species.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

Little information on the pollination and seed dispersal mechanisms of the species is available however given the scabrid nature of the glume and length of the awn it is anticipated that it is likely to be distributed by wind, water and potentially animals. There is no real chance or a possibility that the action would disrupt the breeding cycle of an important since the project is unlikely to significantly reduce the dispersal mechanisms of the species and the project area is not considered to contain an 'important population' of the species.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

No Hairy-joint Grass was recorded within the project area, however the wet soaks and areas mapped as FWCF TEC do provide marginal potential habitat for the species. The area of marginal potential habitat within the project area is approximately 0.10 ha, however this is considered to be conservative and the actual extent of direct impacts is likely to be far less. Within the likely area of direct impacts (project area), the habitat with greatest potential was identified as the banks of the Clarence River immediately under the proposed alignment. The set back of the piers and ramps for the proposed bridge are anticipated to minimise the direct impacts of the project on habitat for Hairy-joint Grass such as vegetation removal and piling. Indirect impacts of the project would include increased shading under the bridge and potential increased recruitment of exotic grasses. Given the species is shade tolerant, and provided hygiene protocols are adhered to, it is unlikely that the extent of potential habitat for the species would be significantly reduced.

The habitat for Hairy-joint Grass is considered to be marginal given the lack of rainforest edge or wet eucalypt forest habitat. Based on this, the potential habitat identified within the project area is considered to be of low regional importance for the species.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Diseases which may impact Hairy-joint Grass include the introduction of Root Rot Fungus (*Phytophthora cinnamomi*) and other plant pathogens. Although *Phytophthora* was not identified within the project area, the eastern seaboard of NSW is considered the Area of greatest impact and there is a confirmed site located between Grafton and Tenterfield. Recommendations regarding hygiene protocols would minimise the risk of spread or introduction of *Phytophthora* within the project area.

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

The OEH lists 10 priority actions and five activities to assist this species, including:

- Protect habitat from frequent fire.
- Avoid slashing or mowing around rainforest edges.
- Fence habitat remnants to protect from stock.
- Control introduced grasses in areas with known populations.
- Protect areas of rainforest, wet eucalypt forest and swamp from clearing and development.

The proposed development is not in conflict with these activities.

Conclusion

The significant impact criteria assessment concludes that the project is unlikely to have a significant impact on an important population of Hairy-joint Grass due to the species not being recorded during the site visit and the marginal potential habitat that is present within the project area.

Flying foxes: Grey-headed Flying-fox (*Pteropus poliocephalus*)

Is there a real chance or possibility that the action will lead to a long-term decrease in the size of an important population of a species

The Grey-headed Flying-fox (Vulnerable, TSC Act; Vulnerable, EPBC Act) is found in a variety of habitats, including rainforest, mangroves, paperbark swamps, wet and dry sclerophyll forests and cultivated areas (Churchill, 1998). The species is a canopy-feeding frugivore and nectarivore. Their major food source is Myrtaceae blossom (mostly eucalypt) and fruits such as native figs (*Ficus* spp.) and cultivated fruit orchards (Churchill 1998). Bats commute daily to foraging areas, usually within 15 km of the day roost (Strahan, 1995), although some individuals may travel up to 70 km. The species was recorded during field surveys foraging within and surrounding the project area (Biosis 2010; 2013). A resident camp site (breeding habitat) is known to occur on Susan Island only 1 km west of the project area. This large camp has records of between 80-7000 individuals (BioNet 2013). Depending on the season, there may be many tens of thousands of flying-foxes on the island, with numbers in summer sometimes exceeding 100 000 (NSW NPWS, 2009). Given the distribution of records of the species within 10 km, individuals from the Susan Island camp site are considered highly likely to utilise resources within the project area, particularly for foraging on fleshy fruited food trees including *Ficus* sp.

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

The project would result in the removal of 5 significant feed trees (*Ficus* sp), and therefore it is considered that the availability of potential foraging habitat within the region would be reduced considerably for this species. However, given the high mobility of the Grey-headed Flying-fox (able to travel up to 70 km from a camp site) and the availability of known and potential habitat in the locality (including alternative significant *Ficus* sp trees occurring throughout the city of Grafton), the loss of up these trees are considered unlikely to lead to a long-term decrease in the size of an important population of the species.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?

The majority of the project area is covered by urban residential areas and grazed paddocks that contain little native vegetation. Wildlife corridors in the project area, therefore, are limited. The Grey-headed Flying-fox is highly mobile and capable of negotiating disturbed habitats including the existing Clarence River bridge crossing and surrounding farmland. The small areas of proposed vegetation removal is therefore not considered to fragment or isolate areas of habitat within the project area. The proposed location of the second bridge crossing is approximately parallel to the existing bridge and observations of dusk departure from Susan Island did not observe Flying-foxes moving uniformly across the proposed bridge location area suggesting it is not within a flight corridor for this species.

The project involves construction works associated with the Grafton highway upgrade inclusive of the bridge crossing at the Clarence River, in Grafton. There is unlikely to be any possibility of the action reducing the area of occupancy of an important population of this species.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

The project is considered likely to increase the distance between patches of vegetation lying north and south of the existing bridge crossing, however, it is considered unlikely that the project would fragment an existing important population of the species into two or more populations as a result, given the species' high mobility and urban nature of the project area.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The vegetation types which provide habitat for the Grey-headed flying-fox within the project area are continuous and of similar quality in the Locality. The project would remove favourable foraging resources for this species in the form of the removal of 5 mature *Ficus sp* trees and approximately 0.12 ha non-limiting planted vegetation habitat. However, due to the availability of similar quality foraging resources in the surrounding area, there is not considered to be a real chance or a possibility that the action would adversely affect habitat critical to the survival of the Grey-headed Flying-fox as the project area is not considered to contain critical habitat for the species.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

The project area does not contain breeding or roosting habitat for the Grey-headed Flying-fox. The closest known camp is located 1.5 km to the south along Bomaderry Creek, which generally supports a camp of between 80-7000 individuals (BioNet, 2013). Given the distribution of records of the species within 10 km, individuals from the Bomaderry Creek camp site are likely to utilise resources within the project area on occasion, however these habitats are not considered to be limiting in the locality.

Therefore, there is not considered to be a real chance or a possibility that the action would disrupt the breeding cycle of an important population of Grey-headed Flying-fox as the project area is not considered to contain an 'important population' of the species.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The majority of the project area is covered by cleared areas and grazed paddocks that contain little native vegetation. Approximately 9.35 ha of non-limiting woodland/forest and planted vegetation habitat would be removed from the project area as a result of the project. The Clarence Valley LGA has 75.1% of native vegetation remaining intact, with an effective habitat area of 6, 285 ha (Clarence Valley Council SOE, 2012). This equates to only 0.15% of the potential habitat (e.g. eucalypt and riparian forest, rainforest, mangroves and paperbark swamps) available within the Clarence Valley locality.

Given the availability of known and potential habitat within the locality, and, that no breeding habitat would be impacted, it is considered unlikely that the project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

It is likely that invasive species including the red fox (*Vulpes vulpes*), domestic dog (*Canis lupus familiaris*) and cats (*Felis catus*) are already present within the locality; however it is unlikely that these ground-dwelling species are having an effect on Grey-headed Flying-fox's foraging within the project area. Therefore, it is considered that the project would be unlikely to increase their extent or abundance or introduce additional invasive species within the project area that are harmful to Grey-headed Flying-fox.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Australian flying-foxes, including the Grey-headed Flying-fox have been identified as natural reservoirs of three zoonotic diseases being Australian bat lyssavirus, Hendra virus and Menangle virus (DECCW 2009).

Australian bat lyssavirus is a fatal disease that is transmitted to humans through bites or scratches when the saliva of infected bats comes into contact with an open wound (Anon 1996). There is no evidence that the two paramyxoviruses can be transmitted directly from bats to humans, although each has been transmitted to humans by domestic animals (horses and pigs) (DECCW 2009).

Consequently, it is not considered likely that the project would further introduce disease that may cause the species to decline.

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

NSW Government has developed a *Draft National Recovery Plan for the Grey-headed Flying-fox* (DECCW 2009). The overall objectives of recovery of Grey-headed Flying-foxes are:

- to reduce the impact of threatening processes; to arrest decline throughout their range;
- to conserve their functional roles in seed dispersal and pollination of native plants; and,
- to improve the comprehensiveness and reliability of information available to guide recovery.

Conclusion

The significant impact criteria assessment concludes that the project has the potential to have an adverse impact on the Grey-headed flying-fox due to the removal of five significant feed trees, however due to the scope and nature of the project, and availability of additional foraging resources in the surrounding area, it is considered unlikely. Albeit, a number of measures have been recommended in Section 6 of this Report, which aim to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

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Reptiles: Three-toed Snake-tooth Skink (*Coeranoscincus reticulatus*)

Is there a real chance or possibility that the action will lead to a long-term decrease in the size of an important population of a species

The Three-toed snake-tooth skink (Vulnerable, TSC Act; Vulnerable, EPBC Act) has been found in loose, well mulched friable soil, in and under rotting logs, in forest litter, under fallen hoop pine bark and under decomposing cane mulch. In NSW, the species has been recorded in dry rainforest, northern warm temperate rainforest, subtropical rainforest, grassy wet sclerophyll forest and shrubby sclerophyll forest. Records have been made in logged and unlogged forest. More recent records have shown that this species persists in fragmented habitats, and restored riparian vegetation indicating that the species has some adaptability to modified environments as a result of clearing (DoE SPRAT, 2013).

The species was not recorded during field surveys conducted within the project area (Biosis 2010; 2012). However, this species has been historically recorded in Grafton, with some records from within the proposed project area (BioNet, 2013). Given its cryptic habit, there are no population estimates for the Three-toed snake-tooth skink (DoE SPRAT, 2013).

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks.

The project would result in disturbance to, and removal of potential suitable habitat for this species, and therefore it is considered that the availability of potential habitat within the region would be reduced for this species. Furthermore, given the species low mobility and small home-range, the loss of this habitat is considered to have the potential to lead to a long-term decrease in the size of an known important population of the species.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?

The majority of the project area is covered by urban residential areas and grazed paddocks that contain little native vegetation. Wildlife corridors in the project area, therefore, are considered to be limited. The species has however, been historically recorded within residential areas in and around the project area, in particular within the proposed construction compounds of the north bank of the Clarence River, in Grafton. The extent of occurrence of the Three-toed snake-tooth skink has been estimated at 20,000 km² (7000 km² in NSW and 13,000 km² in Queensland), although this estimate excludes outlying records and areas of disjuncture (DoE SPRAT, 2013). Furthermore, this species is only known from seven areas within the Northern Rivers Catchment Region in NSW, suggesting that an area of occupancy of any sub-population of this species in the state is of considerable importance to the species.

The proposed location of the second bridge crossing is approximately parallel to the existing bridge and historical records of the Three-toed snake-tooth skink from within the project area suggest that if the species was found to persist in the area, that there is the potential for the action to reduce the area of occupancy of a known important population of this species.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

The project is considered likely to increase the distance between patches of vegetation and potential habitat resources lying north and south of the existing bridge crossing, and if the species was found to be present in the project area, it is considered likely that the project would fragment an existing important population of the species into two or more populations as a result.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

The vegetation types which provide habitat for the Three-toed snake-tooth skink within the project area occur on the urban fringe, and are considered to be highly disturbed and degraded as a result. The project would remove potential suitable habitat for this species in the form of the removal of 0.31 ha of Subtropical coastal floodplain forest TEC, in addition to some areas of disturbed pasture and residential areas in Grafton where this species has been previously recorded (BioNet, 2013). However, there is not considered to be a real chance or a possibility that the action would adversely affect habitat critical to the survival of the Three-toed snake-tooth skink unless the project area (areas not yet surveyed) are found to support the species.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

It is unknown whether the project area contains breeding habitat for the Three-toed snake-tooth skink. Given the distribution of Grafton records of the species, individuals in this area are considered likely to utilise resources within the project area on occasion, and these habitats are considered to be limiting in the locality. Furthermore, based on previous records of occurrence for this species, there is considered to be some potential for areas of privately owned land in the north of Grafton, where the proposed construction compounds are situated, to support this species. For these reasons, there is considered to be potential for the action to disrupt the breeding cycle of an important population of this species.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The majority of the project area is covered by cleared areas and grazed paddocks that contain little native vegetation. Furthermore, the project area is considered to be highly disturbed and degraded. Regardless of the nature of the project area, there is still considered to be some potential for the Three-toed snake-tooth skink to persist in this area. The project would result in significant disturbance to, and removal of potential suitable habitat for this species, and for this reason there is considered to be a real possibility that the action could modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

It is likely that invasive species including the red fox (*Vulpes vulpes*), domestic dog (*Canis lupus familiaris*) and cat (*Felis catus*) are already present within the locality. However it is considered unlikely that the project would increase their extent or abundance or introduce additional invasive species within the project area that are harmful to the Three-toed snake-tooth skink.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

No known disease is known to affect the Three-toed snake-tooth skink, and therefore the project is considered highly unlikely to introduce a disease that may cause the species to decline.

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

An Approved Conservation Advice has been developed for Three-toed snake-tooth skink (TSSC, 2008). The regional and local priority recovery and threat abatement actions that are considered to be relevant to the project, include:

- Manage threats to areas of vegetation that contain populations/ occurrences of the Three-toed Snake-tooth Skink.
- Ensure development activities in areas where the Three-toed snake-tooth skink occurs do not adversely affect known populations.
- Prevent clearing of woodland and forest habitats where the species is known to occur.
- Minimize adverse impacts from land use at known sites.

Conclusion

It has been determined that the project has some likelihood of resulting in a significant impact on the Grafton population of the Three-toed snake-tooth skink. For this reason, targeted surveys were undertaken for this cryptic species at a number of sites in North Grafton and South Grafton, however no individuals were recorded (Biosis, 2013b).

Further targeted survey work for this species is recommended to be undertaken in late Spring/early Summer, in suitable areas, not yet surveyed (ancillary sites, especially in North Grafton where houses are to be demolished) prior to construction works, once residences within the construction compound have been purchased and land in this area is accessible.

A number of measures have been recommended in Chapter 6 of this Report, which aims to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

Depending on targeted survey outcomes a EPBC referral may be required.

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Silver Perch - *Bidyanus bidyanus*

Is there a real chance or possibility that the action will lead to a long-term decrease in the size of a population of a species?

Silver Perch *Bidyanus bidyanus* (Vulnerable, FM Act; Critically Endangered, EPBC Act) were once widespread and abundant throughout most of this area, except for cooler high altitude streams. However, they have now declined to low numbers or disappeared from most of their former range. The species are found in lowland, turbid and slow-flowing rivers. They prefer fast-flowing, open waters, particularly those containing rapids and races (Allen et al 2002). However, they also inhabit warm, sluggish water with cover provided by large woody debris and reeds. Adults migrate upstream in spring and summer to spawn. Juveniles also sometimes move upstream in response to rising water temperatures and levels (DPI, 2005).

The known distribution of the species occurs > 100 km west of Grafton, however there is a stocked population at Grafton hatchery (NSW DPI, 2005; 2006). No Silver Perch were observed during field surveys conducted throughout the proposed project area (Biosis, 2010). However, it should be noted that the species has been recorded in water bodies connected to the Clarence River, and due to the species ability to make long distance movements, there is considered to be some possibility of occurrence within the Clarence River project area.

The only known significant natural population of Silver Perch in NSW occurs in the Murray River, parallel to the NSW/Victorian border (NSW DPI, 2005). Taking this into consideration, it is considered unlikely that the project would lead to a long-term decrease in the size of any important population of the species such that the local population of the species would be placed at risk of extinction.

Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?

Silver Perch are found in the Murray-Darling River System (NSW DPI, 2005). Silver perch are now successfully bred for aquaculture, conservation and to enhance recreational fishing, and large numbers have been stocked into impoundments and smaller numbers into rivers in the Murray-Darling Basin. However, in most cases stocking of silver perch has not managed to establish reproducing populations, and they remain threatened in the wild (NSW DPI, 2005). The Murray-Darling contains approximately 13,245 km of waterways that may encompass suitable habitat for this species. However, tremendous pressure has been placed on rivers in the Murray-Darling Basin as a result of river regulation, flood mitigation works, drainage of wetlands, water extraction for consumptive uses, intensive agricultural practices involving the use of fertilisers, pesticides and cultivation, widespread land clearing, the introduction of exotic species (e.g. carp) and rising populations in regional centres (NSW DPI, 2006).

Due to the distance of the project area from the natural distribution of the Silver Perch, unsuccessful stocking of viable populations outside of these areas, and lack of records from the locality, it is considered unlikely that the project would reduce the area of occupancy of any important population of the species.

Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?

The closest records of the Silver Perch to the project area, includes one record from Angourie South Pool in Yamba (> 20km north-east of Grafton), and two records from the Nymboida River (>20km south-west of Grafton). There are no historical records of this species from the Clarence River (NSW DPI, 2014).

Furthermore, given lack of an existing population within the project area, and that the footprint of the proposed works is located within the Clarence River channel where this species has not been historically recorded, on top of the fact that Silver Perch would be more likely to occupy suitable habitat in other creeks

within the project area including Carrs Creek, Alipou Creek and Cowan Creek, it is thus considered unlikely that the project would fragment an existing important population into two or more populations.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

Not applicable. No Critical habitat is listed on the register of Critical Habitat kept by the Chief Executive, OEH or DII within the project area. To date, no critical habitat has been declared for either of these species.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?

Individuals mature at 3 to 5 years - males at 3 years (~25cm length) earlier than females at 5 years (~29 centimeters length). They spawn in spring and summer after an upstream migration, when large schools often form. The Silver Perch is known to undertake upstream migrations in spring/summer, prior to spawning, and juveniles are known to move in response to slightly elevated water levels and rising water temperatures. This species does not reproduce until the water temperature reaches 23 degrees Celsius (NSW DPI, 2005). Females shed 300,000 or more semi-buoyant eggs that develop into free-feeding stages that drift downstream (Astles et al, 2003). Whilst spawning can occur during non-flood conditions, spawning activity can significantly increase during floods and/or environmental water releases.

The proposed bridge upgrade is unlikely to impede fish passage to a greater extent than the existing bridge and the majority of impacts to aquatic fauna are considered to be short term and predominantly during the construction period. Furthermore, no areas of known habitat for the Murray Cod would be disturbed, and therefore there should be no disruption to the breeding cycle of an important population of the species.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

Silver Perch have been found in a wide range of habitats and climates across the Murray-Darling Basin, from the cool, clear, gravel-bed streams of the upper reaches to the lower, slow flowing, turbid rivers of the west and north, and are also known to occur in lakes and reservoirs (NSW DPI, 2005). The proposed Grafton bridge upgrade would require the development of in-stream structures and associated infrastructure crossing the Clarence River as part of the project. The proposed works will cause some intermediate disturbance to the river bed and associated riparian vegetation on the banks of the Clarence River. However due to the lack of records of this species within the locality, some temporary disturbance to the Clarence River within the alignment is not considered likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered or critically endangered species becoming established in the endangered or critically endangered species' habitat?

A number of non-native species have been introduced into NSW waterways, both deliberately and accidentally, and at least eleven of these have established self-sustaining populations. Introduced species can impact on native species and freshwater ecosystems through predation (particularly on eggs and larvae); competition for habitat and food resources; habitat degradation; spread of diseases and parasites; and in some cases, hybridisation.

The introduced fish species that may have played a part in the decline of silver perch include:

- Carp *Cyprinus carpio*

First released into inland rivers in the 1870s, carp began to spread rapidly in the early 1970s and are now widespread and abundant in most of the Murray-Darling Basin. They can comprise up to 90% of the fish population in some areas. Carp have destructive feeding habits and are widely blamed for increasing water turbidity and siltation, reducing the amount and diversity of aquatic plants, increasing nutrient levels and the incidence of algal blooms, and causing erosion of streambanks, although it is difficult to separate the impacts of carp from other causes of habitat degradation (MDBC 2000, Clunie & Koehn 2001a).

There is no direct evidence that carp have caused a decline in any native fish species within the Murray-Darling Basin, and many species – including silver perch – had experienced well documented declines before carp became widespread. It is unlikely that carp directly prey on Silver perch, since they mainly consume benthic invertebrates, but they may have affected the species by damaging aquatic habitats and/or competing for resources.

- Redfin perch *Perca fluviatilis*

Redfin were introduced into Australia well over a century ago and now occur across much of the Murray-Darling Basin, except warmer waters in parts of northern NSW and Queensland (Weatherley 1963). There is little direct evidence of the effects of redfin on silver perch, and in fact there are some areas where silver perch have declined although redfin are not present (Clunie & Koehn 2001a). Nonetheless, redfin are known to prey on fish and are likely to consume juveniles, larvae and eggs of silver perch as well as other species. Reduced survival of juvenile silver perch has been recorded in impoundments containing redfin (Harris et al. unpubl. data cited in Faragher & Lintermans 1997). Redfin are also known carriers of epizootic haematopoietic necrosis virus (EHNV), to which silver perch are susceptible (see below).

- Gambusia *Gambusia holbrooki*

Gambusia were actively introduced into the wild in Australia, particularly in the early part of the 20th century, to control mosquitos. They can reproduce rapidly and are often abundant in warm and slow flowing waters, especially along the margins near aquatic vegetation (McDowall 1996).

Being a small fish, the main impacts of Gambusia are by eating eggs and juveniles and attacking and nipping the fins of larger fish (e.g. Lloyd 1990, McKay et al. 2001). They are unlikely to have contributed significantly to the decline of silver perch, although in areas where they are abundant they may pose a threat by preying on eggs, larvae and juveniles.

However, given the existing disturbed nature of the project area, and the lack of observations of Silver Perch in the locality, it is considered unlikely that the project would result in invasive species that are harmful to the species becoming established in the species habitat.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

The main pathogenic concern for the Silver perch is the introduction of exotic diseases by invasive fish species. Of particular concern is the EHN virus which is carried by Redfin Perch, and the Silver perch is particularly susceptible to. Other diseases that pose a risk to the species include:

- Epizootic Haematopoietic Necrosis virus (EHNV)
- Viral Encephalopathy and Retinopathy (VER)
- Goldfish Ulcer Disease (GUD)
- Asian Fish Tapeworm *Bothriocephalus acheilognathis*
- Parasitic copepod Anchorworm *Lernaea cyprinacea*

It is unlikely however, that works associated with the proposed development route would result in any of these diseases being introduced to the project area, that would in turn cause the species to decline.

Is there a real chance or a possibility that the action will interfere with the recovery of the species?

The Recovery Plan specifies those specific objectives required to prevent the extinction and ensure the recovery of the Silver perch populations in NSW (NSW DPI, 2005). The proposed development is considered to be generally consistent with the plan and objectives of this program. However, those actions that are considered to be relevant to the project, include:

- Ensure that management authorities carry out appropriate planning and impact assessment and make management decisions which minimise impacts on Silver Perch habitats.
- Encourage protection and rehabilitation of river reaches known to support important Silver Perch populations.

The project is considered to be consistent with the priority actions listed within the recovery plan.

Furthermore, given the lack of records of the species from within the locality, and given aquatic mitigation measures are adopted, the project is not considered to have a real chance or possibility of interfering with the recovery of the species.

Conclusion

The significant impact criteria assessment concludes that the project is not likely to significantly impact on the Silver perch. As such, a referral to the Minister is not required for this species. A number of management measures are recommended in Section 6 of this report to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

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Migratory species: Cattle egret (*Ardea ibis*), White-bellied sea eagle (*Haliaeetus leucogaster*), Rainbow bee-eater (*Merops ornatus*), Clamorous reed-warbler (*Acrocephalus stentoreus*) and Common tern (*Sterna hirundo*)

Is there a real chance or possibility that the action will substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?

The **Cattle egret** (Migratory, EPBC Act) occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It has been recorded on earthen dam walls and ploughed fields. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation (DoE, 2013).

The **White-bellied sea eagle** (Migratory, EPBC Act) is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, and the sea). Birds have been recorded in (or flying over) a variety of terrestrial habitats (DoE, 2013).

The **Rainbow bee-eater** (Migratory, EPBC Act) occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches (DoE, 2013).

The **Clamorous reed-warbler** (Migratory, EPBC Act) inhabits reed beds and other dense vegetation near water. Flies low over water (Simpson and Day, 1999).

The **Common tern** (Migratory, EPBC Act) is marine, pelagic and coastal. In Australia, they are recorded in all marine zones, but are commonly observed in near-coastal waters, both on ocean beaches, platforms and headlands and in sheltered waters, such as bays, harbours and estuaries with muddy, sandy or rocky shores (DoE, 2013).

The project involves an additional bridge crossing of the Clarence River at Grafton, and associated infrastructure upgrades to street corridors (inclusive of, from north to south: Fitzroy St to Bent St, through Ryan St to Pacific Highway; and Dobie-Villiers St interchange). Therefore, it is considered that the construction phase of the project would result in some temporary disturbance to the terrestrial and aquatic environments within the project area. Furthermore, it is considered likely that the works associated with the project would result in subsequent significant changes in localised abiotic factors (i.e. shading, temperature, water flow and inundation etc.) in and around the project area. However, the final proposed strategic concept design alignment mostly utilises existing roadways and reserves in northern and southern Grafton, with some sections including previously undisturbed grazing paddocks and river banks. As such, due to the nature of the project, it is considered unlikely that the project would have a significant impact on any areas of habitat that would have the ability to seriously disrupt the lifecycle of an ecologically significant proportion of the population of any of these migratory species.

It is considered unlikely that there would be a real chance or possibility that the project would substantially modify, destroy or isolate an area of important habitat for any of these migratory species.

Is there a real chance or possibility that the action will result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?

The project involves construction works associated with the Grafton highway upgrade inclusive of the bridge crossing at the Clarence River, in Grafton. There is unlikely to be any possibility of invasive species being introduced to the surrounding terrestrial or marine environment as a result of the proposed works.

Is there a real chance or possibility that the action will seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?

The **Cattle egret** population in Australia, New Guinea and New Zealand is estimated to be around 100,000 birds. East coast colonies operate in a well defined period from October to January, occasionally extending by a month either side. This species breeds colonially and are known to breed in urban areas, which mean that a significant proportion of the population can be present in breeding colonies. The species feeds mostly on grasshoppers during the breeding season. It is, however, known to consume other insects including cicadas, centipedes, spiders, cattle ticks, frogs (including cane toads), lizards (particularly skinks) and small mammals. In Australia the Cattle Egret is a partial migrant; some of the population migrates to New Zealand, while the remainder migrates locally. The birds migrate from breeding colonies in south-east Queensland and north-east NSW to spend winter in either south-east Australia or New Zealand (DoE, 2013). A Cattle egret breeding colony was recorded by Biosis ecologists in Grafton (located between Prince and North Streets, in Grafton) (refer to Figure 7 of Biosis, 2010). However, it should be noted that the finalised route option does bypass this colony. Given the high degree of tolerance of human presence and activities exhibited by the species, it is considered unlikely that any indirect impacts associated with works occurring in proximity to the colony would be significant.

The **White-bellied sea eagle** population is estimated at more than 500 pairs, in Australia. In south-eastern Australia alone is estimated to be 410 – 430 pairs. The species first breeds at approximately six years old. Although the mortality rate is high amongst newly-independent birds, if juveniles survive to breeding age they may live for up to 30 years. The species breeds in solitary and monogamous pairs that mate for life. However, if one member of the pair dies, it is quickly replaced. The species feeds opportunistically on a variety of fish, birds, reptiles, mammals and crustaceans, and on carrion and offal. White-bellied sea eagles are described as a breeding resident throughout much of its range in Australia. Breeding adult birds are generally sedentary, although they forage over large areas and are capable of undertaking long-distance movements (DoE, 2013).

The total population size of the **Rainbow bee-eater** in Australia has not been estimated. However, the population size is assumed to be reasonably large based on reporting rates for the species (i.e. the Atlas of Australian Birds has received more than 30 000 records of the Rainbow Bee-eater since 1998. Based on the maximum interval between banding and re-sighting dates for individual birds, the Rainbow Bee-eater is capable of living for up to 24 months in the wild. The species breeds in socially monogamous pairs that are sometimes assisted by a varying number of auxiliary birds or 'helpers' that are usually male. The nests are typically concentrated together in loose colonies, although in some instances pairs would nest solitarily. The Rainbow Bee-eater mainly feeds on insects, and would occasionally take other prey items including earthworms, spiders, and tadpoles. The movement patterns of the Rainbow Bee-eater are complex, and are not fully understood. Populations that breed in southern Australia are migratory. After breeding, they move north and remain there for the duration of the Australian winter (DoE, 2013).

The population size of the **Clamorous reed-warbler** has not been quantified, however is believed to be stable (Birdlife, 2013). The species breeds from September – December, building a deep cup nest of reed

sheaths, woven around reed stems and wouldow strands. The Clamorous reed-warbler eats insects. The species is widespread in eastern Australia, and to a lesser degree in Western Australia, and is also found from New Guinea to south-eastern Africa (Pizzey and Knight, 2006; Birdlife Australia).

The **Common tern** has a large global population, estimated to be 1,100,000–4,500,000 individuals. The species is a non-breeding migrant to Australia, where it is widespread and common on the eastern coast south to eastern Victoria, and common on parts of the northern coast, mainly east of Darwin. Common Terns are fairly opportunistic, with a diet predominantly of small fish (greater than or equal to 15 centimeters in length), though also often taking crustaceans or insects, and occasionally squid. The species rarely take other invertebrates. This species is strongly migratory, breeding in the northern hemisphere in the boreal spring-summer and migrating south to wintering areas in the Northern and Southern Hemispheres (DoE, 2013).

The construction phase of the project would result in some temporary disturbance to the surrounding terrestrial and aquatic environments within the project area. It is considered likely that the works associated with the project could result in subsequent changes in localised abiotic factors in and around the project area. However, it is considered unlikely that the project would have a significant impact on any areas of habitat that would have the ability to seriously disrupt the lifecycle of an ecologically significant proportion of the population of any of these migratory species.

Even so, a number of measures are proposed to mitigate the potential for any substantial changes to important habitat for these species (refer to Chapter 6). Furthermore, given the relatively small footprint, terrestrial nature, and distance of the species habitat from the project, it is considered unlikely that the project would seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the above-listed migratory species.

Conclusion

The significant impact criteria assessment concludes that the project is unlikely to significantly impact any of the aforementioned migratory species. A number of measures are recommended in Chapter 6, to mitigate the degree of impact to ensure that biodiversity values within the project area are maintained or improved.

References

- Biosis (2011) *Main Road 83 Summerland Way- Additional Crossing of the Clarence River at Grafton: Preliminary Route Options Report. Technical Paper: Ecology*. Report to Arup on behalf of the Roads and Maritime Services – Northern Regional Office
- Biosis (2013) Field surveys conducted as part of the Grafton Highway Upgrade Flora and Fauna Assessment. October, 2013. Biosis Pty Ltd
- Birdlife Australia (2013) Birdlife 'Find a bird' Database. Accessed online 1/11/2013 - <http://birdlife.org.au/all-about-birds/australias-birds/find-a-bird/>
- DoE (2013) Species Profile and Threats Database. Department of the Environment. Accessed online 1/11/2013 - <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>
- Pizzey, G and Knight, F (2006) *The Field Guide to the Birds of Australia*. Seventh Edition, edited by Menkhorst, P. Harper Collins Publishers, Sydney.
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Appendix 5: Targeted Survey: Three-toed Snake-tooth Skink

Additional Crossing of the Clarence River at Grafton
Targeted Threatened Species Survey –
Three-toed snake-tooth skink *Coeranoscincus reticulatus*

Prepared for Arup

30 May 2014



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1 Introduction

1.1 Background

Biosis Pty Ltd was commissioned by Arup to undertake a targeted threatened species survey for the Three-toed snake-tooth skink *Coeranoscincus reticulatus* (hereafter referred to as TTSTS) in order to support the flora and fauna assessment and broader EIS for the Additional Crossing of the Clarence at Grafton (the project).

In addition to the preliminary ecological surveys already undertaken by Biosis within the study area in 2010, 2012 and 2013, recent discussions between Biosis, Arup, Roads and Maritime Services (Roads and Maritime) and Commonwealth Department of the Environment (DoE) identified the need for additional surveys to be conducted within the project area targeting this species during the optimal survey period.

Targeted surveys were undertaken at a latter stage in the project as a result of the release of the Commonwealth *EPBC Act Survey guidelines for Australia's threatened reptiles* (DSEWPaC, published late 2011, after initial reptile targeted surveys, stipulating more detailed survey guideline requirements for this species, which were not set out in the preceding survey requirements guided by the Commonwealth *Action Plan for Australian Reptiles* (Cogger et al, 1993).

The following definitions apply to the project and are used throughout this document:

The **project area** encompasses the project during operation and construction, including:

- Operational road boundary.
- Permanent ancillary elements such as operational detention basin and pump station in Grafton.
- Construction work zone, which includes temporary facilities such as South Grafton ancillary site, Pound Street ancillary site and the jetty for barge launching.
- Flood mitigation works construction zone, which includes temporary stockpile areas.

The **study area** encompasses project area and any adjoining or adjacent area where potential indirect impacts may occur.

1.2 Scope of works

The scope of works for this study involved targeted surveys for TTSTS in line with relevant species survey guidelines to be undertaken during late spring, early summer within areas of suitable habitat within the project area and study area, inclusive of the following areas:

- Area S1 - ARTC land, South Grafton
- Area S2 - Alipou Creek site A & B, South Grafton
- Area S3 - Induna Reserve site A & B, South Grafton
- Area N1 - Clarence St Waterfront, North Grafton
- Area N2 - Villiers St Waterfront, North Grafton
- Area N3 - Mary St Waterfront, North Grafton

It should be noted that due to the nature of the project, a proportion of the project area was inaccessible to undertake surveys, due to access restrictions. For example a number of historical records for the TTSTS (Bionet,

2013) occur within the locality of the proposed ancillary sites, which is within privately owned residential blocks. Furthermore, a number of initially proposed survey sites were found to be subject to high pedestrian traffic, and trapping was not considered to be an appropriate approach to be undertaken in these public places due to the highly visible nature of the funnel trap and drift fence line configuration.

Suitable habitat survey sites for TTSTS were identified using information included within the following documents, including:

- Cogger, H.G., E.E. Cameron, R.A. Sadler & P. Eggler (1993). *The Action Plan for Australian Reptiles*. [Online]. Canberra, ACT: Australian Nature Conservation Agency
- DoE SPRAT (2013) Species Profile and Threats database – Three-toed snake-tooth skink *Coeranoscincus reticulatus*. Department of the Environment.
- DSEWPac (2011) *Survey guidelines for Australia's Threatened Reptiles*. Department of Sustainability, Environment, Water, Populations and Communities.

1.3 Objectives of the project

The objectives of the survey were to establish whether TTSTS was present within the project area, and if present, individuals were to be tagged using Visible Implant Elastomer (VIE) tags (NMT, 2013), and population densities and abundance data was to be collected.

The tasks of the project are identified as follows:

- Undertake a targeted threatened species survey for the TTSTS within the project area and or suitable adjoining habitat (study area).
- Determine the potential for the project area to provide habitat for the threatened species.
- Determine the potential impacts to the TTSTS within the project area, and identify potential mitigation measures.

Given the scope of works outlined above, and relevant species survey guidelines and requirements for TTSTS, this report documents the following:

- Background information
- Survey methodology
- Survey limitations
- Results of the field survey
- Survey conclusion

2 Background

2.1 Legislation

The TTSTS *Coeranoscincus reticulatus* is listed as Vulnerable under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and as Vulnerable under the Commonwealth *Environment Protection Biodiversity Act, 1999* (EPBC Act) (refer to Plate 1).

Plate 1 – Three-toed snake-tooth skink¹



2.2 Habitat and ecology

TTSTS habitat was originally considered to be restricted to dry rainforest, northern warm temperate rainforest, subtropical rainforest, grassy wet sclerophyll forest and shrubby sclerophyll forest. However, more recent records have shown that the species persists in fragmented habitats, and restored riparian vegetation (Duncan, 2009) indicating that the species has some adaptability to modified environments as a result of clearing (DoE SPRAT, 2013).

Furthermore, the common Three-toed skink *Saiphos equalis* was found beneath debris on the southern bank of the Clarence River during active searches conducted by zoologists in 2010 (Biosis, 2010). *S. equalis* and the TTSTS occur as sympatric species, and phylogenetic analysis of the two species showed that they exist as the closest sister taxa to each other (Reeder, 2003).

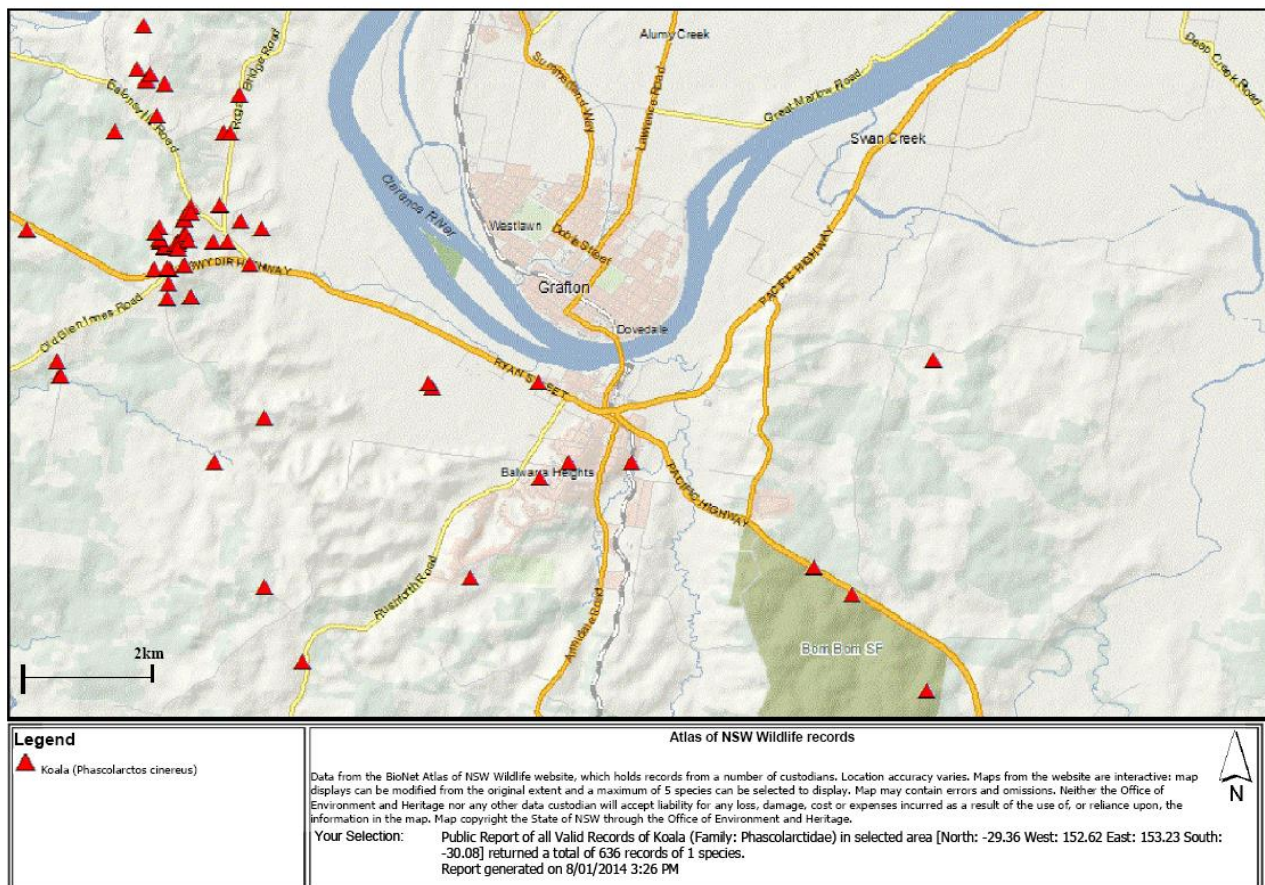
2.3 Species distribution

¹ © Stewart Macdonald (Arkive, 2013)

In NSW, there appears to be three distinct sub-populations of the TTSTS. The species is known from as far south as the Macleay Valley and Crescent Head, although it is considered very rare south of Grafton (NSW OEH 2013c). Collections have been made from the Clarence River valley, Tweed River valley, Richmond Range, Beauriy State Forest (SF), Koreelah SF, Whian Whian SF, Grafton, Grady's Creek Flora Reserve, Wiangaree SF, Yabbara SF and Mt Lion Road near the Queensland border (DoE, 2013).

Figure 1 shows the locality of historical records of the species in Grafton (NSW OEH Bionet, 2013).

Figure 1 - Known records of the Three-toed snake tooth skink



2.4 Correspondence

In order to glean further information in relation to known records of the TTSTS in Grafton, a number of contacts were established to source species specific information in regards to the TTSTS. Information used to guide the survey was collected by continual liaison with a range of stakeholders, including consultant ecologists, government officers, community groups and local landowners, including:

- Robert Spiers, Senior Ecologist, Biosis.
- James Hammond, Threatened Species Officer Commonwealth Department of the Environment (DoE).
- Dr Grey Clancy, Ecologist, Clarence Valley.
- Colleen Turnbull, Animal Ethics Committee (AEC).
- Susan Moore, Clarence Valley Landcare Group.

3 Methodology

3.1 Field Survey

The Biosis field survey effort was conducted under the authority of a current NSW *National Parks and Wildlife Act, 1974* Scientific Licence (S10318) to harm/trap/pick/hold/study protected fauna and native flora, and a current Animal Research Authority (ARA) (issued under the NSW *Animal Research Act, 1985* Certificate of Approval by the Animal Ethics Committee (AEC) of the Director-General of NSW Agriculture to conduct fauna survey work carried out as part of Environmental Impact Statements, Species Impact Statements and general wildlife research.

A variation request to our ARA protocol was submitted to undertake VIE tagging and/ or UV fluorescent tattooing for the TTSTS, and was approved by the AEC prior to undertaking the survey on 3/12/2013 (TRIM 11/355).

The recommended survey effort included targeted survey for the TTSTS involving the deployment of funnel traps accompanied by drift fence lines, and active searches conducted within areas of potentially suitable habitat within the project area.

3.1.2 Survey effort and timing

A four night/ five day targeted TTSTS survey was undertaken during early summer within the study area, inclusive of December 9 – 13, 2013. The targeted survey was guided by the Commonwealth EPBC Act *Survey Guidelines for Australia's Threatened Reptiles* (DSEWPoC, 2011), NSW *Threatened Biodiversity and Assessment Guidelines* (DEC, 2004), in addition to the Department of the Environment's (DoE) Species Profile and Threats Database (SPRAT) and Commonwealth Approved Conservation Advice for the species (TSSC, 2008).

3.1.3 Weather conditions

Local weather conditions for Grafton were documented on a daily basis, throughout the week of the survey, and precipitation events were made note of, given the species is considered to be occasionally active on the surface at night, particularly after periods of rain (Swanson, 2007).

3.1.4 Survey sites

A site reconnaissance was undertaken on the 9 December, 2013 to identify suitable TTSTS survey sites within the study area. Survey sites were chosen based predominately on land permissibility and accessibility, and the presence of potentially suitable TTSTS habitat and key habitat features. The following key habitat features were taken in to consideration when identifying suitable survey sites, including:

- Vegetation composition and structure,
- Habitat features, including rocky outcrops, coarse woody debris (CWD), and leaf litter.

Survey sites were also selected as to avoid impacts from pedestrian traffic on site, edge effects, and particularly disturbed or degraded locations.

3.1.5 Survey methods

The targeted survey included the following survey methodology, including:

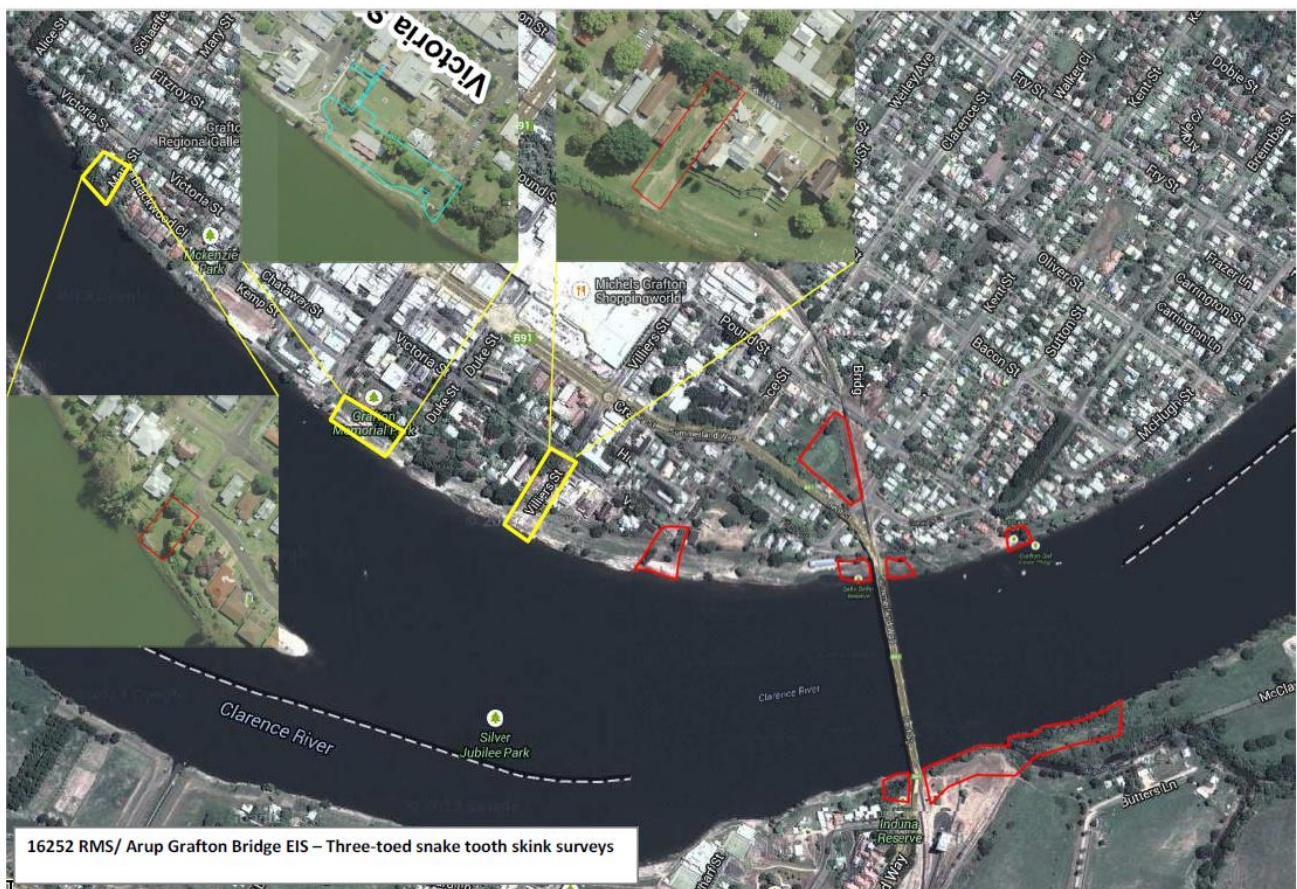
- The deployment of a total of 24 funnel traps at six sites within the study area (refer to Figure 2). With 16 funnel traps set in the south, and eight in the north. Funnel traps were paired and set along a drift fence line of three metres (m) in length in south Grafton. In north Grafton, due to the nature of the available survey sites, funnel traps were set without drift fence lines to reduce visibility and detectability by the public.

- Active searches implicating rock lifting, log rolling and raking in suitable habitat within the project area, and greater Grafton area.

3.2 Survey limitations

Surveys were undertaken during the optimal survey period recommended for the species (late summer, early spring). Surveys aimed to cover as much ground as possible during the survey period. However, given the accessibility restrictions associated with some areas of the study area, funnel trapping (with drift fences) were unable to be deployed across the entire study area. Rather, funnel trapping (with drift fences) were set at a series of survey sites where site access was permissible within the study area, and taking into consideration the provision of potential suitable habitat for the species.

Figure 2 – Survey locations



4 Results

4.1 Field survey

4.1.2 Survey effort and timing

A total survey effort of 96 trap nights was undertaken targeting TTSTS through the deployment of 24 funnel traps within the study area, over a four night/ five day period. An additional six hours were expended by one ecologist undertaking active searches throughout areas of suitable TTSTS habitat (refer to Table 1). As such, the recommended survey guidelines for this species were successfully met. In addition to the targeted survey effort undertaken, a number of incidental observations were recorded within the study area.

Table 1 - Summary of fauna survey effort

Fauna Group	Technique	Survey effort	Total effort
Reptiles	Active reptile searches	6 person hours	6 person hours
	Funnel traps with drift fences	4 trap nights	96 trap nights

The total survey effort for TTSTS for this project, showing effort expended for each field survey is compiled below, in Table 2.

Table 2 - Total survey effort for TTSTS

Dates	Survey method	Person hours
August 9 – 11, 2010	- Active reptile searches	6 person hours
February 7 – 8, 2012	- Active reptile searches	6 person hours
December 9 – 13, 2013	- Active reptile searches	6 person hours
	- Funnel traps with drift fences	96 trap nights
Total Effort		18 person hours
		96 trap nights

No TTSTS were found within the study area during Biosis surveys. However, a number of incidental species were recorded during the targeted threatened species survey, of which the results are provided in Table 4, of Appendix A.

4.1.3 Weather conditions

The local weather conditions for the targeted survey were on average around 30°C and calm, with varying degrees of cloud cover and precipitation. The most unusual weather condition recorded during the survey week was a midweek hailstorm on the Wednesday evening. This weather event was favorable for the this survey, taking into consideration the cryptic nature of the TTSTS, which is known to be more active at nights following periods of rain (Swanson, 2007).

Weather conditions for Grafton were recorded during the survey week, with average temperatures calculated and tabulated in Table 3 below, adopted from the Commonwealth Bureau of Meteorology (BOM) Daily Weather Observations for Grafton for the month of December, 2013.

Table 3 – Weather Conditions

**Grafton, New South Wales
December 2013 Daily Weather Observations**

Most observations from Grafton, but some from Grafton Airport.



Australian Government
Bureau of Meteorology

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9am					3pm						
		Min	Max				Dirn	Spd	Time	Temp	RH	Cld	Dirn	Spd	MSLP	Temp	RH	Cld	Dirn	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	Su		24.8	0.6			SSE	44	13:10	20.5	65	3	S	19	1023.2				SSE	19	1022.5
2	Mo	16.9	26.7	0			ESE	35	16:33	20.8	65	3	SSW	15	1021.9				SE	19	1018.2
3	Tu	14.5	26.8	0			SE	33	14:30	21.5	62	2	SW	13	1017.3				E	17	1013.9
4	We	16.6	30.8	0			NNE	33	13:09	21.9	67	0	N	13	1011.6				NNE	20	1005.4
5	Th	20.0	32.4	0			WSW	52	17:38	25.1	70	7	N	13	1000.8				NW	17	997.2
6	Fr	12.2	26.3	0			SE	37	16:19	19.6	36	1	WSW	9	1013.5				ESE	20	1012.5
7	Sa	11.2	27.6	0			NE	35	15:45	18.3	69	0	W	4	1021.2				NNE	13	1017.5
8	Su	14.0	28.6	0			ENE	35	15:00	20.6	66	3	E	4	1019.9				NNE	17	1015.4
9	Mo	16.2	31.5	0			NE	35	13:41	21.7	78	3	NNE	11	1014.6				NE	22	1008.8
10	Tu	19.6	26.5	0.1			WSW	44	19:09	22.3	77	8	NNE	11	1009.1				N	11	1006.1
11	We	19.1	30.6	0.3			SE	39	13:58	23.1	77	6		Calm	1008.7				SE	20	1005.3
12	Th	19.6	28.3	24.2			SE	31	15:42	23.5	85	7	WSW	9	1009.0				SE	17	1008.5
13	Fr	18.3	29.6	0.1			E	30	14:44	24.0	98	4		Calm	1013.2				ESE	20	1011.1
14	Sa	19.2	31.0	0			E	37	13:53	23.5	80	3	N	9	1014.4				ENE	26	1011.0
15	Su	19.6	29.0	12.6			E	30	14:30	23.6	79	4	NNW	7	1016.9				ESE	19	1014.8
16	Mo	19.5	25.5	2.6			SSE	28	10:59	24.0	75	5	SE	11	1019.3				E	15	1018.0
17	Tu	19.4	27.5	1.6			E	35	13:45	22.2	74	5	SSE	15	1020.9				ESE	19	1019.6
18	We	16.4	27.4	0			E	35	14:23	23.5	73	3	SE	7	1022.8				E	19	1021.6
19	Th	16.5	28.1	0			N	28	12:06	23.1	83	3	SE	9	1023.7				NE	13	1020.8
20	Fr	15.6		0						21.9	75	1	N	7	1021.2						
Statistics for the first 20 days of December 2013																					
Mean		17.1	28.4							22.2	72	3		9	1016.2					18	1013.1
Lowest		11.2	24.8							18.3	36	0		Calm	1000.8				N	11	997.2
Highest		20.0	32.4	24.2			WSW	52		25.1	98	8	S	19	1023.7				ENE	26	1022.5
Total				42.1																	

4.1.4 Survey sites

Survey sites in south Grafton were largely associated with the Freshwater Wetlands on Coastal Floodplains (FWCF) threatened ecological community (TEC) found on the banks of the Clarence River, and supported by dense canopy vegetation adjacent to the banks including thickets of Small-leaved privet *Ligustrum sinense*, Camphor laurel *Cinnamomum camphora*, Wild bush lemon *Citrus limonia*, Rubber vine *Cryptostegia grandiflora*, and Lantana *Lantana camara*. Some large deposits of CWD were evident at these sites, with remnant stumps and stags were also observed to be scattered close to the banks of the Clarence River, containing hollows, splits, fissures and cracks of various sizes, providing potential suitable habitat for a range of small mammals, birds and reptiles.

Survey sites in north Grafton were largely impacted by the urban sprawl and development associated with the town centre. The sites consisted of highly modified parkland environments, dominated by exotic grasslands subjected to regular mowing. In these areas, the banks of Clarence River support little floristic diversity in riparian vegetation, lined mainly with *Phragmites australis*. As such, these areas support very little in way of habitat resources (i.e. no rocky outcrops, or deposits of coarse woody debris). However, it should be noted that higher quality habitat for terrestrial fauna is present in the surrounding areas, mainly in privately owned lands adjacent to these sites (i.e. residential dwellings).

Plate 2 –Induna Reserve (Area S3), South Grafton



5 Discussion and conclusions

5.1 Conclusions

Biosis completed a targeted survey for the TTSTS within the study area to meet the Commonwealth survey requirement guidelines for the species as part of the environmental assessment approval process for the proposed Grafton bridge upgrade.

The survey was undertaken within areas of suitable habitat for the species, based on known habitat requirements for the species as documented in available scientific literature. Biosis' survey effort was considered to have adequately met survey requirements for the species as outlined in the Commonwealth *EPBC Act Survey guidelines for Australia's threatened reptiles* (DSEWPaC, 2011). The survey effort was also informed by expert guidance throughout the survey, from:

- Robert Spiers, Senior Ecologist, Biosis.
- James Hammond, Threatened Species Officer Commonwealth Department of the Environment (DtE).
- Dr Grey Clancy, Ecologist, Clarence Valley.
- Colleen Turnbull, Animal Ethics Committee (AEC).
- Susan Moore, Clarence Valley Landcare Group.

No TTSTS were identified within the areas of the study area that were granted access to survey. However, there still remains some potential for this species to be found in the project area, especially in areas where access was not possible due to land ownership issues, and the contentious nature of the project. There is also some uncertainty surrounding the species potential to persist in this area, which is difficult to ascertain given the highly cryptic nature of the species. This is further supported by acknowledging the details related to the historical records of this species obtained from the NSW OEH Wildlife Atlas and subsequent discussions with field experts, where one of the records was come across by chance, as a result of the excavation of a driveway in Grafton; while the other record was made as a post-mortem identification by National Parks and Wildlife Services (NPWS) as a result of finding an individual that had drowned in a Grafton pool.

In conclusion, pre-clearance field surveys targeting this species are recommended to be conducted in areas associated with the ancillary sites, and associated areas subject to excavation activities.

6 References

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7 Appendices

Table 4 – Species list

Common name	Scientific name
<u>Reptilia</u>	
Eastern water dragon	<i>Physignathus lesueurii</i>
Garden sun-skink	<i>Lampropholis delicata</i>
Grass sun-skink	<i>Lampropholis guichenoti</i>
Red-bellied black snake	<i>Pseudechis porphyriacus</i>

Plate 3 – Eastern water dragon *Physignathus lesueurii* caught in Funnel trap

